DOES SOCIAL SECURITY PRIVATIZATION PRODUCE EFFICIENCY GAINS?

Shinichi Nishiyama

Congressional Budget Office
Washington, DC
E-mail: shinichi.nishiyama@cbo.gov

Kent Smetters

University of Pennsylvania & NBER
Philadelphia, PA
E-mail: smetters@wharton.upenn.edu

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Abstract

While privatizing Social Security would not produce Pareto efficiency gains or losses in a deterministic economy with labor taxes and inelastic labor supply, the presence of elastic labor supply and uncertainty changes matters considerably. On one hand, privatization could reduce the effective tax rate on labor supply even if all policy instruments are second best. On the other hand, privatization could reduce valuable risk sharing when households face uninsurable wage shocks or uninsurable longevity uncertainty. Determining the overall change in efficiency requires the use of simulation analysis.

We investigate these competing effects using a heterogeneous overlapping-generations (OLG) model in which agents with elastic labor supply face idiosyncratic earnings shocks and longevity uncertainty. We find that a stylized privatization can have a very powerful effect on labor supply incentives: When wages and longevity are insurable, privatization can produce new resources of roughly \$150,000 per each future household (growth adjusted over time), that is, after all households in the short run that would otherwise lose from reform have been fully compensated. Even if private annuity markets do not exist, privatization can produce over \$120,000 in new resources for each future household. However, when wages are not insurable, a stylized complete privatization *reduces* efficiency—by roughly \$100,000 per future household—despite the improved labor supply incentives even with perfect private annuity markets. (The losses increase to over \$110,000 per future household if private annuity markets do not exist.) This loss is reduced to under \$40,000 if privatization is gradually phased-in and some risk sharing is introduced into the privatized system by subsidizing wage contributions on a progressive basis and paying for the subsidy by increasing general revenue income taxes in a proportional manner.

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1 Introduction

It has been known for some time that shutting down ("privatizing") a pay-as-you-go Social Security system would simply reallocate resources between generations when all economic variables are fully deterministic, government revenue is financed by labor taxes, and labor supply is inelastic (see, e.g., Breyer, 1989; Geanakoplos, Mitchell and Zeldes, 1998; Murphy and Welch, 1998; Mariger, 1999; Shiller, 1999; Diamond and Orszag, 2003). In particular, no new resources would be created in present value once the "winners" have fully compensated the "losers." As a result, analysis about privatization in this model setting necessarily focuses on distributional fairness and not on the potential for improving Pareto economic efficiency.

The intuition for this zero-sum result is not widely appreciated since other fiscal reforms, such as removing a capital income tax, could produce efficiency gains in a deterministic economy with inelastic labor supply. Like a capital income tax, a pay-as-you-go Social Security program might substantially "crowd out" capital saving (Feldstein, 1974). But, unlike a capital income tax, a pay-as-you-go Social Security system financed by labor income taxes does not directly distort the relative price of consumption over the lifecycle. Shutting down Social Security would increase the returns on saving earned by the young and future generations who, under Social Security, are required to pay off the implicit debt inherited from previous generations who received more in present value than they contributed. But the gains to young and future generations from privatization would come at an equal cost (in present value) to the initial elderly. Compensating the initial elderly for their loses, therefore, would simply undo the privatization experiment without changing relative prices.

Allowing for elastic labor supply and various sources of uncertainty that cannot be easily insured in the private market, however, can change the potential for efficiency gains considerably. In this richer environment, privatization can lead to either efficiency gains or even losses.

1.1 Elastic Labor Supply

With elastic labor supply, privatization could produce large efficiency gains by reducing the effective tax rate on labor supply. Social Security payroll taxes are distortionary because each extra dollar contributed to Social Security does not produce an extra dollar in benefits in present value. Instead, some of the contributions are effectively used to pay off the implicit debt inherited from past generations who received more than they contributed. Moreover, the Social Security program in the U.S. is progressive in the sense that it gives households with a low average index of monthly wages (AIME) a larger Social Security benefit *relative* to the AIME (i.e., a larger "replacement rate"). Contributions by households with higher-than average lifetime earnings, therefore, are effectively used to subsidize the contributions by households with lower-than average lifetime earnings.

If the losers (the initial elderly) from privatization can be assumed to be compensated with first-best (lump sum) transfers by levying first-best taxes on the winners (young and future generations), privatization can obviously produce efficiency gains by removing the distortions to labor supply. The assumption of first-best compensation is implicit in the traditional welfare analysis of Hicks (1943, 1944-5) and Harberger (1974), which has been rigorously extended to the overlapping generations environment by Auerbach and Koltlikoff (1987). We further extend the method developed by Auerbach and Kotlikoff to an environment with stochastic wages and uncertain longevity.

A point that is less obvious, however, is that, in a model in which agents are allowed to live *three* or more periods, shutting down Social Security could produce efficiency gains even if the losers were compensated by levying second-best (labor income) taxes on the winners.[1] In particular, in a model in which agents work the first two periods of life and retire the third period, shutting down Social Security would "default" on both the Social Security benefits owed to initial third-period agents *and* the benefits accrued to date by second-period workers. The "default" to third-period agents, of course, does not produce efficiency gains itself since they must be compensated for their losses using second-best taxes levied on workers. But the

[1] The distinction between first-best and second-best compensation is not important for revenue-neutral policy changes such as fundamental tax reform (e.g., Nishiyama and Smetters, 2003). The interpretation of efficiency changes, however, becomes more important for other experiments which are not revenue neutral.

"default" on benefits accrued by second-period workers can produce efficiency gains because this implicit lump sum "wealth levy" is used to finance part of the higher rate of return that they will earn on their second-period contributions after privatization, thereby reducing the effective tax rate on labor (Smetters, 2004).

1.2 Uninsurable Shocks

The progressive nature of the U.S. Social Security system effectively provides insurance against wage shocks.[2] Since these shocks are typically difficult to insure in the private market, privatization could reduce a valuable source of risk sharing unless the privatized system is complementary with some other form of risk sharing such as matching contributions on a progressive basis. We consider a contribution match later in the paper.

Social Security also pays benefits until the beneficiary and spouse dies rather than over a fixed number of years. To the extent that longevity uncertainty is difficult to insure in the private market, privatization could also reduce risk sharing by eliminating a valuable source of annuity protection. However, the best evidence suggests that private annuities are close to being actuarially fair (Brown, et al, 2001) and so, to be conservative, the bulk of our analysis will focus on the case in which the private annuity market is operative.

1.3 Summary of Net Effects

Determining the overall change in efficiency requires the use of simulation analysis. We investigate these competing effects using a heterogeneous overlapping-generations (OLG) model in which agents with elastic labor supply face idiosyncratic earnings shocks and longevity uncertainty.

We find that a stylized privatization can have a very powerful effect on labor supply incentives: When wages and longevity are insurable, privatization can produce new resources

[2]The value of Social Security in insuring earnings and longevity shocks that are difficult to insure in the private market has been investigated by Imrohoroglu, Imrohoroglu, and Joines (1995) and Conesa and Krueger (1999). Imrohoroglu et al. focus on steady states and find that the risk sharing benefit is outweighed by the crowding out of capital when the Social Security system is unfunded. Conesa and Krueger consider a voting model that includes the effect of Social Security reform on transitional generations. Consistent with previous deterministic models, they find that the losses from privatization to voting transitional generations might explain why a pay-as-you-go system is politically stable even though the newborns are better off; the loss in risk sharing serves as another reason for the political stability. In our analysis, we find that privatization may not, in fact, produce efficiency gains when the transitional generations are fully compensated.

equal to \$150,000 per each future household (growth adjusted over time), that is, after all households in the short run that would otherwise lose from reform have been fully compensated. Even if private annuity markets do not exist, privatization can produce over \$120,000 in new resources for each future household. However, when wages are not insurable, privatization *reduces* efficiency – by as much as \$95,000 per future household – despite the improved labor supply incentives even with perfect private annuity markets. (The losses increase to over \$110,000 per future household if private annuity markets do not exist.) This loss is reduced to about \$40,000 if privatization is gradually phased-in and some risk sharing is introduced into the privatized system by subsidizing wage contributions on a progressive basis and paying for the subsidy by increasing general revenue income taxes in a proportional manner.

1.4 Outline

The rest of the paper is laid out as follows: Section 2 describes the model, Section 3 explains the calibration of the model, Section 4 and Section 5 explain the policy experiments of Social Security privatization, and Section 6 concludes the paper.

2 Model

The model we use to analyze tax reform has three sectors: heterogeneous households with elastic labor supply; a competitive representative firm with constant-returns-to-scale production technology; and a government with a full commitment technology. Like most previous analyses of Social Security reform, our model's pre-reform neoclassical economy is stationary by construction, and so we don't capture the effects that projected demographic changes might have on factor prices in the baseline economy in the closed economy version of our model.[3] We, however, are only interested in comparing the efficiency of gains from privatization against the baseline, not examining the implications of demographics on factor prices in the baseline economy.

[3] We are aware of only two papers, De Nardi, Imrohoroglu and Sargent (1999) and Kotlikoff, Smetters and Walliser (2001), that attempt to capture the effect of non-stationary demographics on baseline factor prices.

2.1 The Household Sector

Households are heterogeneous with respect to ages i, working abilities e_i (measured by their hourly wages), beginning-of-period wealth holdings a_i, and average historical earnings b_i that determine their Social Security benefits. Every year, a large number (normalized to unity) of new households of age 20 enter the economy. The population of this economy grows at a constant rate of ν. A household of age i observes an idiosyncratic working ability shock, e_i, at the beginning of each year and chooses its optimal consumption c_i, working hours h_i, and end-of-period wealth holding a_{i+1}, taking the government's policy rule and series of factor prices and the government's policy variables as given.[4] At the end of each year, a fraction of households die based on the mortality tables. The model assumes that no one lives longer than 110 years. For simplicity, all households are assumed to be two-earner married couples of the same age.

2.1.1 The Household's Problem

Let $\mathbf{s}_i$ denote the state of an age i household,

$$\mathbf{s}_i = (i, e_i, a_i, b_i), \tag{1}$$

where $i \in I = \{20, ..., 109\}$ is the household's age, $e_i \in E = [e^{\min}, e^{\max}]$ is its working ability (the hourly wage), $a_i \in A = [a^{\min}, a^{\max}]$ is its beginning-of-period wealth, and $b_i \in B = [b^{\min}, b^{\max}]$ is its average historical earnings for Social Security purposes.[5]

Let $\mathbf{S}_t$ denote the state of the economy at the beginning of year t,

$$\mathbf{S}_t = (x_t(\mathbf{s}_i), W_{R,t}, W_{G,t}), \tag{2}$$

where $x_t(\mathbf{s}_i)$ is the joint distribution of households with $\mathbf{s}_i \in I \times E \times A \times B$, $W_{R,t}$ is the beginning-of-period net wealth held by the Lump-Sum Redistribution Authority (LSRA), which is described below, and $W_{G,t}$ is the net wealth of the rest of the government.

[4]Because there are no aggregate shocks in the present model, households can perfectly foresee these factor prices and policy variables, using the current distribution of households and the current policy variables. Yet, their own future working ability and mortality are uncertain.

[5]The average historical earnings are used to calculate the Social Security benefits of each household. The variable b_i approximates the average indexed monthly earnings (AIME) multiplied by 12 as of age i.

Let $\mathbf{\Psi}_t$ denote the government policy schedule known at the beginning of year t,[6]

$$\mathbf{\Psi}_t = \{W_{R,s+1}, W_{G,s+1}, C_{G,s}, tr_{LS,s}, \tau_{I,s}(.), \tau_{P,s}(.), tr_{SS,s}(\mathbf{s}_i), tr_{R,s}(\mathbf{s}_i)\}_{s=t}^{\infty}, \quad (3)$$

where $C_{G,s}$ is government consumption, $tr_{LS,s}$ is lump-sum transfers (lump-sum tax if negative), $\tau_{I,s}(.)$ is an income tax function, $\tau_{P,s}(.)$ is a payroll tax function for Social Security (OASDI), $tr_{SS,s}(.)$ is a Social Security benefit function, and $tr_{R,s}(\mathbf{s}_i)$ is an LSRA wealth redistribution function.

The household's problem is

$$v(\mathbf{s}_i, \mathbf{S}_t; \mathbf{\Psi}_t) = \max_{c_i, h_i} u_i(c_i, h_i) + \beta \phi_i E[v(\mathbf{s}_{i+1}, \mathbf{S}_{t+1}; \mathbf{\Psi}_{t+1}) | e_i] \quad (4)$$

subject to

$$\begin{aligned} a_{i+1} = & \frac{1}{1+\mu}\{w_t e_i h_i + (1+r_t)(a_i + tr_{R,t}(\mathbf{s}_i)) \\ & - \tau_{I,t}(w_t e_i h_i, r_t(a_i + tr_{R,t}(\mathbf{s}_i)), tr_{SS,t}(\mathbf{s}_i)) + tr_{LS,t} - \tau_{P,t}(w_t e_i h_i) \\ & + tr_{SS,t}(i, b_i) - c_i\} \geq a_{i+1,t}^{\min}(\mathbf{s}_i), \\ a_{20} = & \ 0, \quad a_{i \in \{65,\ldots,110\}} \geq 0, \end{aligned} \quad (5)$$

where $u_i(.)$ is a period utility function of an age i household, β is the time-preference factor, ϕ_i is the survival rate, w_t is the wage rate per efficiency unit of labor, and r_t is the interest rate (the rate of return to capital).[7] Individual variables of the model are normalized by the steady-state per capita growth rate μ. $a_{i+1,t}^{\min}(\mathbf{s}_i)$ is the state-contingent minimum level of end-of-period wealth that is sustainable, that is, even if the household receives the worst possible shocks in future working abilities. At the beginning of the next period, the state of the household becomes

$$\mathbf{s}_{i+1} = (i+1, e_{i+1}, a_{i+1} + q_t, b_{i+1}), \quad (6)$$

where q_t denotes accidental bequests that a household receives at the end of the period. In

[6] In this model economy, the government does not solve an optimization problem. The government's policy rule is described as a set of tax and spending functions, in which functional forms are possibly time variant, and a financing rule must satisfy an intertemporal budget constraint.

[7] So, $w_t e_i h_i$ is the earnings of a household of age i with working ability e_i in year t.

the presence of perfect annuity markets, the household's state in the next period is

$$\mathbf{s}_{i+1} = \left(i+1, e_{i+1}, a_{i+1}/\phi_i, b_{i+1}\right),$$

instead. The average historical earnings b_i for Social Security purposes follows

$$b_{i+1} = \begin{cases} 0 & \text{if } i \leq 24 \\ \frac{1}{i-24}\{(i-25)b_i\frac{w_t}{w_{t-1}} + \min\left(w_t e_i h_i/2, weh_t^{\max}\right)\} & \text{if } 25 \leq i \leq 59 \\ b_i/(1+\mu) & \text{if } i \geq 60, \end{cases}$$

where $weh_t^{\max}$ is the Old-Age, Survivors, and Disability Insurance (OASDI) tax cap, which is $80,400 in 2001. For simplicity, the model assumes that the highest 35 years of earnings correspond to those in ages between 25 and 59.[8]

2.1.2 The Measure of Households

Let $x_t(\mathbf{s}_i)$ denote the measure of households, and let $X_t(\mathbf{s}_i)$ be the corresponding cumulative measure. The measure of households is adjusted by the steady-state population growth rate ν. The population of age 20 households is normalized to be unity in the baseline economy on the balanced growth path, that is,

$$\int_E \mathrm{d}X_t\left(20, e_{20}, 0, 0\right) = 1. \tag{9}$$

Let $\mathbf{1}_{[a=y]}$ be an indicator function that returns 1 if $a = y$ and 0 if $a \neq y$. Then, the law of motion of the measure of households is, for $i \in I = \{20, ..., 109\}$,

$$\begin{aligned} x_{t+1}\left(\mathbf{s}_{i+1}\right) = \frac{\phi_i}{1+\nu}\int_{E\times A\times B} & \mathbf{1}_{[a_{i+1}=a_{i+1}(\mathbf{s}_i,\mathbf{S}_t;\mathbf{\Psi}_t)+q_t]} \\ & \times\mathbf{1}_{[b_{i+1}=b_{i+1}(w_t e_i h_i(\mathbf{s}_i,\mathbf{S}_t;\mathbf{\Psi}),b_i)]}\pi_{i,i+1}(e_{i+1}|e_i)\mathrm{d}X_t\left(\mathbf{s}_i\right), \end{aligned} \tag{10}$$

where $\pi_{i,i+1}$ denotes the transition probability of working ability from age i to age $i+1$. For simplicity, a working age household is assumed to receive accidental bequests q_t with constant probability η, where q_t is the average wealth left by deceased households and η is

[8] Social Security benefits in the United States are computed on the basis of the highest 35 years of earnings, adding an additional state variable to the model. Earnings before age 60 are wage indexed and earnings after age 60 are price indexed.

the ratio of deceased household to the surviving working-age households. That is,

$$q_t = \frac{\sum_{i=20}^{109}(1-\phi_i)\int_{E\times A\times B} a_{i+1}(\mathbf{s}_i,\mathbf{S}_t;\mathbf{\Psi}_t)\mathrm{d}X_t\left(\mathbf{s}_i\right)}{\sum_{i=20}^{109}(1-\phi_i)\int_{E\times A\times B}\mathrm{d}X_t\left(\mathbf{s}_i\right)}, \tag{11}$$

$$\eta = \frac{\sum_{i=20}^{109}(1-\phi_i)\int_{E\times A\times B}\mathrm{d}X_t\left(\mathbf{s}_i\right)}{\sum_{i=20}^{64}\phi_i\int_{E\times A\times B}\mathrm{d}X_t\left(\mathbf{s}_i\right)}. \tag{12}$$

The steady-state condition is

$$\mathbf{S}_{t+1} = \mathbf{S}_t \tag{13}$$

for all t and $\mathbf{s}_i \in I\times E\times A\times B$.

2.2 The Firm

National wealth W_t is the sum of total private wealth and government's net wealth $W_{G,t}$. Total labor supply L_t is measured in efficiency units.

$$W_t = \sum_{i=20}^{109}\int_{E\times A\times B} a_i\mathrm{d}X_t\left(\mathbf{s}_i\right) + W_{R,t} + W_{G,t}, \tag{14}$$

$$L_t = \sum_{i=20}^{109}\int_{E\times A\times B} e_i h_i(\mathbf{s}_i,\mathbf{S}_t;\mathbf{\Psi}_t)\mathrm{d}X_t\left(\mathbf{s}_i\right). \tag{15}$$

There is a perfectly competitive representative firm in this economy. In a closed economy, capital stock is equal to national wealth, that is, $K_t = W_t$, and gross national product Y_t is determined by a constant-returns-to-scale production function,

$$Y_t = F(K_t, L_t). \tag{16}$$

The profit-maximizing condition of the firm is

$$F_K(K_t, L_t) = r_t + \delta, \tag{17}$$

$$F_L(K_t, L_t) = w_t, \tag{18}$$

where δ is the depreciation rate of capital.

In a small open economy, factor prices, r_t^* and w_t^* are fixed at international levels, and domestic capital stock $K_{D,t}$ and labor supply L_t are determined so that the firm's profit maximizing condition satisfies,

$$F_K(K_{D,t}, L_t) = r_t^* + \delta, \tag{19}$$

$$F_L(K_{D,t}, L_t) = w_t^*. \tag{20}$$

Gross domestic product $Y_{D,t}$ is determined by the production function,

$$Y_{D,t} = F(K_{D,t}, L_t),$$

and gross national product Y_t is determined by

$$Y_t = (r_t^* + \delta)\, W_t + w_t^*\, L_t.$$

Net foreign investment is shown by the difference between national wealth and domestic capital stock, that is, $W_t - K_{D,t}$.

2.3 The Government

In our policy experiments reported below, we follow Auerbach and Kotlikoff (1987) by measuring the pure efficiency gains from a policy change using a Lump-Sum Redistribution Authority, but we extend their approach to a heterogeneous-agent OLG model. To see how the LSRA works, suppose that a new policy is announced at the beginning of period 1. The LSRA first makes a lump-sum transfer (tax if negative), $tr_{CV,1}\,(\mathbf{s}_i)$, to *each living* household of age i to bring its expected remaining lifetime utility at state $\mathbf{s}_i$ back to its pre-reform level in the baseline economy. Next, the LSRA makes a lump-sum transfer (or tax), $tr_{CV,t}\,(\mathbf{s}_{20})$, to *each future* household (that is, each newborn household in periods 2, 3, ...) to make it as well off in the baseline economy, conditional on its initial state at age 20. Thus far, however, the net present value of these transfers at the beginning of period 1 across living and future households will generally not sum to zero. So, finally, the LSRA makes an additional lump-sum transfer (tax), Δtr, to each future household so that the net present value across all transfers is zero. For illustrative purposes, we assume that these additional transfers are uniform across future generations on a growth-adjusted basis. The lump-sum transfers made by the LSRA, therefore, are

$$tr_{R,t}(\mathbf{s}_i) = \begin{cases} tr_{CV,t}\left(\mathbf{s}_i\right) & \text{if } t = 1 \\ tr_{CV,t}\left(\mathbf{s}_i\right) + \Delta tr, & \text{if } t > 1 \text{ and } i = 20 \\ 0 & \text{otherwise} \end{cases} .$$

If $\Delta tr > 0$ then tax reform has produced extra resources after the expected remaining lifetime utility of each household has been restored to its pre-reform level. In this case, we say that tax reform has generated efficiency gains. If, however, $\Delta tr < 0$, then tax reform reduces efficiency. The total net lump-sum transfer to living households at time t, $Tr_{LS,t}$, is

$$Tr_{R,t} = \sum_{i=20}^{109} \int_{E\times A\times B} tr_{R,t}\left(\mathbf{s}_i\right) \mathrm{d}X_t\left(\mathbf{s}_i\right). \tag{21}$$

Government tax revenue consists of federal income tax $T_{I,t}$ and payroll tax for Social Security (OASDI) $T_{P,t}$. These revenues are

$$T_{I,t} = \sum_{i=20}^{109} \int_{E\times A\times B} \tau_{I,t}\left(w_t e_i h_i(\mathbf{s}_i, \mathbf{S}_t; \mathbf{\Psi}_t), r_t\left(a_i + tr_{R,t}\left(\mathbf{s}_i\right)\right), tr_{SS,t}\left(\mathbf{s}_i\right)\right) \mathrm{d}X_t\left(\mathbf{s}_i\right), \tag{22}$$

$$T_{P,t} = \sum_{i=20}^{109} \int_{E\times A\times B} \tau_{P,t}\left(w_t e_i h_i(\mathbf{s}_i, \mathbf{S}_t; \mathbf{\Psi}_t)\right) \mathrm{d}X_t\left(\mathbf{s}_i\right). \tag{23}$$

Total lump-sum transfer $Tr_{LS,t}$ and Social Security (OASDI) benefit expenditure $Tr_{SS,t}$ are

$$Tr_{LS,t} = tr_{LS,t} \sum_{i=20}^{109} \int_{E\times A\times B} \mathrm{d}X_t\left(\mathbf{s}_i\right), \tag{24}$$

$$Tr_{SS,t} = \sum_{i=20}^{109} \int_{E\times A\times B} tr_{SS,t}\left(\mathbf{s}_i\right) \mathrm{d}X_t\left(\mathbf{s}_i\right). \tag{25}$$

The law of motion of the government wealth (normalized by productivity growth and population growth) is

$$W_{G,t+1} = \frac{1}{(1+\mu)(1+\nu)} \left\{(1+r_t)W_{G,t} + T_{I,t} - T_{LS,t} - C_{G,t}\right\}, \tag{26}$$

$$W_{R,t+1} = \frac{1}{(1+\mu)(1+\nu)} (1+r_t)\left(W_{A,t} - T_{R,t}\right), \tag{27}$$

where $C_{G,t}$ is government consumption. In this paper, the payroll tax rate is adjusted so that the Social Security OASDI budget is always balanced, i.e., $T_{P,t} = Tr_{SS,t}$.

2.4 Recursive Competitive Equilibrium

***Definition* Recursive Competitive Equilibrium (Equilibrium Transition Path):** Let $\mathbf{s}_i = (i, e_i, a_i, b_i)$ be the individual state of households, let $\mathbf{S}_t = (x_t(\mathbf{s}_i), W_{R,t}, W_{G,t})$ be the state of the economy, and let $\mathbf{\Psi}_t$ be the government policy schedule known at the beginning of year t,

$$\mathbf{\Psi}_t = \{W_{R,s+1}, W_{G,s+1}, C_{G,s}, tr_{LS,s}, \tau_{I,s}(.), \tau_{P,s}(.), tr_{SS,s}(.), tr_{R,s}(\mathbf{s}_i)\}_{s=t}^{\infty}.$$

A series of factor prices $\{r_s, w_s\}_{s=t}^{\infty}$, accidental bequests $\{q_s\}_{s=t}^{\infty}$, the policy variables $\{W_{R,s+1}, W_{G,s+1}, C_{G,s}, tr_{LS,s}, tr_{R,s}(\mathbf{s}_i)\}_{s=t}^{\infty}$, the parameters of policy functions $\{\varphi_s\}_{s=t}^{\infty}$, the value function of households $\{v(\mathbf{s}_i, \mathbf{S}_s; \mathbf{\Psi}_s)\}_{s=t}^{\infty}$, the decision rule of households

$$\{\mathbf{d}(\mathbf{s}_i, \mathbf{S}_s; \mathbf{\Psi}_s)\}_{s=t}^{\infty} = \{c_i(\mathbf{s}_i, \mathbf{S}_s; \mathbf{\Psi}_s), h_i(\mathbf{s}_i, \mathbf{S}_s; \mathbf{\Psi}_s), a_{i+1}(\mathbf{s}_i, \mathbf{S}_s; \mathbf{\Psi}_s)\}_{s=t}^{\infty},$$

and the measure of households $\{x_s(\mathbf{s}_i)\}_{s=t}^{\infty}$, are in a recursive competitive equilibrium if, in every period $s = t, ..., \infty$, each household solves the utility maximization problem (1)–(5) taking $\mathbf{\Psi}_t$ as given; the firm solves the profit maximization problem, and the capital and labor markets clear, that is, (14)–(20) hold; the government policy schedule satisfies (21)–(26); and the goods market clears.

***Definition* Recursive Competitive Equilibrium (Steady State):** Let $\mathbf{s}_i = (i, e_i, a_i, b_i)$ be the individual state of households and let $\mathbf{\Psi}$ be the time-invariant government policy rules,

$$\mathbf{\Psi} = \{W_R, W_G, C_G, tr_{LS}, \tau_I(.), \tau_P(.), tr_{SS}(.), tr_R(\mathbf{s}_i)\}.$$

Factor prices (r, w), accidental bequests q, the policy variables $(W_R, W_G, C_G, tr_{LS}, tr_R(\mathbf{s}_i))$, the parameters φ of policy functions, the value function of households $v(\mathbf{s}_i; \mathbf{\Psi})$, the decision rule of households

$$\mathbf{d}(\mathbf{s}_i; \mathbf{\Psi}) = \{c_i(\mathbf{s}_i; \mathbf{\Psi}), h_i(\mathbf{s}_i; \mathbf{\Psi}), a_{i+1}(\mathbf{s}_i; \mathbf{\Psi})\},$$

Table 1: Parameters

		Economies without Wage Shocks		Economies with Wage Shocks	
		with Annuity Markets	w/o Annuity Markets	with Annuity Markets	w/o Annuity Markets
Time preference parameter *1	β	1.022	1.016	0.986	0.982
Share parameter for consumption *2	α	0.427	0.433	0.479	0.494
Coefficient of relative risk aversion	γ	2.0			
Capital share of output	θ	0.30			
Depreciation rate of capital stock	δ	0.047			
Long-term real growth rate	μ	0.018			
Population growth rate	ν	0.010			
Total factor productivity	A	0.949			

*1. The capital-GDP ratio is assumed to be 2.74.

*2. The average annual working hours are 3414 per married couple when $h_{\max}$= 8760.

and the measure of households $x(\mathbf{s}_i)$, are in a steady-state recursive competitive equilibrium if, in every period, each household solves the utility maximization problem (1)–(5) taking $\mathbf{\Psi}$ as given; the firm solves the profit maximization problem, and the capital and labor markets clear, that is, (14)–(20) hold; the government policy rules satisfy (21)–(27); the goods market clears; and the measure of households is constant, that is, (13) holds.

3 Calibration

Table 1 summarizes the key parameters discussed below.

3.1 Households

Utility Function. We use the following Cobb-Douglas utility function that is nested within a time-separable isoelastic functional form, which is compatible with the existence of a steady state:

$$u(c,h) = \frac{\left\{((1+n_i/2)^{-\zeta}\, c)^{\alpha}(h^{\max}-h)^{1-\alpha}\right\}^{1-\gamma}}{1-\gamma}.$$

γ is the coefficient of relative risk aversion, n_i is the number of dependent children at the parents' age i, ζ is the "adult equivalency scale" parameter that is used to convert the con-

Table 2: Number of People Under 18 Years of Age in a Married Household

Age cohorts	Number of children	Age cohorts	Number of children
20-24	0.642	50-54	0.908
25-29	1.167	55-59	0.562
30-34	1.451	60-64	0.231
35-39	1.755	65-69	0.156
40-44	1.753	70-74	0.055
45-49	1.439	75-plus	0.000

Source: Authors' calculations from the 2001 Survey of Consumer Finances (SCF).

sumption by children into their adult equivalent amounts, and $h_i^{\max}$ is the maximum working hours.[9] The coefficient of relative risk aversion is initially assumed to be 2.0. The number of dependent children by age cohort is calculated using the 2001 Survey of Consumer Finances (SCF) (see Table 2). The consumption adjustment parameter is assumed to be 0.6.[10]

The annual working hours in the model are the sum of the working hours of a husband and a wife. The maximum working hours, $h_i^{\max}$, are set at 8,760, which equals 12 hours per day per person $\times$ 365 days $\times$ two persons.[11] Using a smaller value for maximum hours would reduce the effective labor supply elasticity. The parameter α is chosen so that the average working hours of households between age 20 and age 64 equals 3,414 hours in the initial steady-state economy, the average number of hours supplied by married households in the 2001 SCF.

Working Ability. The working ability in this calibration corresponds to the hourly wage (labor income per hour) of each household in the 2001 SCF.[12] The average hourly wage of a married couple (family members #1 and #2 in SCF) used in the calibration is calculated by

$$\text{Hourly Wage} = \frac{\text{Regular and Additional Salaries (\#1 + \#2)}}{\max\{\text{Working Hours (\#1 + \#2), 2080}\}}.$$

[9]The growth-adjusted β, therefore, is $\beta(1+\mu)^{\alpha(1-\gamma)}$.

[10]Hence, a married couple with two dependent children must consume about 52 percent (i.e., $2^{0.6} = 1.517$) more than a married couple with no children to attain the same level of utility, ceteris paribus.

[11]The 95th and 99th percentiles of the working hours per married couple of aged 20-64 in the 2001 SCF are 5,280 and 6,375, respectively.

[12]According to Bureau of Labor Statistics data, the average hourly earnings of production workers have increased by 3.8 percent from 2000 to 2001. Since the 2001 SCF wages correspond to year 2000 while our tax function introduced below is calibrated to the year 2001, we multiply the SCF wages shown in Table 3 by 1.038 to convert the hourly wages in 2000 into growth-adjusted wages in 2001.

Table 3: Working Abilities of a Household (in U.S. Dollars per Hour)

	Percentile	Age Cohorts					
		20-24	25-29	30-34	35-39	40-44	45-49
e^1	0-20th	3.89	5.47	6.86	6.01	7.43	5.73
e^2	20-40th	8.35	10.11	12.38	12.27	13.90	13.14
e^3	40-60th	10.28	14.04	16.46	16.96	18.76	18.47
e^4	60-80th	12.31	17.30	21.87	22.57	25.79	25.71
e^5	80-90th	17.47	21.58	29.37	30.19	35.37	35.56
e^6	90-95th	22.17	27.21	33.96	46.92	48.30	54.59
e^7	95-99th	29.43	36.60	43.76	81.75	96.44	97.48
e^8	99-100th	42.31	62.29	182.78	327.65	262.03	284.00
	Percentile	Age cohorts					
		50-54	55-59	60-64	65-69	70-74	75-79
e^1	0-20th	5.00	2.42	0.00	0.00	0.00	0.00
e^2	20-40th	13.99	10.65	3.36	0.00	0.00	0.00
e^3	40-60th	20.95	15.60	11.00	1.92	0.00	0.00
e^4	60-80th	29.13	24.60	18.33	11.14	1.77	1.30
e^5	80-90th	40.89	34.75	29.08	19.14	10.93	10.21
e^6	90-95th	54.11	51.62	44.41	29.99	20.66	20.88
e^7	95-99th	91.67	99.24	91.12	56.19	38.26	26.41
e^8	99-100th	282.18	333.58	555.90	244.71	193.00	86.76

Source: Authors' calculations from the 2001 SCF.

We adjusted the salaries in the numerator by adding imputed payroll taxes paid by their employers. The max operator in the denominator is used to adjust the hourly wage for a small fraction of households with large reported salaries but few reported working hours such as executives and the self-employed.

Table 3 shows the eight discrete levels of working abilities of five-year age cohorts. We use a shape-preserving cubic spline interpolation between each five-year age cohort to obtain the working ability for each age cohort.[13] In the version of our model where we "turn off" the idiosyncratic wage shocks, the hourly wages of the representative household are assumed to be the weighted averages of the values shown in Table 3.

Table 3, however, only shows the different potential "wage buckets" by age as well as the proportion of households in each bucket. It does not itself capture the uncertainty over

[13] An alternative approach of estimating eight different wage rates for each age would have relied on too few observations.

wages. Using the Panel Study of Income Dynamics (PSID), therefore, we estimate Markov transition matrixes that specify the probabilities that a household's wage will move from one wage a different wage the next year. Separate transition matrixes were constructed for four age ranges—20-29, 30-39, 40-49, and 50-59—in order to capture the possibility that the probabilities themselves might change over the lifecycle. (For households aged 60 or older, we used the matrix for ages 50-59.) The probability η of receiving bequests each year for a working-age household is calculated to 0.0161 by Equation (12). The Appendix reports the estimation procedure and the matrixes in more detail.

Population Growth and Mortality. The population growth rate ν is set to one percent per year, which is consistent with Social Security Administration (2001) long-run estimates. The survival rate ϕ_i at the end of age $i = \{20, ..., 109\}$ are the weighted averages of the male and female survival rates calculated by SSA (Table 4.C6). The survival rates at the end of age 109 are replaced by zero, thereby capping the maximum length of life. See Appendix A for more details.

3.2 Production

Capital and Private Wealth. Capital K is the sum of private fixed assets and government fixed assets. In 2000, private fixed assets were $21,165 billion, government fixed assets were $5,743 billion, and the public held about $3,410 billion of government debt.[14] Government net wealth, therefore, is set equal to 9.5 percent of total private wealth in the initial steady-state economy in our model. Moreover, the time preference parameter β is chosen in each version of our model so that the capital-GDP ratio in the initial steady state economy is 2.74, the empirical value in 2000.[15]

Production Technology. Production takes the Cobb-Douglas form,

$$F(K_t, L_t) = A_t K_t^{\theta} L_t^{1-\theta}.$$

[14]Source: Department of Commerce, Bureau of Economic Analysis.
[15]*Ibid.*

where, recall, L_t is the sum of working hours in efficiency units. The capital share of output θ is chosen equal to

$$\theta = 1 - \frac{\text{Compensation of Employees } + (1-\theta) \times \text{Proprietors' Income}}{\text{National Income } + \text{ Consumption of Fixed Capital}}.$$

The value of θ in 2000 was 0.30.[16] The annual per-capita growth rate μ is assumed to be 1.8 percent, the average rate between 1869 to 1996 (Barro [1997]). Total factor productivity A is set at 0.949, which normalizes the wage (per efficient labor unit) to unity.

The Depreciation Rate of Fixed Capital. The depreciation rate of fixed capital δ is chosen by the following steady-state condition,

$$\delta = \frac{\text{Total Gross Investment}}{\text{Fixed Capital}} - \mu - \nu.$$

In 2000, private gross fixed investment accounted for 17.2 percent of GDP, and government (federal and state) gross investment accounted for 3.3 percent of GDP.[17] With a capital-output ratio of 2.74, the ratio of gross investment to fixed capital is 7.5 percent. Subtracting productivity and population growth rates, the annual depreciation rate is 4.7 percent.

3.3 The Government

Income Taxes. Federal income tax and state and local taxes are assumed to be at the level in year 2001 before the passage of the "Economic Growth and Tax Relief Reconciliation Act of 2001" (EGTRRA). Since households in our model are assumed to be married, we use a standard deduction of $7,600. However, following Altig *et al.* (2001), we allow higher income households to itemize deductions when it is more valuable to do so, and we assume that the value of the itemized deduction increases linearly in the Adjusted Gross Income.[18] The additional exemption per dependent person is $2,900 where the number of dependent children is consistent with Table 2. Table 4 shows the statutory marginal tax rates before

[16] Source: Department of Commerce, Bureau of Economic Analysis. The average of θ in years between 1996 and 2000 is 0.31.

[17] *ibid*.

[18] In particular, the deduction taken by a household is the greater of the standard deduction and $0.0755 \times \text{AGI}$, or $\max\{\$7600, 0.0755 \times \text{AGI}\}$.

Table 4: Marginal Individual Income Tax Rates in 2001 (Married Household, Filed Jointly)

Taxable Income			Marginal Income Tax Rate (%)
\$0	–	\$45,200	$15.0 \times \varphi_I$
\$45,200	–	\$109,250	$28.0 \times \varphi_I$
\$109,250	–	\$166,500	$31.0 \times \varphi_I$
\$166,500	–	\$297,350	$36.0 \times \varphi_I$
\$297,350	–		$39.6 \times \varphi_I$

EGTRRA.[19] As explained before, a household's labor income in this calibration includes the imputed payroll tax paid by its employer. Thus, taxable income is obtained by subtracting the employer portion of payroll tax from labor income.

The standard deduction, the personal exemption, and all tax brackets grow with productivity over time so that there is no real bracket creep; this indexing is also needed for the initial economy to be in steady state. In 2000, the ratio of total individual income tax revenue (not including Social Security and Medicare taxes) to nominal GDP was 0.102 and the ratio of corporate income tax to GDP was 0.021. Each statutory federal income tax rate shown in Table 4, therefore, is multiplied by φ_I so that income tax revenue (including corporate income tax) totals 12.3 percent of GDP in the initial steady state. The adjustment factor is 0.76-0.77 for heterogeneous-agent economies with idiosyncratic wage shocks and 1.19-1.22 for representative-agent economies without wage shocks. Also, since the effective tax rate on capital income is reduced by investment tax incentives, accelerated depreciation and other factors (Auerbach [1996]), the tax function is further adjusted so that the cross-sectional average tax rate on capital income is about 25 percent lower than the average tax on labor income.[20] State and local income taxes are modeled parsimoniously with a 4.0 percent flat tax on income above the deduction and exemption levels used at the federal level.

Social Security. The tax rate levied on both employers and employees for Old-Age, Survivors, and Disability Insurance (OASDI) is 12.4 percent, and the tax rate for Medicare (HI) is 2.9 percent. In 2001, employee compensation above \$80,400 was not taxable for OASDI.

[19]The key qualitative results reported herein are unaffected if the tax function were instead modeled as net taxes, that is, after substracting transfers indicated in the Statistics of Income.

[20]This relative reduction to the tax rate on capital is commonly used by CBO, and it balances the legal tax preferences given to capital versus the legal tax benefits given to labor, including tax-preferred fringe benefits.

Table 5: Marginal Payroll Tax Rates in 2001

Taxable Labor Income per Worker	Marginal Tax Rate (%) OASDI	HI
\$0 – \$80,400	$12.4 \times \varphi_P$	2.9
\$80,400 –	$0.0 \times \varphi_P$	2.9

Note: The same taxes are levied to employers. The payroll tax adjustment factor φ_P is assumed to be 1.0.

Table 6: OASDI Replacement Rates in 2001

AIME (b/12)	Marginal Replacement Rate (%)
\$0 – \$561	$90.0 \times \varphi_{tr}$
\$561 – \$3,381	$32.0 \times \varphi_{tr}$
\$3,381 –	$15.0 \times \varphi_{tr}$

Note: The OASDI benefit adjustment factor φ_{tr} is set so that the OASDI is pay-as-you-go in the baseline economies.

(See Table 5.)

Social Security benefits are based on each worker's Average Indexed Monthly Earnings (AIME), $b_i/12$, and the replacement rate schedule in the United States. The replacement rates are 90 percent for the first \$561, 32 percent for amounts between \$561 and \$3,381, and 15 percent for amounts above \$3,381.

In this calibration, OASDI benefits are adjusted so that total benefit equals total payroll tax revenue for OASDI. The adjustment factor φ_{tr} is 1.34 in economies without wage shocks and 1.37-1.38 in economies with wage shocks. The benefits received by retired workers accounted for 69.1 percent of total OASDI benefits in December 2000.[21] Considering spousal and survivors' benefits, these adjustment factors are roughly consistent with the U.S. OASDI system.

4 Policy Experiments

Assets in the new private (or individual) saving accounts are assumed to be perfect substitutable of other private assets. In particular, both assets earn the market rate of return and

[21] See Table 5.A1 in Social Security Administration (2001).

the income produced is taxed by the same income tax schedule. Privatization of Social Security (OASDI), therefore, is equivalent to simply eliminating Social Security. This section describes the 26 stylized privatization experiments that we conducted.

The Immediate Elimination of OASDI. The first set of experiments analyzes the immediate privatization (elimination) of Social Security. At the beginning of year 1, both the payroll tax rate for OASDI and benefits are reduced to zero immediately. Since privatization will change the size of the general-revenue income tax base, the experiments shown in these tables also assume that changes in revenue are transferred back to households in either a lump-sum fashion or by changing income taxes in a proportional manner in order to maintain a constant level of government revenue as in the stationary pre-reform economy.

As summarized in Table 7, privatization is evaluated under many combinations of model assumptions: (i) In a representative-agent economy without idiosyncratic wage shocks or in a heterogeneous-agent economy with wage shocks; (ii) with a perfect annuity market or without a private annuity market; and (iii) in a closed economy or in a small open economy. The Lump-Sum Redistribution Authority (LSRA) is always "turned on" in all of the "Immediate" privatization runs since there are some poor retired households that rely solely on Social Security benefits and, therefore, would violated the Inada conditions without the LSRA.

The Phase-In Privatization of Social Security. As shown in Table 7, the second set of experiments assumes the phase-in privatization (elimination) of Social Security. OASDI benefits are reduced linearly between those ages 65 and 25 in the year of the reform . Specifically, households of age 66 or older in year 1 receive the current-law (baseline) benefits throughout the rest of their lifetime; households of age 65 in year 1 receive benefits 2.5% lower than the current-law level throughout the rest of lifetime; households of age 65 in year 2 receive benefits 5.0% lower than the current law-level, etc. Households of age 25 or younger in year 1 receive no traditional Social Security benefits. During this transition, Social Security benefits are financed by the traditional payroll tax so that the Social Security budget is balanced every year. The rest of the government budget is balanced by the pro-

Table 7: Summary of the Design of Each Experiment

Table # in Appendix	Wage Shocks Operative?	Annuity Markets Available?	Tax Adjusted to Balance Rest of Government	LSRA "Turned on"?	Closed or Small Open?	Δtr^{*1} ($1,000)
The Immediate Elimination of OASDI						
A.1	No	Yes	Lump-Sum	Yes	Closed	+23.7
	No	Yes	Lump-Sum	Yes	Small Open	+29.8
A.2	No	Yes	Income Tax	Yes	Closed	+147.8
	No	Yes	Income Tax	Yes	Small Open	+280.5
A.3	No	No	Lump-Sum	Yes	Closed	-3.7
	No	No	Lump-Sum	Yes	Small Open	-7.7
A.4	No	No	Income Tax	Yes	Closed	+123.9
	No	No	Income Tax	Yes	Small Open	+225.4
A.5	Yes	Yes	Lump-Sum	Yes	Closed	-41.4
	Yes	Yes	Lump-Sum	Yes	Small Open	-47.0
A.6	Yes	Yes	Income Tax	Yes	Closed	-95.3
	Yes	Yes	Income Tax	Yes	Small Open	-144.4
A.7	Yes	No	Lump-Sum	Yes	Closed	-60.2
	Yes	No	Lump-Sum	Yes	Small Open	-54.7
A.8	Yes	No	Income Tax	Yes	Closed	-114.2
	Yes	No	Income Tax	Yes	Small Open	-155.9
The Phase-In Privatization of OASDI						
A.9	No	Yes	Income/Payroll	No	Closed	–*
	No	Yes	Income/Payroll	No	Small Open	–*
A.10	No	Yes	Income/Payroll	Yes	Closed	+92.1*
	No	Yes	Income/Payroll	Yes	Small Open	+100.2*
A.11	Yes	Yes	Income/Payroll	No	Closed	–*
	Yes	Yes	Income/Payroll	No	Small Open	–
A.12	Yes	Yes	Income/Payroll	Yes	Closed	-39.8*
	Yes	Yes	Income/Payroll	Yes	Small Open	-54.9*
The Phase-In Privatization with Contribution Matching						
A.13	Yes	Yes	Income/Payroll	No	Closed	–*
A.14	Yes	Yes	Income/Payroll	Yes	Closed	-38.6*

*1 Welfare gains (+) or losses (-) measured by the additional transfer to each future household (compensating variations in wealth in 2001 growth-adjusted 1,000 dollars). These numbers are preliminary. Due to the difficulty in calculating LSRA transfers in a closed economy, the susceptibility of the labor supply and saving on marginal tax rate increases, and drastic policy changes we imposed, many experiments are not converged within our usual criteria (Δx/x $<$ 5e-4 or 1e-3). The numbers in the tables with * are less reliable than others.

portional changes in marginal income tax rates. These policy changes are evaluated (i) in a representative-agent economy or a heterogeneous-agent economy with wage shocks; (ii) with perfect annuity markets or in the absence of those; and (iii) in a closed economy or in a small open economy.

The Phase-In Privatization with Contribution Matching. The pre-reform Social Security system is progressive in the sense that it gives households with a lower average index of pre-retirement wages a larger Social Security benefit relative to their pre-retirement wages (i.e., a larger "replacement rate"). None of the privatized experiments considered above maintain any progressivity. In the last set of experiments, therefore, we augment the phase-in privatization discussed above with a progressive contribution match. In particular, working households with no labor income receive a match equal to a 20% of their *earnings*. This matching rate declines linearly to 0% as labor income approaches $40,000 of labor income per household.[22] As before, the costs for the traditional benefits are financed by the payroll taxes so that the Social Security budget is balanced each year. The match, however, is exactly financed each year by increasing the marginal income tax rates proportionally. In addition, income tax rates are changed so that the rest of government budget is balanced throughout the transition path.

5 Results

5.1 Immediate Elimination of Social Security

5.1.1 No Wage Shocks

Tables A.1(a) and (b) in Appendix C report the impact that immediate privatization of Social Security will have on macroeconomic variables and efficiency gains in an economy without wage shocks and with perfect annuity markets. As in all of the immediate privatization experiments, the LSRA is turned on, which ensures that all retirees at the time of the reform will have a positive level of consumption. Since privatization will change the size of the general-revenue income tax base, the experiments shown in these tables also assume

[22] This matching schedule is equivalent with the marginal labor income tax of –20% at $0, 0% at $20,000, 20% at $40,000, and 0% for labor income above $40,000.

that changes in revenue are transferred back to households in a lump-sum fashion in order to maintain a constant level of government revenue. The results show that privatization can produce large efficiency gains, equal to about $24,000 per each future household, that is, after all households alive at the time of the reform have been compensated by just enough to return their remaining expected lifetime utilities to their pre-reform levels. Since wages are deterministic and fair private annuities are available, these efficiency gains are driven by reductions in labor supply distortions; aggregate labor supply increases by 3.9% in the long run. After compensating households during the transition, these efficiency gains eventually net a positive level of resources for the LSRA, which leads to a 4.9% increase in the size of national wealth.

Tables A.2(a) and (b) report the results from the same experiment except that general-revenue income taxes are now reduced in a proportional manner as the general-revenue tax base expands after privatization. This shift from lump-sum rebates to a reduction in income taxes leads to even larger efficiency gains, equal to about $148,000 per future household. Under the fairly large effective labor supply elasticity in our representative-agent economy, the reduction in income tax rates helps produce a 14.1% increase in aggregate labor; in contrast, the lump-sum rebates previously reported in Tables A.1(a) and (b) slightly dampened the increase in labor supply. National wealth eventually increases by 31.8%, helped by both the reduction in capital income tax rates and the LSRA that spreads the efficiency gains out over the long run.

Tables A.3(a) and (b) repeat the results from the experiment shown in Tables A.1(a) and (b)—that is, where lump-sum rebates are used to maintain a constant amount of general revenue—except private annuity markets are assumed to no longer exist. In this case, privatizing Social Security leads to smaller gains since its annuity payout cannot be replicated in the private market. Indeed, the $24,000 efficiency gain now turns to a small -$4,000 loss. Similarly, Tables A.4(a) and (5) report the results corresponding to the experiments shown in Tables A.2(a) and (b) where income taxes are reduced to maintain a constant amount of government revenue. The absence of a private annuity market now reduces the efficiency gains from about $148,000 to $124,000.

5.1.2 With Wage Shocks

Tables A.5(a) and (b) report the results from the experiment shown in Tables A.1(a) and (b) except with wage shocks. Fair private annuity markets are again assumed to be operative. Lump-sum rebates (possibly negative) are again used to maintain a constant amount of government revenue. The $24,000 in efficiency gains reported for the previous case without wage shocks now becomes a loss of about $41,000 per each future household. Since wage shocks cannot be insured in the private market, privatizing Social Security, therefore, removes an important source of risk sharing. Aggregate labor supply continues to increase in the long run, by 3.3%. However, national wealth declines by 5.9%, in part, due to the additional debt carried by the LSRA, which borrows capital in order to compensate households during the transition; future households pay the interest on this debt. This additional debt outweighs the increase in household precautionary saving after the partial wage insurance that was once provided by Social Security is removed.

Tables A.6(a) and (b) show that adjusting income taxes rather than lump-sum taxes in response to changes in the size of the tax base following privatization produces a larger increase in the aggregate labor supply in the long run (5.8% versus 3.3%) and a smaller reduction in the amount of national wealth (3.8% versus 5.9%). But the efficiency losses are even larger, increasing to about $95,000 per future household. The reason is that an income tax, despite its many distortions, is potentially much better at sharing risks than a lump-sum tax system, which, despite having no distortions, does not share risks. This type of result is consistent with the theoretical analysis presented in Eaton and Rosen (1980a,b), Varian (1980), and Persson (1983), and investigated in a larger-scale model similar to that herein by Nishiyama and Smetters (2003).

Tables A.7 and A.8 show the results from both of these experiments except where private annuities are assumed to no longer exist. Not surprisingly, the efficiency losses increase. The efficiency loss per future household in the case with lump-sum rebates increases from $41,000 to about $60,000. When income taxes are instead changed after privatization, the loss increases to $114,000 per future household, up from $95,000 when private annuity markets are operative.

5.2 Phased-In Privatization

5.2.1 Without Wage Shocks

Tables A.9(a) and (b) show the effects of privatization in the economy without wage shocks but where privatization is gradually phased-in as described in the previous Section. Private annuity markets are operative. The LSRA is turned off in order to show the direct welfare effects on each generation. These tables do not, however, indicate any changes in efficiency since the losers from the reforms are not compensated. National wealth increases dramatically in the long run, by 52.3%. Labor supply also has a strong response, increasing by 14.0% in the long run. While most retirees alive at the time of the reform suffer very little welfare loss by construction, those aged 70 to 90 still lose some resources (about $6,000 at age 70) due to the decrease in interest rates in the closed economy following the increase in capital stock. Those aged 40 at the time of the reform are the biggest losers (about $160,000) since they must continue to contribute during the transition but will received reduced benefits. However, all future generations benefit greatly from privatization, by about $115,000.

Table A.10(a) and (b) show that there are plenty resources remaining – about $92,000 per each future household – even after the would-be losers are fully compensated after privatization by the LSRA. These gains are smaller, however, than immediate privatization since the phased-in privatization does not remove the labor supply distortions as quickly, in particular, for many households alive at the time of the reform. National wealth increases by 17.0% in the long run, less than without the LSRA since the LSRA must compensate many households during the transition for their losses. Labor supply, however, increases by 15.0% in the long run.

5.2.2 With Wage Shocks

Tables A.11 and A.12 show the results from the same phased-in privatization experiments except with wage shocks. Without the LSRA (Tables A.11), workers around age 40 at the time of the reform continue to lose significantly while the gains to those born in the long-run decrease to about $95,000 (on average across all income groups), down from $115,000 in the case without wage shocks. With the LSRA (Tables A.12), efficiency losses now emerge, equal to about $40,000 per each future household. This efficiency loss, however, is smaller than the \$96,000 loss reported in Table A.6(b) for the corresponding immediate privatization experiment. The reason is that fewer generations are exposed to loss in risk sharing under phased-in privatization relative to immediate privatization.

5.2.3 With Progressive Contribution Matching

Tables A.13 and A.14 report the results from experiments with progressive contribution matches financed by increasing the income tax in a proportional manner. Without the LSRA, Tables A.13(a) shows that national wealth increases by 36.8% in the long run, less than the increase of 39.5% without the match in Table A.11(a). The smaller increase in national wealth is partly due to the increase in income taxes that are used to pay for the match. Labor supply also increases by less in the long run (4.6% verses 5.4%). With the LSRA, Tables A.14(a) and (b) show that the efficiency loss equals about \$39,000 per future household, which is slightly less than the loss of \$40,000 without the contribution match in Table A.12(b).

6 Concluding Remarks

Privatization could produce efficiency gains by reducing the effective tax rate on labor supply. But privatization could also lead to efficiency losses by reducing the sharing of uninsurable wage risks and potentially even longevity uncertainty if private annuity markets are not operative. Determining the overall change in efficiency requires the use of simulation analysis. We investigate these competing effects using a heterogeneous overlapping-generations (OLG) model in which agents with elastic labor supply face idiosyncratic earnings shocks and longevity uncertainty. We find that a stylized privatization can have a very powerful effect on labor supply incentives: When wages and longevity are insurable, privatization can produce new resources equal to \$150,000 per each future household (growth adjusted over time), that is, after all households in the short run that would otherwise lose from reform have been fully compensated. Even if private annuity markets do not exist, privatization can produce over \$120,000 in new resources for each future household. However, when wages are not insurable, privatization reduces efficiency—by as much as \$95,000 per future household—despite the improved labor supply incentives even with perfect private annuity markets. (The losses increase to over \$110,000 per future household if private annuity markets do not exist.) This loss is reduced to about $40,000 if the privatization is phased-in over time and some risk sharing is introduced into the privatized system by subsidizing wage contributions on a progressive basis and paying for the subsidy by increasing general revenue income taxes in a proportional manner.

Appendices

A Transition Matrixes and Survival Rates

Markov Transition Matrixes. The Markov transition matrixes of working ability are constructed for four age groups—20-29, 30-39, 40-49, and 50-59—from the hourly wages in the PSID individual data 1990, 91, 92, and 93. The transition matrix of each age group is the average of three transition matrixes, from 1989 to 90, from 90 to 91, and from 91 to 92. For households aged 60 or older, we used the matrix for ages 50-59.

$$\Gamma_{i\in\{20,\dots,29\}} = \begin{pmatrix} 0.5964 & 0.2499 & 0.0875 & 0.0464 & 0.0118 & 0.0048 & 0.0029 & 0.0003 \\ 0.2093 & 0.4594 & 0.2322 & 0.0756 & 0.0104 & 0.0088 & 0.0042 & 0.0001 \\ 0.1044 & 0.1902 & 0.4084 & 0.2385 & 0.0342 & 0.0153 & 0.0048 & 0.0042 \\ 0.0642 & 0.0831 & 0.2016 & 0.4576 & 0.1314 & 0.0380 & 0.0241 & 0.0000 \\ 0.0313 & 0.0202 & 0.0784 & 0.2947 & 0.4285 & 0.0882 & 0.0408 & 0.0179 \\ 0.0246 & 0.0005 & 0.0898 & 0.1084 & 0.2462 & 0.3216 & 0.1862 & 0.0227 \\ 0.0108 & 0.0248 & 0.0432 & 0.0373 & 0.1163 & 0.2858 & 0.3923 & 0.0895 \\ 0.0376 & 0.0440 & 0.0000 & 0.0012 & 0.2615 & 0.0291 & 0.3714 & 0.2552 \end{pmatrix},$$

$$\Gamma_{i\in\{30,\dots,39\}} = \begin{pmatrix} 0.6936 & 0.2078 & 0.0546 & 0.0330 & 0.0031 & 0.0018 & 0.0061 & 0.0000 \\ 0.1972 & 0.5587 & 0.2001 & 0.0341 & 0.0077 & 0.0006 & 0.0000 & 0.0016 \\ 0.0620 & 0.1796 & 0.5233 & 0.2018 & 0.0154 & 0.0110 & 0.0069 & 0.0000 \\ 0.0214 & 0.0413 & 0.2024 & 0.5411 & 0.1526 & 0.0281 & 0.0116 & 0.0015 \\ 0.0272 & 0.0068 & 0.0348 & 0.3065 & 0.4581 & 0.1182 & 0.0484 & 0.0000 \\ 0.0163 & 0.0309 & 0.0084 & 0.0907 & 0.2946 & 0.3798 & 0.1512 & 0.0281 \\ 0.0404 & 0.0000 & 0.0007 & 0.0621 & 0.0830 & 0.2624 & 0.4869 & 0.0645 \\ 0.0000 & 0.0302 & 0.0000 & 0.0334 & 0.0379 & 0.0384 & 0.3209 & 0.5392 \end{pmatrix},$$

$$\Gamma_{i\in\{40,\dots,49\}} = \begin{pmatrix} 0.7111 & 0.2340 & 0.0352 & 0.0110 & 0.0070 & 0.0017 & 0.0000 & 0.0000 \\ 0.1847 & 0.5571 & 0.2078 & 0.0261 & 0.0142 & 0.0052 & 0.0020 & 0.0029 \\ 0.0579 & 0.1520 & 0.5429 & 0.1996 & 0.0339 & 0.0117 & 0.0020 & 0.0000 \\ 0.0214 & 0.0430 & 0.1833 & 0.5587 & 0.1576 & 0.0311 & 0.0027 & 0.0022 \\ 0.0191 & 0.0145 & 0.0217 & 0.3155 & 0.4644 & 0.1055 & 0.0593 & 0.0000 \\ 0.0416 & 0.0089 & 0.0512 & 0.1385 & 0.1427 & 0.3653 & 0.2094 & 0.0424 \\ 0.0247 & 0.0086 & 0.0354 & 0.0493 & 0.0777 & 0.2486 & 0.4942 & 0.0615 \\ 0.0000 & 0.0543 & 0.0000 & 0.0475 & 0.0786 & 0.1300 & 0.2502 & 0.4394 \end{pmatrix},$$

$$\Gamma_{i\in\{50,\dots,78\}} = \begin{pmatrix} 0.7000 & 0.2164 & 0.0514 & 0.0121 & 0.0110 & 0.0015 & 0.0076 & 0.0000 \\ 0.2215 & 0.5452 & 0.2117 & 0.0189 & 0.0027 & 0.0000 & 0.0000 & 0.0000 \\ 0.0439 & 0.1743 & 0.5353 & 0.2043 & 0.0197 & 0.0123 & 0.0102 & 0.0000 \\ 0.0170 & 0.0525 & 0.1651 & 0.6075 & 0.1220 & 0.0190 & 0.0169 & 0.0000 \\ 0.0276 & 0.0085 & 0.0352 & 0.2608 & 0.4774 & 0.1690 & 0.0215 & 0.0000 \\ 0.0002 & 0.0127 & 0.0429 & 0.0898 & 0.2605 & 0.3345 & 0.2444 & 0.0150 \\ 0.0189 & 0.0210 & 0.0409 & 0.0213 & 0.2008 & 0.2026 & 0.4079 & 0.0866 \\ 0.0000 & 0.0000 & 0.0000 & 0.0000 & 0.0127 & 0.1701 & 0.2386 & 0.5786 \end{pmatrix},$$

where $\Gamma_i(j,k) = \pi(e_{i+1} = e_{i+1}^k | e_i = e_i^j)$.

Survival Rates of Households. The survival rates ϕ_i at the end of age $i = \{20, ..., 109\}$ are the weighted averages of males and females and calculated from the period life table (Table 4.C6) in Social Security Administration (2001). The survival rates at the end of age 109 are replaced by zero.

Table 8: Survival Rates in 1998 in the United States (Weighted Average of Males and Females)

Age	Survival Rate	Age	Survival Rate	Age	Survival Rate	Age	Survival Rate	Age	Survival Rate
20	0.999104	40	0.997966	60	0.989315	80	0.937788	100	0.676630
21	0.999057	41	0.997807	61	0.988305	81	0.931527	101	0.658554
22	0.999027	42	0.997640	62	0.987134	82	0.924684	102	0.639355
23	0.999018	43	0.997451	63	0.985773	83	0.917252	103	0.618962
24	0.999023	44	0.997252	64	0.984249	84	0.909150	104	0.597297
25	0.999034	45	0.997027	65	0.982548	85	0.900275	105	0.574281
26	0.999040	46	0.996778	66	0.980759	86	0.890541	106	0.549828
27	0.999033	47	0.996514	67	0.979000	87	0.879882	107	0.523850
28	0.999006	48	0.996237	68	0.977325	88	0.868264	108	0.496251
29	0.998962	49	0.995938	69	0.975647	89	0.855676	109	0.000000
30	0.998911	50	0.995603	70	0.973769	90	0.842119		
31	0.998857	51	0.995222	71	0.971613	91	0.827606		
32	0.998796	52	0.994797	72	0.969264	92	0.812154		
33	0.998727	53	0.994324	73	0.966703	93	0.795784		
34	0.998651	54	0.993795	74	0.963868	94	0.778522		
35	0.998564	55	0.993198	75	0.960661	95	0.761075		
36	0.998466	56	0.992534	76	0.957027	96	0.743640		
37	0.998358	57	0.991818	77	0.952967	97	0.726432		
38	0.998240	58	0.991051	78	0.948449	98	0.709688		
39	0.998111	59	0.990216	79	0.943423	99	0.693653		

Source: Authors' calculations from the Table 4.C6, Social Security Administration (2001).

B The Computation of Equilibria

The algorithm to solve the model for a steady-state equilibrium and an equilibrium transition path is similar to those in Conesa and Krueger (1999), Nishiyama (2002), and Nishiyama and Smetters (2003).[23]

B.1 The Discretization of the State Space

The state of a household is $\mathbf{s}_i = (i, e_i, a_i, b_i) \in I \times E \times A \times B$, where $I = \{20, ..., 109\}$, $E = [e^{\min}, e^{\max}]$, $A = \left[a^{\min}, a^{\max}\right]$, and $B = [b^{\min}, b^{\max}]$. To compute an equilibrium, the state space of a household is discretized as $\hat{\mathbf{s}}_i \in I \times \hat{E}_i \times \hat{A} \times \hat{B}$, where $\hat{E}_i = \{e_i^1, e_i^2, ..., e_i^{N_e}\}$,

[23]The authors are grateful to José Víctor Ríos-Rull for his teaching of the computational procedure of heterogeneous agent models.

$\hat{A} = \{a^1, a^2, ..., a^{N_a}\}$, and $\hat{B} = \{b^1, b^2, ..., b^{N_b}\}$. For all these discrete points, the model computes the optimal decision of households, $\mathbf{d}(\hat{\mathbf{s}}_i, \mathbf{S}_t; \mathbf{\Psi}_t) = (c_i(.), h_i(.), a_{i+1}(.)) \in (0, c^{\max}] \times [0, h_i^{\max}] \times A$, the marginal values, $\frac{\partial}{\partial a} v(\hat{\mathbf{s}}_i, \mathbf{S}_t; \mathbf{\Psi}_t)$ and $\frac{\partial}{\partial b} v(\hat{\mathbf{s}}_i, \mathbf{S}_t; \mathbf{\Psi}_t)$, and the values $v(\hat{\mathbf{s}}_i, \mathbf{S}_t; \mathbf{\Psi}_t)$, given the expected factor prices and policy variables.[24]

To find the optimal end-of-period wealth, the model uses the Euler equation and bilinear interpolation (with respect to a and b) of marginal values at the beginning of the next period.[25] In a heterogeneous-agent economy, N_e, N_a, and N_b are 8, 57, and 8, respectively. In a representative-agent economy, the numbers of grid points are 1, 61, and 6, respectively.[26]

B.2 A Steady-State Equilibrium

The algorithm to compute a steady-state equilibrium is as follows. Let $\mathbf{\Psi}$ denote the time-invariant government policy rule $\mathbf{\Psi} = (W_R, W_G, C_G, tr_{LS}, \tau_I(.), \tau_P(.), tr_{SS}(.), tr_R(\hat{\mathbf{s}}_i))$.

1. Set the initial values of factor prices (r^0, w^0), accidental bequests q^0, the policy variables $(W_R^0, W_G^0, C_G^0, tr_{LS}^0)$, and the parameters φ^0 of policy functions $(\tau_I(.), \tau_P(.), tr_{SS}(.))$ if these are determined endogenously.[27]

2. Given $\mathbf{\Omega}^0 = (r^0, w^0, q^0, W_R^0, W_G^0, C_G^0, tr_{LS}^0, \varphi^0)$, find the decision rule of a household $\mathbf{d}(\hat{\mathbf{s}}_i; \mathbf{\Psi}, \mathbf{\Omega}^0)$ for all $\hat{\mathbf{s}}_i \in I \times \hat{E}_i \times \hat{A} \times \hat{B}$.[28]

   (a) For age $i = 109$, find the decision rule $\mathbf{d}(\hat{\mathbf{s}}_{109}; \mathbf{\Psi}, \mathbf{\Omega}^0)$. Since the survival rate $\phi_{109} = 0$, the end-of-period wealth $a_{i+1}(\hat{\mathbf{s}}_{109}; .) = 0$ for all $\hat{\mathbf{s}}_{109}$. Compute consumption and working hours $(c_i(\hat{\mathbf{s}}_{109}; .), h_i(\hat{\mathbf{s}}_{109}; .))$ and, then, marginal values $\frac{\partial}{\partial a} v(\hat{\mathbf{s}}_{109}; \mathbf{\Psi}, \mathbf{\Omega}^0)$ and values $v(\hat{\mathbf{s}}_{109}; \mathbf{\Psi}, \mathbf{\Omega}^0)$ for all $\hat{\mathbf{s}}_{109}$.[29]

   (b) For age $i = 108, ..., 20$, find the decision rule $\mathbf{d}(\hat{\mathbf{s}}_i; \mathbf{\Psi}, \mathbf{\Omega}^0)$, marginal values $\frac{\partial}{\partial a} v(\hat{\mathbf{s}}_i; \mathbf{\Psi}, \mathbf{\Omega}^0)$, and values $v(\hat{\mathbf{s}}_i; \mathbf{\Psi}, \mathbf{\Omega}^0)$ for all $\hat{\mathbf{s}}_i$, using $\frac{\partial}{\partial a} v(\hat{\mathbf{s}}_{i+1}; \mathbf{\Psi}, \mathbf{\Omega}^0)$ and $\frac{\partial}{\partial b} v(\hat{\mathbf{s}}_{i+1}; \mathbf{\Psi}, \mathbf{\Omega}^0)$ recursively.

      i. Set the initial guess of $a_{i+1}^0(\hat{\mathbf{s}}_i; .)$.

      ii. Given $a_{i+1}^0(\hat{\mathbf{s}}_i; .)$, compute $(c_i(\hat{\mathbf{s}}_i; .), h_i(\hat{\mathbf{s}}_i; .))$, using $\frac{\partial}{\partial b} v(\hat{\mathbf{s}}_{i+1}; \mathbf{\Psi}, \mathbf{\Omega}^0)$. Plug these into the Euler equation with $\frac{\partial}{\partial a} v(\hat{\mathbf{s}}_{i+1}; \mathbf{\Psi}, \mathbf{\Omega}^0)$.

[24] Because the marginal value with respect to historical earnings, $\frac{\partial}{\partial b} v(\hat{\mathbf{s}}_i, \mathbf{S}_t; \mathbf{\Psi}_t)$, is difficult to obtain analytically, it is approximated by $(v(., b^{j+1}, \mathbf{S}_t; \mathbf{\Psi}_t) - v(., b^j, \mathbf{S}_t; \mathbf{\Psi}_t))/(b^{j+1} - b^j)$ where $j = 1, 2, ..., N_b$.

[25] The marginal values with respect to wealth, $\frac{\partial}{\partial a} v(\hat{\mathbf{s}}_i, \mathbf{S}_t; \mathbf{\Psi}_t)$, are used in the Euler equation to obtain optimal savings, the marginal values with respect to historical earnings, $\frac{\partial}{\partial b} v(\hat{\mathbf{s}}_i, \mathbf{S}_t; \mathbf{\Psi}_t)$, are used in the marginal rate of substitution condition of consumption for leisure to obtain optimal working hours, and the values, $v(\hat{\mathbf{s}}_i, \mathbf{S}_t; \mathbf{\Psi}_t)$, are used to calculate welfare changes measured by compensating and equivalent variations in wealth.

[26] The grid points on A and B are not equally spaced. In a heterogeneous-agent economy, $\hat{A}$ ranges from -$271,000 to $33,825,000 (in 2001 growth-adjusted dollars) and $\hat{B}$ ranges from $8,000 to $80,400. In a representative-agent economy, $\hat{A}$ and $\hat{B}$ range from -$333,000 to $1,573,000 and from $8,000 to $80,400, respectively.

[27] Actually, if we find the capital-labor ratio, both r and w are calculated from the given production function and depreciation rate.

[28] In the steady-state economy, the decision rule of a household $\mathbf{d}(\hat{\mathbf{s}}_i; \mathbf{\Psi}, \mathbf{\Omega}^0)$ is not a function of the aggregate state of economy $\hat{\mathbf{S}} = (x(\hat{\mathbf{s}}_i), W_R, W_G)$. The measure of household $x(\hat{\mathbf{s}}_i)$ is determined uniquely by the steady-state condition, and the government's wealth W_G is determined by the policy rule $\mathbf{\Psi}$.

[29] The marginal value with respect to historical earnings, $\frac{\partial}{\partial b} v(\hat{\mathbf{s}}_i; \mathbf{\Psi}, \mathbf{\Omega}^0)$, is zero when $i > 60$ in this paper.

iii. If the Euler error is sufficiently small, then stop. Otherwise, update $a^0_{i+1}(\hat{\mathbf{s}}_i;.)$ and return to Step ii.

3. Find the steady-state measure of households $x(\hat{\mathbf{s}}_i;\mathbf{\Omega}^0)$ using the decision rule obtained in Step 2. This computation is done forward from age 20 to age 109. Repeat this step to iterate q for q^1.

4. Compute new factor prices (r^1, w^1), the policy variables $(W^1_R, W^1_G, C^1_G, tr^1_{LS})$, and the parameters φ^1 of policy functions.[30]

5. Compare $\mathbf{\Omega}^1 = (r^1, w^1, q^1, W^1_G, C^1_G, tr^1_{LS}, \varphi^1)$ with $\mathbf{\Omega}^0$. If the difference is sufficiently small, then stop. Otherwise, update $\mathbf{\Omega}^0$ and return to Step 2.

B.3 An Equilibrium Transition Path

Assume that the economy is in the initial steady state in period 0, and that the new policy schedule (rule) $\mathbf{\Psi}_1$, which was not expected in period 0, is announced at the beginning of period 1, where $\mathbf{\Psi}_1 = \{W_{R,t+1}, W_{G,t+1}, C_{G,t}, tr_{LS,t}, \tau_{I,t}(.), \tau_{P,t}(.), tr_{SS,t}(.), tr_{R,t}(\hat{\mathbf{s}}_i)\}^{\infty}_{t=1}$. Let $\hat{\mathbf{S}}_1 = (x_1(\hat{\mathbf{s}}_i), W_{R,1}, W_{G,1})$ be the state of the economy at the beginning of period 1. The state of the economy $\hat{\mathbf{S}}_1$ is usually equal to that of the initial steady state. The algorithm to compute a transition path to a new steady-state equilibrium (thereafter, final steady-state equilibrium) is as follows.

1. Choose a sufficiently large number, T, such that the economy is said to reach the new steady state within T periods.[31] Set the initial guess, $\{\mathbf{\Omega}^0_t\}^T_{t=1}$, on factor prices (r^0_t, w^0_t), accidental bequests q^0_t, the policy variables $(W^0_{R,t+1}, W^0_{G,t+1}, C^0_{G,t}, tr^0_{LS,t})$, and the parameters φ^0_t of policy functions for $t = 1, 2, ..., T$.

2. Given $\mathbf{\Omega}^0_T = (r^0_T, w^0_T, q^0_T, W^0_{R,T}, W^0_{G,T}, C^0_{G,T}, tr^0_{LS,T}, \varphi^0_T)$, find the final steady-state decision rule $\mathbf{d}(\hat{\mathbf{s}}_i, \hat{\mathbf{S}}_T; \mathbf{\Psi}_T; \mathbf{\Omega}^0_T)$, marginal values, $\frac{\partial}{\partial a}v(\hat{\mathbf{s}}_i, \hat{\mathbf{S}}_T; \mathbf{\Psi}_T; \mathbf{\Omega}^0_T)$, and values $v(\hat{\mathbf{s}}_i, \hat{\mathbf{S}}_T; \mathbf{\Psi}_T; \mathbf{\Omega}^0_T)$ for all $\hat{\mathbf{s}}_i \in I \times \hat{E}_i \times \hat{A} \times \hat{B}$. (See the algorithm for a steady-state equilibrium.)

3. For period $t = T-1, T-2, ..., 1$, based on the guess, $\mathbf{\Omega}^0_t$, find backward the decision rule $\mathbf{d}(\hat{\mathbf{s}}_i, \hat{\mathbf{S}}_t; \mathbf{\Psi}_t; \mathbf{\Omega}^0_t)$, marginal values $\frac{\partial}{\partial a}v(\hat{\mathbf{s}}_i, \hat{\mathbf{S}}_t; \mathbf{\Psi}_t; \mathbf{\Omega}^0_t)$, and values $v(\hat{\mathbf{s}}_i, \hat{\mathbf{S}}_t; \mathbf{\Psi}_t; \mathbf{\Omega}^0_t)$ for all $\hat{\mathbf{s}}_i \in I \times \hat{E}_i \times \hat{A} \times \hat{B}$, using the next period marginal values $\frac{\partial}{\partial a}v(\hat{\mathbf{s}}_{i+1}, \hat{\mathbf{S}}_{t+1}; \mathbf{\Psi}_{t+1}; \mathbf{\Omega}^0_{t+1})$ and values $v(\hat{\mathbf{s}}_{i+1}, \hat{\mathbf{S}}_{t+1}; \mathbf{\Psi}_{t+1}; \mathbf{\Omega}^0_{t+1})$ recursively.

4. For period $t = 1, 2, ..., T-1$, compute forward $\mathbf{\Omega}^1_t = (r^1_t, w^1_t, q^1_t, W^1_{G,t+1}, C^1_{G,t}, tr^1_{LS,t}, \varphi^1_t)$ and the measure of households $x_{t+1}(\widehat{\mathbf{s}}_i)$, using the decision rule $\mathbf{d}(\hat{\mathbf{s}}_i, \hat{\mathbf{S}}_t; \mathbf{\Psi}_t; \mathbf{\Omega}^0_t)$ obtained in Step 3 and using the state of economy $\hat{\mathbf{S}}_t = (x_t(\hat{\mathbf{s}}_i), W_{R,t}, W_{G,t})$ recursively.

[30] In this paper, the endogenous policy variables are C_G in baseline economies and $\varphi_{\tau r}$ or φ_I, φ_P, and W_R in policy experiments.

[31] As in Auerbach and Kotlikoff (1987), we found setting T at 150 to be sufficient.

5. Compare $\{\mathbf{\Omega}_t^1\}_{t=1}^T$ with $\{\mathbf{\Omega}_t^0\}_{t=1}^T$. If the difference is sufficiently small, then stop. Otherwise, update $\{\mathbf{\Omega}_t^0\}_{t=1}^T$ and return to Step 2. If the final steady-state equilibrium is known, return to Step 3 instead.

B.4 The Lump-Sum Redistribution Authority

When the Lump-Sum Redistribution Authority (LSRA) is assumed, the following computation is added to the iteration process.

1. For period $t = T, T-1, ..., 2$, compute the lump-sum transfers to newborn households $tr_{CV}(\hat{\mathbf{s}}_{20}, \hat{\mathbf{S}}_t; \mathbf{\Psi}_t, \mathbf{\Omega}_t^0)$ to make those households as well off as under the pre-reform economy.
   (a) Set the initial value of lump-sum transfers $tr_{CV}(\hat{\mathbf{s}}_{20}, \hat{\mathbf{S}}_t; \mathbf{\Psi}_t; \mathbf{\Omega}_t^0)$ to newborn households.
   (b) Given $tr_{CV}(\hat{\mathbf{s}}_{20}, \hat{\mathbf{S}}_t; .)$, find the decision rule of newborn households $\mathbf{d}(\hat{\mathbf{s}}_{20}, \hat{\mathbf{S}}_t; .)$ and values $v(\hat{\mathbf{s}}_{20}, \hat{\mathbf{S}}_t; .)$.
   (c) Find the compensating variation in wealth $\Delta tr_{CV}(\hat{\mathbf{s}}_{20}, \hat{\mathbf{S}}_t; .)$ to make those households indifferent from the baseline economy. (The initial wealth of newborn households is assumed to be zero since they do not receive any bequests.) If the absolute value of $\Delta tr_{CV}(\hat{\mathbf{s}}_{20}, \hat{\mathbf{S}}_t; .)$ is sufficiently small, then go to Step (d). Otherwise, update $tr_{CV}(\hat{\mathbf{s}}_{20}, \hat{\mathbf{S}}_t; .)$ by adding $\Delta tr_{CV}(\hat{\mathbf{s}}_{20}, \hat{\mathbf{S}}_t; .)$ and return to Step (b).
   (d) Set the lump-sum transfers $tr_{R,t}(\hat{\mathbf{s}}_{20}) = tr_{CV}(\hat{\mathbf{s}}_{20}, \hat{\mathbf{S}}_t; .) + \Delta tr$ where an additional lump-sum transfer Δtr is precalculated, and find the decision rule of newborn households $\mathbf{d}(\hat{\mathbf{s}}_{20}, \hat{\mathbf{S}}_t; .)$.
2. For period $t = 1$, compute the lump-sum transfers to all current households $tr_{CV}(\hat{\mathbf{s}}_i, \hat{\mathbf{S}}_1; \mathbf{\Psi}_1; \mathbf{\Omega}_1^0)$ to make those households as much better off as the pre-reform economy. The procedure is similar to Step 1. Set the lump-sum transfers $tr_{R,1}(\hat{\mathbf{s}}_i) = tr_{CV}(\hat{\mathbf{s}}_i, \hat{\mathbf{S}}_1; .)$.
3. Compute an additional lump-sum transfer Δtr to newborn households so that the net present value of all transfers becomes zero. Compute the LSRA wealth, $\{W_{R,t}^1\}_{t=1}^T$, which will be used to calculate national wealth. Recompute Δtr and $\{W_{R,t}^1\}_{t=1}^T$ using new interest rates $\{r_t\}_{t=1}^T$.

C Detailed Tables of Policy Experiments

[PRELIMINARY. See the footnote of Table 7 in Section 4.] Tables A.1 (a) to A.14 (a) show the effects of Social Security privatization on macroeconomic variables in selected years and Tables A.1 (b) to A.14 (b) show the welfare gains or losses of households of selected age cohorts and temporary working abilities.

Table A.1 (a) The Immediate Elimination of OASDI with Lump-Sum Transfer Adjustments

(Changes from the Baseline Economy; In a Representative-Agent Economy without Working Ability Shocks; With LSRA; With Perfect Annuity Markets)

	Year													Average		
	1	5	10	15	20	25	30	40	50	60	80	100	150	01-25	26-50	51-75
(Closed Economy)																
%ch(National Wealth)	0.0	1.0	2.1	3.0	3.6	4.0	4.4	4.7	4.8	4.8	4.8	4.8	4.9	2.4	4.6	4.8
%ch(Labor)	4.9	4.8	4.6	4.3	4.2	4.1	4.0	3.9	3.8	3.9	3.9	3.9	3.9	4.5	3.9	3.9
%ch(GNP=GDP)	3.4	3.6	3.8	3.9	4.0	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.2	3.8	4.1	4.1
%ch(Consumption)	4.5	4.5	4.7	4.8	4.9	5.0	5.0	5.1	5.1	5.2	5.2	5.2	5.2	4.7	5.1	5.2
%ch(Gross Investment)	3.4	4.3	4.7	4.9	5.0	5.1	5.1	5.0	4.8	4.8	4.8	4.8	4.9	4.7	5.0	4.8
ch(Lump-Sum Transfer/GDP%)	3.85	3.87	3.88	3.89	3.89	3.89	3.89	3.88	3.87	3.88	3.88	3.88	3.88	3.88	3.88	3.88
ch(Income Tax/GDP%)	3.17	3.20	3.23	3.26	3.27	3.28	3.28	3.28	3.28	3.29	3.29	3.28	3.29	3.24	3.28	3.28
ch(Interest Rate%)	0.37	0.28	0.18	0.10	0.04	0.00	-0.03	-0.06	-0.07	-0.07	-0.07	-0.07	-0.07	0.15	-0.05	-0.07
%ch(Wage Rate)	-1.4	-1.1	-0.7	-0.4	-0.2	0.0	0.1	0.3	0.3	0.3	0.3	0.3	0.3	-0.6	0.2	0.3
ch(Private Wealth/GDP%)	0.0	97.0	101.5	104.9	107.4	109.2	110.4	111.6	111.8	111.8	111.8	111.8	111.9	98.9	111.2	111.8
ch(Gov't Wealth/GDP%)	0.0	-94.2	-95.7	-96.8	-97.6	-98.1	-98.4	-98.6	-98.7	-98.7	-98.7	-98.7	-98.6	-92.3	-98.5	-98.7
(Small Open Economy)																
%ch(National Wealth)	0.0	0.2	1.2	2.5	3.8	5.1	6.3	8.0	8.7	9.0	9.1	9.1	9.1	2.1	7.5	9.0
%ch(Labor)	5.0	5.2	5.1	4.9	4.6	4.4	4.1	3.7	3.5	3.5	3.5	3.5	3.5	4.9	3.8	3.5
%ch(GNP)	3.5	3.7	3.9	4.2	4.4	4.6	4.8	5.0	5.1	5.1	5.2	5.2	5.2	4.1	4.9	5.1
%ch(GDP)	5.0	5.2	5.1	4.9	4.6	4.4	4.1	3.7	3.5	3.5	3.5	3.5	3.5	4.9	3.8	3.5
%ch(Consumption)	5.8	5.3	5.0	4.8	4.7	4.7	4.7	4.9	5.1	5.3	5.4	5.4	5.4	5.0	4.9	5.3
%ch(Gross Dom. Investment)	68.5	5.5	4.4	4.3	4.0	3.7	3.5	3.2	3.5	3.5	3.5	3.5	3.5	7.1	3.4	3.5
ch(Lump-Sum Transfer/GDP%)	3.88	3.92	3.94	3.95	3.96	3.95	3.94	3.91	3.88	3.89	3.89	3.89	3.89	3.94	3.91	3.89
ch(Income Tax/GDP%)	3.26	3.29	3.31	3.32	3.33	3.33	3.32	3.30	3.28	3.28	3.28	3.28	3.28	3.31	3.30	3.28
ch(Net Foreign Assets/GDP%)	-13.7	-13.5	-10.6	-6.6	-2.3	2.0	5.9	11.7	14.4	15.3	15.5	15.5	15.4	-7.5	10.0	15.3
ch(Private Wealth/GDP%)	0.0	95.0	97.6	100.9	104.5	108.0	111.2	115.8	117.9	118.8	119.0	119.0	119.0	96.3	114.4	118.8
ch(Gov't Wealth/GDP%)	0.0	-94.3	-94.2	-94.2	-94.1	-94.0	-94.0	-94.0	-94.0	-94.0	-94.0	-94.0	-94.1	-90.4	-94.0	-94.0

Table A.1 (b) Efficiency Gains and Losses Corresponding to Table A.1 (a)

(Compensating Variations in Wealth; In 1,000 Growth-Adjusted US Dollars)

	Year When Age 20 (Top) / Age in Year 1 (Bottom)																
	-88	-79	-69	-59	-49	-39	-29	-19	-9	1	11	21	41	61	81	101	120
	109	100	90	80	70	60	50	40	30	20	10	0	-20	-40	-60	-80	-99
(Closed Economy)	delta_tr ($1000) =			**23.75**													
After LSRA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.7	23.7	23.7	23.7	23.7	23.7	23.7
Before LSRA	-13.3	-68.9	-91.5	-165.7	-297.4	-282.5	-122.8	-0.9	83.7	125.9	129.2	131.3	132.8	132.9	132.9	132.9	133.0
(Small Open Economy)	delta_tr ($1000) =			**29.80**													
After LSRA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.8	29.8	29.8	29.8	29.8	29.8	29.8
Before LSRA	-13.3	-69.8	-93.1	-171.2	-307.8	-294.4	-128.8	0.0	90.7	136.6	136.6	136.4	135.8	135.9	135.9	135.9	135.9

Note: The efficiency gains are evaluated at the beginning of year 1 for current households and at the beginning of age 20 for future households. The numbers are growth adjusted but not discounted.

Table A.2 (a) The Immediate Elimination of OASDI with Income Tax Rate Adjustments

(In a Representative-Agent Economy without Working Ability Shocks; With LSRA; With Perfect Annuity Markets)

	Year													Average		
	1	5	10	15	20	25	30	40	50	60	80	100	150	01-25	26-50	51-75
(Closed Economy)																
%ch(National Wealth)	0.0	8.6	16.4	21.8	25.6	28.2	29.9	31.6	31.8	31.8	31.8	31.7	31.8	17.8	31.0	31.8
%ch(Labor)	17.9	16.9	15.9	15.5	15.1	14.8	14.5	14.1	13.8	14.1	14.1	14.1	14.1	15.9	14.2	14.1
%ch(GNP=GDP)	12.2	14.3	16.1	17.3	18.2	18.7	18.9	19.1	18.9	19.1	19.2	19.1	19.2	16.4	19.0	19.1
%ch(Consumption)	8.9	12.2	15.0	16.9	18.2	19.0	19.5	20.1	20.2	20.4	20.5	20.5	20.5	15.4	19.9	20.4
%ch(Gross Investment)	32.7	33.1	33.2	33.7	33.9	33.7	33.5	32.7	31.6	31.9	31.7	31.7	31.8	33.5	32.7	31.8
ch(Lump-Sum Transfer/GDP%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ch(Income Tax/GDP%)	-1.36	-1.27	-1.20	-1.16	-1.14	-1.11	-1.10	-1.07	-1.05	-1.07	-1.07	-1.07	-1.07	-1.20	-1.07	-1.07
ch(Interest Rate%)	1.34	0.58	-0.03	-0.40	-0.65	-0.81	-0.92	-1.04	-1.07	-1.05	-1.05	-1.05	-1.05	-0.09	-1.00	-1.05
%ch(Wage Rate)	-4.8	-2.2	0.1	1.6	2.6	3.4	3.9	4.4	4.5	4.4	4.4	4.4	4.4	0.4	4.2	4.4
ch(Private Wealth/GDP%)	0.0	90.0	119.0	138.9	152.8	162.0	167.9	173.5	173.7	173.6	173.5	173.5	173.5	121.8	171.3	173.6
ch(Gov't Wealth/GDP%)	0.0	-66.5	-74.1	-79.2	-82.7	-84.8	-86.0	-86.8	-86.6	-86.5	-86.5	-86.5	-86.3	-73.0	-86.4	-86.5
(Small Open Economy)																
%ch(National Wealth)	0.0	17.2	38.4	58.6	77.4	94.0	108.1	127.8	136.3	139.7	141.0	141.1	141.1	49.3	121.8	139.8
%ch(Labor)	25.7	24.2	21.9	20.0	17.7	15.2	12.8	8.3	5.9	6.2	6.3	6.3	6.3	20.7	9.5	6.2
%ch(GNP)	18.0	22.1	26.8	31.5	35.6	38.9	41.4	44.2	45.0	46.3	46.7	46.7	46.7	29.3	43.2	46.3
%ch(GDP)	25.7	24.2	21.9	20.0	17.7	15.2	12.8	8.3	5.9	6.2	6.3	6.3	6.3	20.7	9.5	6.2
%ch(Consumption)	9.5	10.4	11.9	13.8	15.8	17.7	19.6	22.8	25.3	27.4	28.6	28.6	28.6	13.2	22.0	27.5
%ch(Gross Dom. Investment)	350.9	20.0	16.4	14.7	11.6	8.9	6.7	3.0	6.5	6.5	6.3	6.3	6.3	28.4	4.7	6.4
ch(Lump-Sum Transfer/GDP%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ch(Income Tax/GDP%)	-1.34	-1.36	-1.40	-1.44	-1.46	-1.46	-1.44	-1.36	-1.30	-1.34	-1.35	-1.35	-1.35	-1.41	-1.37	-1.34
ch(Net Foreign Assets/GDP%)	-70.3	-19.2	45.2	105.9	163.6	215.9	261.2	327.4	357.4	365.9	369.2	369.4	369.5	78.6	307.8	365.9
ch(Private Wealth/GDP%)	0.0	26.9	84.9	140.0	191.2	236.8	275.4	329.6	353.1	362.5	366.0	366.2	366.2	115.6	313.1	362.6
ch(Gov't Wealth/GDP%)	0.0	20.1	20.3	20.6	20.8	20.8	20.8	20.6	20.4	20.4	20.4	20.4	20.4	19.7	20.6	20.4

Table A.2 (b) Efficiency Gains and Losses Corresponding to Table A.2 (a)

(Compensating Variations in Wealth; In 1,000 Growth-Adjusted US Dollars)

	Year When Age 20 (Top) / Age in Year 1 (Bottom)																
	-88	-79	-69	-59	-49	-39	-29	-19	-9	1	11	21	41	61	81	101	120
	109	100	90	80	70	60	50	40	30	20	10	0	-20	-40	-60	-80	-99
(Closed Economy)	delta_tr ($1000) =			**147.8**													
After LSRA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	147.8	147.8	147.8	147.8	147.8	147.8	147.8
Before LSRA	-16.0	-60.9	-105.2	-183.1	-319.1	-296.1	-96.0	54.1	142.7	162.3	192.4	207.6	216.7	216.3	216.2	216.3	216.2
(Small Open Economy)	delta_tr ($1000) =			**280.5**													
After LSRA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	280.5	280.5	280.5	280.5	280.5	280.5	280.5
Before LSRA	-16.2	-62.6	-110.3	-195.8	-336.1	-288.6	-39.0	153.0	258.7	258.5	259.3	257.6	256.6	257.5	257.5	257.5	257.5

Note: The efficiency gains are evaluated at the beginning of year 1 for current households and at the beginning of age 20 for future households. The numbers are growth adjusted but not discounted.

Table A.3 (a) The Immediate Elimination of OASDI with Lump-Sum Transfer Adjustments

(Changes from the Baseline Economy; In a Representative-Agent Economy without Working Ability Shocks; With LSRA; Without Perfect Annuity Markets)

	Year													Average		
	1	5	10	15	20	25	30	40	50	60	80	100	150	01-25	26-50	51-75
(Closed Economy)																
%ch(National Wealth)	0.0	0.8	1.7	2.3	2.7	3.0	3.2	3.3	3.3	3.3	3.3	3.3	3.4	1.9	3.3	3.3
%ch(Labor)	4.4	4.2	4.0	3.9	3.8	3.7	3.7	3.7	3.7	3.8	3.8	3.8	3.7	4.0	3.7	3.8
%ch(GNP=GDP)	3.1	3.2	3.3	3.4	3.5	3.5	3.5	3.6	3.6	3.6	3.6	3.6	3.6	3.3	3.6	3.6
%ch(Consumption)	4.0	4.0	4.1	4.2	4.3	4.4	4.5	4.5	4.6	4.6	4.6	4.6	4.6	4.2	4.5	4.6
%ch(Gross Investment)	2.9	3.4	3.6	3.7	3.7	3.6	3.5	3.4	3.4	3.3	3.3	3.3	3.4	3.5	3.4	3.3
ch(Lump-Sum Transfer/GDP%)	4.48	4.50	4.51	4.51	4.51	4.51	4.51	4.51	4.52	4.52	4.52	4.52	4.52	4.51	4.51	4.52
ch(Income Tax/GDP%)	3.72	3.75	3.77	3.79	3.80	3.80	3.80	3.81	3.81	3.81	3.81	3.81	3.81	3.77	3.81	3.81
ch(Interest Rate%)	0.33	0.26	0.18	0.12	0.08	0.05	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.16	0.03	0.03
%ch(Wage Rate)	-1.3	-1.0	-0.7	-0.5	-0.3	-0.2	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.6	-0.1	-0.1
ch(Private Wealth/GDP%)	0.0	157.6	161.4	164.1	165.9	167.0	167.6	168.1	168.2	168.2	168.2	168.2	168.3	156.0	167.9	168.2
ch(Gov't Wealth/GDP%)	0.0	-155.4	-156.8	-157.7	-158.3	-158.7	-158.9	-159.0	-159.0	-159.0	-159.0	-159.0	-159.0	-150.8	-159.0	-159.0
(Small Open Economy)																
%ch(National Wealth)	0.0	-0.4	-0.5	-0.4	-0.2	0.0	0.1	0.2	0.3	0.3	0.3	0.3	0.2	-0.3	0.2	0.3
%ch(Labor)	4.1	4.2	4.2	4.2	4.1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.2	4.0	4.0
%ch(GNP)	2.9	2.8	2.8	2.8	2.8	2.8	2.8	2.9	2.9	2.9	2.9	2.9	2.9	2.8	2.9	2.9
%ch(GDP)	4.1	4.2	4.2	4.2	4.1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.2	4.0	4.0
%ch(Consumption)	5.3	4.9	4.6	4.4	4.4	4.3	4.3	4.4	4.4	4.5	4.5	4.5	4.5	4.6	4.4	4.5
%ch(Gross Dom. Investment)	56.6	4.3	4.3	4.0	3.9	3.9	3.9	4.0	4.0	4.0	4.0	4.0	4.1	6.2	4.0	4.0
ch(Lump-Sum Transfer/GDP%)	4.48	4.49	4.51	4.51	4.51	4.50	4.50	4.50	4.51	4.51	4.51	4.51	4.51	4.50	4.50	4.51
ch(Income Tax/GDP%)	3.77	3.79	3.80	3.81	3.80	3.80	3.80	3.80	3.80	3.80	3.80	3.80	3.80	3.80	3.80	3.80
ch(Net Foreign Assets/GDP%)	-11.3	-12.6	-12.9	-12.4	-11.7	-11.1	-10.6	-10.3	-10.3	-10.3	-10.2	-10.2	-10.5	-12.2	-10.5	-10.3
ch(Private Wealth/GDP%)	0.0	161.0	160.7	161.1	161.6	162.1	162.5	162.8	162.9	163.0	163.0	163.1	163.0	154.8	162.7	163.0
ch(Gov't Wealth/GDP%)	0.0	-162.1	-162.0	-162.0	-162.1	-162.1	-162.2	-162.2	-162.2	-162.2	-162.2	-162.2	-162.5	-155.6	-162.2	-162.2

Table A.3 (b) Efficiency Gains and Losses Corresponding to Table A.3 (a)

(Compensating Variations in Wealth; In 1,000 Growth-Adjusted US Dollars)

	Year When Age 20 (Top) / Age in Year 1 (Bottom)																
	-88	-79	-69	-59	-49	-39	-29	-19	-9	1	11	21	41	61	81	101	120
	109	100	90	80	70	60	50	40	30	20	10	0	-20	-40	-60	-80	-99
(Closed Economy)	delta_tr ($1000) =			**-3.65**													
After LSRA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-3.6	-3.6	-3.6	-3.6	-3.6	-3.6	-3.6
Before LSRA	-13.0	-81.5	-170.4	-298.5	-449.4	-416.6	-194.4	-19.9	105.0	174.5	177.1	178.8	179.8	180.0	180.0	180.0	180.0
(Small Open Economy)	delta_tr ($1000) =			**-7.73**													
After LSRA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-7.7	-7.7	-7.7	-7.7	-7.7	-7.7	-7.7
Before LSRA	-13.0	-82.1	-172.9	-305.7	-463.4	-433.0	-205.5	-25.3	104.8	179.0	177.7	177.4	177.8	177.9	177.9	177.9	177.9

Note: The efficiency gains are evaluated at the beginning of year 1 for current households and at the beginning of age 20 for future households. The numbers are growth adjusted but not discounted.

Table A.4 (a) The Immediate Elimination of OASDI with Income Tax Rate Adjustments

(Changes from the Baseline Economy; In a Representative-Agent Economy without Working Ability Shocks; With LSRA; Without Perfect Annuity Markets)

	Year													Average		
	1	5	10	15	20	25	30	40	50	60	80	100	150	01-25	26-50	51-75
(Closed Economy)																
%ch(National Wealth)	0.0	8.9	16.7	22.0	25.5	27.8	29.3	30.6	30.7	30.7	30.7	30.7	30.7	17.9	30.1	30.7
%ch(Labor)	18.0	17.0	16.2	15.7	15.4	15.1	14.9	14.7	14.5	14.7	14.7	14.7	14.7	16.1	14.7	14.7
%ch(GNP=GDP)	12.3	14.5	16.4	17.5	18.3	18.8	19.1	19.2	19.1	19.3	19.3	19.3	19.3	16.6	19.1	19.3
%ch(Consumption)	8.6	12.0	14.9	16.8	18.1	18.9	19.4	19.9	20.0	20.1	20.2	20.2	20.2	15.3	19.7	20.1
%ch(Gross Investment)	33.9	33.8	33.7	33.3	32.9	32.5	32.2	31.3	30.6	30.8	30.7	30.7	30.7	33.3	31.5	30.7
ch(Lump-Sum Transfer/GDP%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ch(Income Tax/GDP%)	-1.57	-1.47	-1.40	-1.35	-1.32	-1.30	-1.29	-1.27	-1.26	-1.27	-1.27	-1.27	-1.27	-1.39	-1.27	-1.27
ch(Interest Rate%)	1.35	0.57	-0.03	-0.40	-0.63	-0.77	-0.86	-0.95	-0.97	-0.96	-0.96	-0.96	-0.96	-0.08	-0.92	-0.96
%ch(Wage Rate)	-4.8	-2.1	0.1	1.6	2.6	3.2	3.6	4.0	4.1	4.0	4.0	4.0	4.0	0.4	3.8	4.0
ch(Private Wealth/GDP%)	0.0	178.2	211.9	234.2	248.9	258.1	263.8	268.6	268.9	268.9	268.9	268.9	268.9	211.2	266.7	268.9
ch(Gov't Wealth/GDP%)	0.0	-154.0	-166.1	-174.0	-178.9	-181.9	-183.6	-184.8	-184.8	-184.7	-184.7	-184.7	-184.7	-162.0	-184.3	-184.7
(Small Open Economy)																
%ch(National Wealth)	0.0	16.3	36.0	54.3	70.9	85.4	97.4	113.8	121.3	124.6	126.3	126.4	126.4	45.5	108.9	124.7
%ch(Labor)	24.8	23.2	21.1	19.2	17.2	15.1	13.2	10.0	8.3	8.4	8.3	8.2	8.2	20.0	10.8	8.3
%ch(GNP)	17.4	21.1	25.5	29.7	33.3	36.2	38.4	41.1	42.2	43.2	43.7	43.7	43.7	27.6	40.2	43.3
%ch(GDP)	24.8	23.2	21.1	19.2	17.2	15.1	13.2	10.0	8.3	8.4	8.3	8.2	8.2	20.0	10.8	8.3
%ch(Consumption)	9.3	10.3	11.9	13.8	15.7	17.6	19.3	22.0	23.9	25.3	26.1	26.2	26.2	13.2	21.3	25.4
%ch(Gross Dom. Investment)	339.1	18.5	13.4	14.3	11.9	10.0	8.3	6.6	8.4	8.4	8.2	8.2	8.3	27.6	7.4	8.3
ch(Lump-Sum Transfer/GDP%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ch(Income Tax/GDP%)	-1.48	-1.50	-1.54	-1.58	-1.60	-1.61	-1.60	-1.56	-1.54	-1.56	-1.57	-1.57	-1.57	-1.56	-1.57	-1.56
ch(Net Foreign Assets/GDP%)	-67.9	-18.9	40.8	96.1	147.3	192.5	230.8	284.5	309.6	318.5	323.4	323.8	323.8	70.0	268.6	318.9
ch(Private Wealth/GDP%)	0.0	118.7	174.9	227.1	274.5	315.8	350.1	397.1	419.0	428.6	433.3	433.7	433.6	199.2	383.1	428.9
ch(Gov't Wealth/GDP%)	0.0	-74.2	-76.3	-78.3	-80.2	-81.8	-83.2	-85.4	-86.6	-87.1	-87.3	-87.3	-87.3	-74.5	-84.8	-87.1

Table A.4 (b) Efficiency Gains and Losses Corresponding to Table A.4 (a)

(Compensating Variations in Wealth; In 1,000 Growth-Adjusted US Dollars)

	Year When Age 20 (Top) / Age in Year 1 (Bottom)																
	-88	-79	-69	-59	-49	-39	-29	-19	-9	1	11	21	41	61	81	101	120
	109	100	90	80	70	60	50	40	30	20	10	0	-20	-40	-60	-80	-99
(Closed Economy)	delta_tr ($1000) =			**123.9**													
After LSRA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	123.9	123.9	123.9	123.9	123.9	123.9	123.9
Before LSRA	-16.2	-112.1	-212.2	-347.9	-502.0	-458.9	-188.8	23.5	158.1	212.2	250.7	268.0	277.2	277.7	277.6	277.6	277.6
(Small Open Economy)	delta_tr ($1000) =			**225.4**													
After LSRA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	225.4	225.4	225.4	225.4	225.4	225.4	225.4
Before LSRA	-16.4	-114.7	-221.4	-366.0	-524.6	-454.5	-132.9	116.6	261.3	292.0	299.2	306.1	318.0	324.4	325.2	325.3	325.3

Note: The efficiency gains are evaluated at the beginning of year 1 for current households and at the beginning of age 20 for future households. The numbers are growth adjusted but not discounted.

Table A.5 (a) The Immediate Elimination of OASDI with Lump-Sum Transfer Adjustments

(Changes from the Baseline Economy; In a Heterogeneous-Agent Economy with Working Ability Shocks; With LSRA; With Perfect Annuity Markets)

	Year													Average		
	1	5	10	15	20	25	30	40	50	60	80	100	150	01-25	26-50	51-75
(Closed Economy)																
%ch(National Wealth)	0.0	-2.3	-4.0	-4.9	-5.4	-5.7	-5.8	-5.9	-5.9	-5.9	-5.9	-5.9	-5.9	-4.0	-5.9	-5.9
%ch(Labor)	2.3	2.5	2.8	3.0	3.1	3.2	3.2	3.3	3.3	3.3	3.3	3.3	3.3	2.9	3.3	3.3
%ch(GNP=GDP)	1.6	1.0	0.7	0.6	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.7	0.4	0.4
%ch(Consumption)	5.6	4.4	3.6	3.2	3.0	2.8	2.7	2.7	2.7	2.7	2.7	2.7	2.7	3.6	2.7	2.7
%ch(Gross Investment)	-8.9	-8.2	-7.2	-6.7	-6.4	-6.2	-6.0	-5.9	-5.9	-5.9	-5.9	-5.9	-5.9	-7.2	-5.9	-5.9
ch(Lump-Sum Transfer/GDP%)	1.44	1.40	1.41	1.43	1.44	1.44	1.45	1.45	1.45	1.45	1.45	1.46	1.45	1.42	1.45	1.45
ch(Income Tax/GDP%)	1.07	1.01	0.98	0.98	0.97	0.97	0.97	0.98	0.98	0.98	0.98	0.98	0.98	0.99	0.98	0.98
ch(Interest Rate%)	0.17	0.37	0.54	0.64	0.69	0.71	0.73	0.74	0.74	0.74	0.74	0.74	0.73	0.55	0.73	0.74
%ch(Wage Rate)	-0.7	-1.4	-2.0	-2.4	-2.6	-2.7	-2.7	-2.7	-2.8	-2.8	-2.8	-2.8	-2.7	-2.1	-2.7	-2.8
ch(Private Wealth/GDP%)	0.0	65.9	60.1	57.0	55.4	54.6	54.2	54.0	54.0	54.0	53.9	53.9	53.9	57.2	54.1	54.0
ch(Gov't Wealth/GDP%)	0.0	-72.1	-71.1	-70.6	-70.3	-70.2	-70.2	-70.1	-70.1	-70.1	-70.2	-70.2	-70.0	-68.2	-70.1	-70.1
(Small Open Economy)																
%ch(National Wealth)	0.0	-7.1	-13.6	-17.9	-20.8	-22.7	-23.9	-25.0	-25.3	-25.4	-25.4	-25.4	-25.4	-14.6	-24.6	-25.4
%ch(Labor)	-0.2	1.3	2.6	3.6	4.1	4.5	4.7	4.8	4.9	4.9	4.9	4.9	4.9	2.8	4.8	4.9
%ch(GNP)	-0.1	-1.3	-2.2	-2.9	-3.4	-3.7	-3.9	-4.1	-4.2	-4.2	-4.2	-4.2	-4.2	-2.4	-4.0	-4.2
%ch(GDP)	-0.2	1.3	2.6	3.6	4.1	4.5	4.7	4.8	4.9	4.9	4.9	4.9	4.9	2.8	4.8	4.9
%ch(Consumption)	8.8	7.2	5.6	4.4	3.6	2.9	2.5	2.0	1.8	1.7	1.7	1.7	1.7	5.2	2.1	1.7
%ch(Gross Dom. Investment)	-2.7	5.5	5.6	5.5	5.3	5.2	5.1	5.0	4.9	4.9	4.9	4.9	4.9	5.1	5.0	4.9
ch(Lump-Sum Transfer/GDP%)	1.27	1.34	1.41	1.45	1.48	1.49	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.41	1.50	1.50
ch(Income Tax/GDP%)	0.99	1.03	1.07	1.10	1.12	1.13	1.13	1.14	1.14	1.14	1.14	1.14	1.14	1.08	1.14	1.14
ch(Net Foreign Assets/GDP%)	0.5	-23.0	-44.4	-58.9	-68.4	-74.5	-78.3	-81.7	-82.8	-83.1	-83.1	-83.1	-83.1	-47.8	-80.6	-83.0
ch(Private Wealth/GDP%)	0.0	78.8	61.2	49.3	41.3	36.2	33.0	30.0	29.1	28.8	28.7	28.7	28.7	54.4	31.0	28.8
ch(Gov't Wealth/GDP%)	0.0	-98.3	-98.4	-98.4	-98.4	-98.5	-98.5	-98.5	-98.5	-98.5	-98.5	-98.5	-98.5	-94.5	-98.5	-98.5

Table A.5 (b) Efficiency Gains and Losses Corresponding to Table A.5 (a)

(Compensating Variations in Wealth; In 1,000 Growth-Adjusted US Dollars)

	Year When Age 20 (Top) / Age in Year 1 (Bottom)																
	-88	-79	-69	-59	-49	-39	-29	-19	-9	1	11	21	41	61	81	101	120
	109	100	90	80	70	60	50	40	30	20	10	0	-20	-40	-60	-80	-99
(Closed Economy)	delta_tr ($1000) =			**-41.37**													
After LSRA -- All	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-41.4	-41.4	-41.4	-41.4	-41.4	-41.4	-41.4
Before LSRA -- e1	-14.1	-56.5	-106.6	-192.6	-311.9	-247.1	-82.5	12.0	59.4	77.4	72.3	71.0	70.8	70.8	70.8	70.9	70.7
Before LSRA -- e3					-311.6	-278.1	-112.9	-0.8	65.9	88.6	83.4	82.1	81.8	81.7	81.8	81.8	81.7
Before LSRA -- e5					-300.9	-278.1	-111.9	7.4	80.0	103.9	98.6	97.2	96.9	96.8	96.9	96.9	96.8
Before LSRA -- e8					-198.8	-102.7	5.5	168.4	136.1	128.5	123.2	121.7	121.3	121.3	121.3	121.3	121.2
Before LSRA -- Average	-14.1	-56.5	-106.6	-192.6	-306.1	-268.7	-102.5	8.7	69.7	91.3	86.0	84.7	84.4	84.4	84.4	84.5	84.4
(Small Open Economy)	delta_tr ($1000) =			**-46.99**													
After LSRA -- All	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-47.0	-47.0	-47.0	-47.0	-47.0	-47.0	-47.0
Before LSRA -- e1	-14.3	-57.3	-108.8	-201.8	-333.0	-276.5	-110.7	-1.8	61.2	88.6	89.9	90.3	90.4	90.4	90.4	90.4	90.4
Before LSRA -- e3					-334.5	-315.7	-155.1	-28.1	56.9	96.2	97.5	97.9	98.0	98.0	98.0	98.0	98.0
Before LSRA -- e5					-330.4	-332.8	-175.1	-49.0	52.2	105.5	106.8	107.2	107.3	107.3	107.3	107.3	107.3
Before LSRA -- e8					-276.5	-309.1	-186.9	-84.9	28.9	114.9	116.2	116.7	116.8	116.8	116.8	116.8	116.8
Before LSRA -- Average	-14.3	-57.3	-108.8	-201.8	-331.2	-311.7	-150.8	-28.5	56.7	97.6	98.9	99.3	99.4	99.4	99.4	99.4	99.4

Note: The hourly wage of a household is stochastic, and it changes its class according to a Markov Transition matrix. The efficiency gain of each age-wage cohort is a population-weighted average across wealth holdings and historical earnings. The efficiency gains are evaluated at the beginning of year 1 for current households and at the beginning of age 20 for future households. The numbers are growth adjusted but not discounted.

Table A.6 (b) The Immediate Elimination of OASDI with Income Tax Rate Adjustments

(Changes from the Baseline Economy; In a Heterogeneous-Agent Economy with Working Ability Shocks; With LSRA; With Perfect Annuity Markets)

	Year													Average		
	1	5	10	15	20	25	30	40	50	60	80	100	150	01-25	26-50	51-75
(Closed Economy)																
%ch(National Wealth)	0.0	-1.5	-2.9	-3.6	-3.9	-4.0	-4.0	-4.0	-3.9	-4.0	-4.0	-4.0	-3.8	-2.9	-4.0	-4.0
%ch(Labor)	4.9	4.5	4.8	5.1	5.3	5.5	5.6	5.8	5.8	5.8	5.8	5.8	5.8	5.0	5.7	5.8
%ch(GNP=GDP)	3.4	2.7	2.4	2.4	2.5	2.6	2.6	2.8	2.8	2.8	2.8	2.8	2.8	2.6	2.7	2.8
%ch(Consumption)	7.3	6.4	5.8	5.6	5.6	5.6	5.7	5.8	5.9	5.9	5.9	5.9	5.9	5.9	5.8	5.9
%ch(Gross Investment)	-5.4	-6.1	-5.3	-4.8	-4.4	-4.1	-3.9	-3.9	-4.0	-4.0	-4.0	-4.0	-3.8	-5.1	-3.9	-4.0
ch(Lump-Sum Transfer/GDP%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ch(Income Tax/GDP%)	-0.57	-0.57	-0.59	-0.62	-0.64	-0.65	-0.66	-0.66	-0.67	-0.67	-0.67	-0.67	-0.66	-0.61	-0.66	-0.67
ch(Interest Rate%)	0.37	0.47	0.60	0.68	0.73	0.75	0.76	0.76	0.77	0.77	0.78	0.78	0.76	0.61	0.76	0.77
%ch(Wage Rate)	-1.4	-1.8	-2.3	-2.6	-2.7	-2.8	-2.8	-2.9	-2.9	-2.9	-2.9	-2.9	-2.8	-2.3	-2.8	-2.9
ch(Private Wealth/GDP%)	0.0	87.9	83.2	80.9	79.7	79.3	79.2	79.4	79.5	79.4	79.3	79.2	79.3	79.6	79.4	79.4
ch(Gov't Wealth/GDP%)	0.0	-92.1	-91.1	-90.6	-90.4	-90.3	-90.2	-90.2	-90.3	-90.3	-90.3	-90.3	-89.7	-87.4	-90.2	-90.3
(Small Open Economy)																
%ch(National Wealth)	0.0	-10.4	-19.7	-26.1	-30.3	-33.0	-34.7	-36.5	-37.5	-38.3	-40.2	-41.0	-41.2	-21.2	-36.0	-38.6
%ch(Labor)	0.7	2.5	4.5	5.9	6.9	7.5	7.9	8.2	8.3	8.3	8.4	8.6	8.7	4.9	8.1	8.3
%ch(GNP)	0.5	-1.3	-2.7	-3.7	-4.3	-4.7	-4.9	-5.2	-5.5	-5.7	-6.1	-6.3	-6.3	-2.9	-5.1	-5.8
%ch(GDP)	0.7	2.5	4.5	5.9	6.9	7.5	7.9	8.2	8.3	8.3	8.4	8.6	8.7	4.9	8.1	8.3
%ch(Consumption)	14.0	11.3	8.9	7.3	6.2	5.4	4.9	4.3	4.1	4.0	3.8	3.7	3.6	8.5	4.5	4.0
%ch(Gross Dom. Investment)	10.1	8.3	9.0	8.9	8.9	8.8	8.6	8.4	8.3	8.3	8.7	8.7	8.7	8.7	8.5	8.3
ch(Lump-Sum Transfer/GDP%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ch(Income Tax/GDP%)	-0.43	-0.46	-0.49	-0.52	-0.54	-0.55	-0.56	-0.57	-0.57	-0.56	-0.57	-0.57	-0.57	-0.50	-0.56	-0.57
ch(Net Foreign Assets/GDP%)	-2.0	-35.4	-66.5	-87.6	-101.7	-110.9	-116.6	-122.5	-125.4	-127.7	-133.2	-135.9	-136.6	-71.6	-120.7	-128.6
ch(Private Wealth/GDP%)	0.0	117.1	91.7	74.7	63.4	56.3	51.9	48.0	46.6	46.1	44.7	42.7	42.2	82.0	49.3	46.0
ch(Gov't Wealth/GDP%)	0.0	-145.5	-145.8	-146.1	-146.4	-146.7	-147.1	-148.0	-149.3	-151.1	-154.8	-155.0	-155.0	-140.2	-147.9	-151.9

Table A.6 (b) Efficiency Gains and Losses Corresponding to Table A.6 (a)

(Compensating Variations in Wealth; In 1,000 Growth-Adjusted US Dollars)

	Year When Age 20 (Top) / Age in Year 1 (Bottom)																
	-88	-79	-69	-59	-49	-39	-29	-19	-9	1	11	21	41	61	81	101	120
	109	100	90	80	70	60	50	40	30	20	10	0	-20	-40	-60	-80	-99
(Closed Economy)	delta_tr ($1000) =			**-95.27**													
After LSRA -- All	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-95.3	-95.3	-95.3	-95.3	-95.3	-95.3	-95.3
Before LSRA -- e1	-15.5	-78.6	-139.0	-230.6	-350.4	-279.3	-116.1	-18.8	34.1	55.0	51.6	50.7	50.6	50.6	50.7	50.8	50.5
Before LSRA -- e3					-349.0	-310.4	-135.9	-20.9	47.4	68.2	64.8	63.9	63.7	63.7	63.9	64.0	63.7
Before LSRA -- e5					-333.5	-294.4	-113.6	8.8	75.2	87.8	84.4	83.5	83.4	83.4	83.6	83.7	83.5
Before LSRA -- e8					-125.0	172.7	187.1	354.9	211.4	124.9	121.7	121.1	121.3	121.3	121.4	121.6	121.4
Before LSRA -- Average	-15.5	-78.6	-139.0	-230.6	-340.7	-291.8	-118.3	-3.5	54.8	72.0	68.6	67.7	67.6	67.6	67.7	67.8	67.6
(Small Open Economy)	delta_tr ($1000) =			**-144.4**													
After LSRA -- All	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-144.4	-144.4	-144.4	-144.4	-144.4	-144.4	-144.4
Before LSRA -- e1	-15.6	-79.6	-165.1	-274.5	-410.5	-343.5	-175.6	-53.0	24.0	58.9	59.5	59.8	59.9	59.9	72.4	73.5	73.5
Before LSRA -- e3					-411.4	-388.6	-214.3	-75.1	21.7	66.8	67.5	67.9	68.1	68.1	82.1	83.3	83.3
Before LSRA -- e5					-405.5	-394.0	-217.6	-80.3	26.0	78.9	80.0	80.5	80.8	80.8	96.6	97.9	97.9
Before LSRA -- e8					-249.4	-90.5	-61.2	44.4	74.7	98.2	100.1	101.3	102.0	102.0	120.7	121.9	121.9
Before LSRA -- Average	-15.6	-79.6	-165.1	-274.5	-406.2	-375.6	-203.4	-68.4	25.1	69.2	70.1	70.5	70.7	70.7	84.9	86.1	86.1

Note: The hourly wage of a household is stochastic, and it changes its class according to a Markov Transition matrix. The efficiency gain of each age-wage cohort is a population-weighted average across wealth holdings and historical earnings. The efficiency gains are evaluated at the beginning of year 1 for current households and at the beginning of age 20 for future households. The numbers are growth adjusted but not discounted.

Table A.7 (a) The Immediate Elimination of OASDI with Lump-Sum Transfer Adjustments

(Changes from the Baseline Economy; In a Heterogeneous-Agent Economy with Working Ability Shocks; With LSRA; Without Perfect Annuity Markets)

	Year													Average		
	1	5	10	15	20	25	30	40	50	60	80	100	150	01-25	26-50	51-75
(Closed Economy)																
%ch(National Wealth)	0.0	-2.5	-3.9	-4.5	-4.7	-4.8	-4.8	-4.8	-4.8	-4.8	-4.8	-4.8	-4.9	-3.7	-4.8	-4.8
%ch(Labor)	2.0	2.6	3.0	3.1	3.2	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	2.9	3.1	3.1
%ch(GNP=GDP)	1.4	1.0	0.9	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.9	0.7	0.7
%ch(Consumption)	5.9	4.4	3.4	3.1	2.9	2.8	2.7	2.7	2.7	2.7	2.7	2.7	2.7	3.5	2.7	2.7
%ch(Gross Investment)	-10.7	-8.1	-6.0	-5.3	-5.0	-4.9	-4.9	-4.8	-4.8	-4.8	-4.8	-4.8	-4.9	-6.3	-4.8	-4.8
ch(Lump-Sum Transfer/GDP%)	1.69	1.72	1.76	1.78	1.79	1.79	1.79	1.80	1.80	1.80	1.80	1.80	1.80	1.76	1.80	1.80
ch(Income Tax/GDP%)	1.26	1.23	1.23	1.24	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.24	1.25	1.25
ch(Interest Rate%)	0.16	0.40	0.55	0.60	0.62	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.64	0.52	0.63	0.63
%ch(Wage Rate)	-0.6	-1.5	-2.1	-2.3	-2.3	-2.4	-2.4	-2.4	-2.4	-2.4	-2.4	-2.4	-2.4	-2.0	-2.4	-2.4
ch(Private Wealth/GDP%)	0.0	99.2	94.4	92.6	92.0	91.7	91.6	91.6	91.7	91.7	91.6	91.6	91.7	91.0	91.6	91.6
ch(Gov't Wealth/GDP%)	0.0	-106.1	-105.2	-104.9	-104.8	-104.8	-104.8	-104.8	-104.8	-104.8	-104.8	-104.8	-104.9	-101.1	-104.8	-104.8
(Small Open Economy)																
%ch(National Wealth)	0.0	-6.6	-11.9	-15.1	-17.2	-18.7	-19.7	-20.9	-21.4	-21.7	-21.9	-21.9	-21.9	-12.4	-20.5	-21.7
%ch(Labor)	0.0	1.7	3.0	3.7	4.0	4.2	4.3	4.4	4.5	4.5	4.5	4.5	4.5	3.0	4.4	4.5
%ch(GNP)	0.0	-0.8	-1.4	-2.0	-2.4	-2.7	-2.9	-3.2	-3.3	-3.3	-3.4	-3.4	-3.4	-1.6	-3.1	-3.4
%ch(GDP)	0.0	1.7	3.0	3.7	4.0	4.2	4.3	4.4	4.5	4.5	4.5	4.5	4.5	3.0	4.4	4.5
%ch(Consumption)	8.8	6.8	5.2	4.2	3.5	3.0	2.6	2.2	2.0	1.9	1.9	1.8	1.8	5.0	2.3	1.9
%ch(Gross Dom. Investment)	-0.6	6.6	5.5	4.9	4.6	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	5.1	4.5	4.5
ch(Lump-Sum Transfer/GDP%)	1.56	1.69	1.77	1.80	1.80	1.80	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.75	1.79	1.79
ch(Income Tax/GDP%)	1.19	1.28	1.34	1.36	1.36	1.36	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.32	1.35	1.35
ch(Net Foreign Assets/GDP%)	0.1	-23.0	-40.8	-51.5	-58.2	-62.6	-65.7	-69.2	-70.9	-71.7	-72.3	-72.4	-72.5	-42.2	-68.1	-71.8
ch(Private Wealth/GDP%)	0.0	112.0	97.5	88.3	82.3	78.2	75.3	72.1	70.5	69.8	69.2	69.1	69.1	90.7	73.1	69.7
ch(Gov't Wealth/GDP%)	0.0	-130.2	-129.9	-129.7	-129.5	-129.4	-129.3	-129.2	-129.2	-129.2	-129.1	-129.1	-129.2	-124.6	-129.2	-129.1

Table A.7 (b) Efficiency Gains and Losses Corresponding to Table A.7 (a)

(Compensating Variations in Wealth; In 1,000 Growth-Adjusted US Dollars)

	Year When Age 20 (Top) / Age in Year 1 (Bottom)																
	-88	-79	-69	-59	-49	-39	-29	-19	-9	1	11	21	41	61	81	101	120
	109	100	90	80	70	60	50	40	30	20	10	0	-20	-40	-60	-80	-99
(Closed Economy)	delta_tr ($1000) =			**-60.15**													
After LSRA -- All	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-60.2	-60.2	-60.2	-60.2	-60.2	-60.2	-60.2
Before LSRA -- e1	-13.9	-95.0	-190.7	-327.2	-457.9	-344.1	-95.4	34.8	92.9	115.4	110.9	110.1	109.9	110.0	110.0	110.0	110.1
Before LSRA -- e3					-461.5	-399.5	-157.7	13.2	102.7	131.0	125.6	124.6	124.5	124.6	124.5	124.5	124.6
Before LSRA -- e5					-462.1	-427.3	-187.3	-1.9	111.9	148.6	142.6	141.5	141.4	141.5	141.4	141.4	141.5
Before LSRA -- e8					-389.9	-283.6	-102.5	123.2	145.2	175.5	168.2	166.8	166.6	166.7	166.7	166.7	166.7
Before LSRA -- Average	-13.9	-95.0	-190.7	-327.2	-458.9	-392.1	-148.9	17.1	103.6	133.3	127.8	126.8	126.7	126.8	126.8	126.8	126.9
(Small Open Economy)	delta_tr ($1000) =			**-54.68**													
After LSRA -- All	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-54.7	-54.7	-54.7	-54.7	-54.7	-54.7	-54.7
Before LSRA -- e1	-14.1	-96.0	-194.0	-340.6	-486.2	-379.8	-123.3	25.8	99.6	129.8	128.8	127.5	126.2	126.0	125.9	125.9	125.9
Before LSRA -- e3					-491.9	-444.5	-200.5	-7.8	102.3	144.7	143.2	141.5	140.1	139.8	139.8	139.8	139.7
Before LSRA -- e5					-500.9	-491.3	-252.2	-50.6	95.9	159.4	157.6	155.6	153.9	153.6	153.5	153.5	153.5
Before LSRA -- e8					-489.6	-519.4	-300.9	-117.0	57.1	175.1	172.7	170.4	168.5	168.1	168.0	168.0	168.0
Before LSRA -- Average	-14.1	-96.0	-194.0	-340.6	-492.2	-443.3	-197.9	-13.7	99.5	145.9	144.4	142.8	141.3	141.0	141.0	141.0	141.0

Note: The hourly wage of a household is stochastic, and it changes its class according to a Markov Transition matrix. The efficiency gain of each age-wage cohort is a population-weighted average across wealth holdings and historical earnings. The efficiency gains are evaluated at the beginning of year 1 for current households and at the beginning of age 20 for future households. The numbers are growth adjusted but not discounted.

Table A.8 (a) The Immediate Elimination of OASDI with Income Tax Rate Adjustments

(Changes from the Baseline Economy; In a Heterogeneous-Agent Economy with Working Ability Shocks; With LSRA; Without Perfect Annuity Markets)

	Year													Average		
	1	5	10	15	20	25	30	40	50	60	80	100	150	01-25	26-50	51-75
(Closed Economy)																
%ch(National Wealth)	0.0	-1.0	-1.1	-0.8	-0.4	-0.1	0.1	0.4	0.4	0.5	0.5	0.7	0.5	-0.7	0.3	0.5
%ch(Labor)	4.9	5.2	5.6	5.7	5.8	5.8	5.9	5.9	6.0	6.0	6.0	6.0	6.0	5.5	5.9	6.0
%ch(GNP=GDP)	3.4	3.3	3.5	3.7	3.9	4.0	4.1	4.2	4.3	4.3	4.3	4.4	4.3	3.6	4.2	4.3
%ch(Consumption)	7.2	6.2	5.9	6.0	6.3	6.4	6.6	6.8	6.9	6.9	6.9	6.9	6.9	6.2	6.7	6.9
%ch(Gross Investment)	-4.8	-2.5	-0.4	0.4	0.6	0.6	0.6	0.5	0.5	0.5	0.6	0.9	0.5	-0.7	0.5	0.5
ch(Lump-Sum Transfer/GDP%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ch(Income Tax/GDP%)	-0.68	-0.71	-0.74	-0.75	-0.75	-0.76	-0.76	-0.76	-0.76	-0.76	-0.76	-0.76	-0.76	-0.74	-0.76	-0.76
ch(Interest Rate%)	0.37	0.47	0.52	0.50	0.47	0.45	0.43	0.42	0.42	0.42	0.41	0.39	0.41	0.48	0.43	0.42
%ch(Wage Rate)	-1.4	-1.8	-2.0	-1.9	-1.8	-1.7	-1.7	-1.6	-1.6	-1.6	-1.6	-1.5	-1.6	-1.8	-1.6	-1.6
ch(Private Wealth/GDP%)	0.0	132.7	133.0	134.9	136.7	138.1	139.0	140.0	140.2	140.2	140.1	140.6	140.1	129.4	139.6	140.2
ch(Gov't Wealth/GDP%)	0.0	-135.5	-136.2	-137.0	-137.7	-138.3	-138.7	-139.0	-139.1	-139.0	-138.7	-138.6	-138.6	-131.3	-138.9	-139.0
(Small Open Economy)																
%ch(National Wealth)	0.0	-2.5	-4.1	-4.9	-5.2	-5.3	-5.2	-5.1	-5.1	-5.3	-5.8	-6.0	-6.1	-4.0	-5.2	-5.4
%ch(Labor)	5.3	5.6	6.2	6.5	6.6	6.7	6.7	6.8	6.8	6.8	6.8	6.9	6.9	6.2	6.7	6.8
%ch(GNP)	3.7	3.2	3.1	3.1	3.1	3.1	3.1	3.2	3.2	3.2	3.0	3.0	3.0	3.1	3.2	3.1
%ch(GDP)	5.3	5.6	6.2	6.5	6.6	6.7	6.7	6.8	6.8	6.8	6.8	6.9	6.9	6.2	6.7	6.8
%ch(Consumption)	9.1	8.1	7.4	7.1	6.9	6.8	6.8	6.9	7.0	7.0	7.0	6.9	6.9	7.4	6.9	7.0
%ch(Gross Dom. Investment)	73.0	7.5	7.2	7.0	6.9	6.8	6.7	6.8	6.8	6.8	6.8	6.9	6.9	9.6	6.8	6.8
ch(Lump-Sum Transfer/GDP%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ch(Income Tax/GDP%)	-0.71	-0.72	-0.73	-0.74	-0.74	-0.75	-0.75	-0.76	-0.76	-0.76	-0.76	-0.76	-0.76	-0.73	-0.75	-0.76
ch(Net Foreign Assets/GDP%)	-14.6	-22.2	-28.3	-31.1	-32.4	-32.8	-32.7	-32.6	-32.6	-33.0	-34.4	-35.2	-35.6	-27.9	-32.7	-33.3
ch(Private Wealth/GDP%)	0.0	165.0	160.5	158.5	157.7	157.6	157.9	158.5	158.9	159.1	159.0	158.6	158.5	154.1	158.4	159.1
ch(Gov't Wealth/GDP%)	0.0	-171.8	-171.8	-171.9	-172.0	-172.1	-172.3	-172.6	-173.0	-173.5	-174.7	-175.0	-175.3	-165.0	-172.5	-173.8

Table A.8 (b) Efficiency Gains and Losses Corresponding to Table A.8 (a)

(Compensating Variations in Wealth; In 1,000 Growth-Adjusted US Dollars)

	Year When Age 20 (Top) / Age in Year 1 (Bottom)																
	-88	-79	-69	-59	-49	-39	-29	-19	-9	1	11	21	41	61	81	101	120
	109	100	90	80	70	60	50	40	30	20	10	0	-20	-40	-60	-80	-99
(Closed Economy)	delta_tr ($1000) =			**-114.2**													
After LSRA -- All	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-114.2	-114.2	-114.2	-114.2	-114.2	-114.2	-114.2
Before LSRA -- e1	-15.6	-137.5	-243.6	-383.6	-512.1	-388.5	-140.1	-3.4	64.9	94.7	95.3	97.2	99.8	100.1	100.1	98.9	99.8
Before LSRA -- e3					-514.5	-445.0	-190.7	-14.6	80.0	111.1	111.6	113.6	116.2	116.5	116.4	115.6	116.1
Before LSRA -- e5					-509.8	-456.3	-198.7	-8.3	102.6	132.5	132.8	134.8	137.3	137.7	137.6	137.0	137.2
Before LSRA -- e8					-319.9	3.7	74.4	291.4	213.7	171.4	170.8	173.1	175.5	176.0	175.9	175.6	175.5
Before LSRA -- Average	-15.6	-137.5	-243.6	-383.6	-508.8	-427.7	-174.9	-3.1	84.9	114.6	115.1	117.1	119.6	120.0	119.9	119.0	119.6
(Small Open Economy)	delta_tr ($1000) =			**-155.9**													
After LSRA -- All	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-155.9	-155.9	-155.9	-155.9	-155.9	-155.9	-155.9
Before LSRA -- e1	-15.6	-140.9	-255.6	-410.4	-554.6	-435.1	-183.7	-57.4	30.0	84.1	83.3	83.1	83.3	83.5	85.6	87.9	87.9
Before LSRA -- e3					-559.0	-499.8	-238.4	-46.9	55.6	100.8	99.9	99.7	100.0	100.1	102.6	105.2	105.2
Before LSRA -- e5					-562.1	-525.5	-258.7	-50.7	82.3	123.5	122.6	122.5	122.8	123.0	125.9	128.9	128.9
Before LSRA -- e8					-409.6	-163.6	-65.6	118.8	163.2	163.5	162.6	162.7	163.4	163.6	167.3	170.8	170.8
Before LSRA -- Average	-15.6	-140.9	-255.6	-410.4	-555.6	-486.5	-227.9	-47.4	58.3	104.7	103.8	103.6	104.0	104.1	106.6	109.2	109.2

Note: The hourly wage of a household is stochastic, and it changes its class according to a Markov Transition matrix. The efficiency gain of each age-wage cohort is a population-weighted average across wealth holdings and historical earnings. The efficiency gains are evaluated at the beginning of year 1 for current households and at the beginning of age 20 for future households. The numbers are growth adjusted but not discounted.

Table A.9 (a) The Phase-In Privatization of OASDI with Income Tax Rate Adjustments

(Changes from the Baseline Economy; In a Representative-Agent Economy without Working Ability Shocks; Without LSRA; With Perfect Annuity Markets)

	Year													Average		
	1	5	10	15	20	25	30	40	50	60	80	100	150	01-25	26-50	51-75
(Closed Economy)																
%ch(National Wealth)	0.0	-0.2	0.0	2.1	6.5	12.2	18.4	30.6	41.0	47.5	51.8	52.2	52.3	3.1	27.9	47.9
%ch(Labor)	-0.4	-3.0	-2.8	1.4	4.6	7.0	9.0	12.6	14.1	14.2	14.0	14.1	14.0	0.4	11.5	14.2
%ch(GNP=GDP)	-0.3	-2.1	-2.0	1.6	5.2	8.5	11.7	17.7	21.6	23.3	24.2	24.4	24.4	1.2	16.1	23.4
%ch(Consumption)	-2.9	-3.3	-2.8	-0.8	1.7	4.5	7.4	13.2	17.5	20.0	21.7	22.1	22.1	-0.8	11.8	20.2
%ch(Gross Investment)	8.1	1.3	1.9	12.1	21.2	28.8	35.4	46.8	52.4	53.4	52.6	52.6	52.3	10.4	43.4	53.2
ch(Lump-Sum Transfer/GDP%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ch(Income Tax/GDP%)	-0.02	0.12	0.10	-0.16	-0.34	-0.47	-0.58	-0.80	-0.89	-0.91	-0.89	-0.90	-0.90	-0.08	-0.73	-0.90
ch(Interest Rate%)	-0.03	-0.21	-0.21	-0.05	-0.14	-0.36	-0.62	-1.08	-1.51	-1.79	-1.99	-2.00	-2.01	-0.20	-0.99	-1.81
%ch(Wage Rate)	0.1	0.8	0.8	0.2	0.6	1.4	2.5	4.6	6.6	8.0	9.0	9.0	9.1	0.8	4.2	8.1
ch(Private Wealth/GDP%)	0.0	-0.6	0.0	5.7	17.9	33.5	50.4	83.9	112.4	130.0	141.8	143.1	143.3	8.4	76.4	131.3
ch(Gov't Wealth/GDP%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Small Open Economy)																
%ch(National Wealth)	0.0	5.9	11.7	17.9	25.9	35.5	46.3	69.5	92.0	108.2	122.2	124.9	125.5	16.4	64.8	110.0
%ch(Labor)	5.2	2.4	1.7	3.8	6.0	8.1	9.5	11.9	11.4	9.6	7.6	7.5	7.4	4.1	10.9	9.3
%ch(GNP)	3.6	3.4	4.7	8.0	11.9	16.3	20.5	29.2	35.6	39.2	42.0	42.7	42.9	7.8	27.1	39.5
%ch(GDP)	5.2	2.4	1.7	3.8	6.0	8.1	9.5	11.9	11.4	9.6	7.6	7.5	7.4	4.1	10.9	9.3
%ch(Consumption)	-1.3	-1.3	-0.6	0.8	2.7	5.0	7.6	13.1	18.1	21.8	26.0	27.3	27.6	0.8	11.9	22.4
%ch(Gross Dom. Investment)	70.7	-4.3	2.5	8.6	11.4	12.8	12.5	14.7	9.3	7.4	7.2	7.4	8.0	8.2	12.6	7.5
ch(Lump-Sum Transfer/GDP%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ch(Income Tax/GDP%)	-0.30	-0.21	-0.22	-0.37	-0.54	-0.72	-0.88	-1.18	-1.32	-1.35	-1.35	-1.36	-1.37	-0.38	-1.09	-1.35
ch(Net Foreign Assets/GDP%)	-14.2	9.5	27.1	38.8	54.5	75.1	100.9	157.8	220.8	270.2	313.9	321.7	323.6	33.5	147.9	276.1
ch(Private Wealth/GDP%)	0.0	16.1	31.9	49.1	70.9	97.2	126.9	190.4	252.0	296.5	334.8	342.1	343.9	44.8	177.6	301.5
ch(Gov't Wealth/GDP%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table A.9 (b) Efficiency Gains and Losses Corresponding to Table A.9 (a)

(Equivalent Variations in Wealth; In 1,000 Growth-Adjusted US Dollars)

	Year When Age 20 (Top) / Age in Year 1 (Bottom)																
	-88	-79	-69	-59	-49	-39	-29	-19	-9	1	11	21	41	61	81	101	120
	109	100	90	80	70	60	50	40	30	20	10	0	-20	-40	-60	-80	-99
(Closed Economy)																	
Without LSRA	0.0	0.0	-0.3	-2.6	-6.0	-68.6	-141.0	-160.4	-138.1	-67.1	-7.9	43.1	101.0	114.1	117.0	115.2	114.9
(Small Open Economy)																	
Without LSRA	0.0	0.0	0.0	0.1	0.4	-48.7	-78.0	-63.3	-18.0	47.1	122.2	187.5	254.6	263.9	264.5	264.0	263.7

Note: The efficiency gains are evaluated at the beginning of year 1 for current households and at the beginning of age 20 for future households. The numbers are growth adjusted but not discounted.

Table A.10 (a) The Phase-In Privatization of OASDI with Income Tax Rate Adjustments

(Changes from the Baseline Economy; In a Representative-Agent Economy without Working Ability Shocks; With LSRA; With Perfect Annuity Markets)

	Year													Average		
	1	5	10	15	20	25	30	40	50	60	80	100	150	01-25	26-50	51-75
(Closed Economy)																
%ch(National Wealth)	0.0	-8.8	-9.6	-8.2	-5.2	-1.6	2.0	8.0	12.5	14.8	15.8	15.8	17.0	-6.8	6.6	14.8
%ch(Labor)	-33.5	-5.3	-1.2	2.3	5.2	7.4	9.1	12.2	13.8	14.7	15.0	15.0	15.0	-0.7	11.3	14.7
%ch(GNP=GDP)	-24.8	-6.4	-3.8	-1.0	2.0	4.6	6.9	10.9	13.4	14.7	15.2	15.2	15.6	-2.7	9.8	14.7
%ch(Consumption)	-9.2	-4.3	-2.9	-0.6	2.1	4.9	7.7	12.7	16.3	18.4	19.6	19.6	19.7	-1.1	11.4	18.5
%ch(Gross Investment)	-86.4	-14.9	-7.3	-1.3	4.3	8.5	11.1	15.5	16.7	16.7	15.9	15.7	17.0	-7.3	14.0	16.5
ch(Lump-Sum Transfer/GDP%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ch(Income Tax/GDP%)	2.00	0.07	-0.24	-0.49	-0.69	-0.83	-0.94	-1.14	-1.24	-1.28	-1.30	-1.30	-1.28	-0.27	-1.08	-1.28
ch(Interest Rate%)	-2.72	0.29	0.70	0.86	0.83	0.69	0.53	0.29	0.09	-0.01	-0.05	-0.05	-0.13	0.49	0.34	-0.01
%ch(Wage Rate)	13.0	-1.1	-2.6	-3.2	-3.1	-2.6	-2.0	-1.1	-0.4	0.0	0.2	0.2	0.5	-1.7	-1.3	0.0
ch(Private Wealth/GDP%)	0.0	32.5	45.2	63.2	84.1	104.8	123.2	151.1	168.5	176.6	180.1	180.1	180.6	58.4	143.7	176.8
ch(Gov't Wealth/GDP%)	0.0	-56.6	-71.6	-85.6	-98.3	-109.1	-117.7	-129.1	-134.4	-136.2	-136.7	-136.7	-134.0	-77.1	-125.7	-136.1
(Small Open Economy)																
%ch(National Wealth)	0.0	-5.8	-13.2	-15.9	-15.5	-12.9	-8.9	1.2	11.6	18.8	24.6	25.7	29.7	-11.6	-0.7	19.6
%ch(Labor)	-0.3	-11.2	-3.1	1.8	5.9	8.8	10.9	14.1	14.8	14.8	14.2	14.2	14.1	-0.7	13.0	14.6
%ch(GNP)	-0.2	-9.6	-6.1	-3.5	-0.5	2.3	5.0	10.2	13.8	16.0	17.3	17.6	18.8	-3.9	8.9	16.1
%ch(GDP)	-0.3	-11.2	-3.1	1.8	5.9	8.8	10.9	14.1	14.8	14.8	14.2	14.2	14.1	-0.7	13.0	14.6
%ch(Consumption)	0.0	-1.3	-0.1	1.5	3.4	5.4	7.4	11.7	15.2	17.8	20.1	20.5	20.6	1.3	10.7	18.1
%ch(Gross Dom. Investment)	-3.4	-8.9	15.1	13.7	15.0	15.0	15.3	17.7	15.2	14.5	14.1	14.2	14.4	3.8	16.0	14.4
ch(Lump-Sum Transfer/GDP%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ch(Income Tax/GDP%)	-0.19	0.34	-0.04	-0.29	-0.53	-0.71	-0.86	-1.12	-1.25	-1.30	-1.31	-1.32	-1.32	-0.18	-1.04	-1.30
ch(Net Foreign Assets/GDP%)	0.7	14.9	-27.8	-48.4	-58.8	-59.6	-54.2	-35.2	-8.7	11.1	28.5	31.5	42.7	-30.0	-37.3	13.6
ch(Private Wealth/GDP%)	0.0	57.2	52.8	58.4	69.2	83.7	99.9	132.9	162.8	183.0	198.8	201.3	201.6	59.8	125.9	185.0
ch(Gov't Wealth/GDP%)	0.0	-73.1	-89.1	-101.9	-111.8	-119.1	-124.2	-129.5	-131.1	-131.4	-131.3	-130.9	-120.2	-91.7	-127.7	-131.3

Table A.10 (b) Efficiency Gains and Losses Corresponding to Table A.10 (a)

(Compensating Variations in Wealth; In 1,000 Growth-Adjusted US Dollars)

	Year When Age 20 (Top) / Age in Year 1 (Bottom)																
	-88	-79	-69	-59	-49	-39	-29	-19	-9	1	11	21	41	61	81	101	120
	109	100	90	80	70	60	50	40	30	20	10	0	-20	-40	-60	-80	-99
(Closed Economy)	delta_tr ($1000) =			**92.14**													
After LSRA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	92.1	92.1	92.1	92.1	92.1	92.1	92.1
Before LSRA	0.0	0.0	-1.1	-1.1	5.2	-50.4	-98.4	-75.6	-24.7	33.5	97.1	153.1	225.4	242.5	243.4	243.7	243.7
(Small Open Economy)	delta_tr ($1000) =			**100.2**													
After LSRA	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	0.0	100.2	100.2	100.2	100.2	100.2	100.2	100.2
Before LSRA	0.0	0.0	0.0	0.1	0.3	-56.2	-106.6	-95.6	-43.2	32.9	113.1	175.4	238.6	248.3	248.9	248.1	247.3

Note: The efficiency gains are evaluated at the beginning of year 1 for current households and at the beginning of age 20 for future households. The numbers are growth adjusted but not discounted.

Table A.11 (a) The Phase-In Privatization of OASDI with Income Tax Rate Adjustments

(Changes from the Baseline Economy; In a Heterogeneous-Agent Economy with Working Ability Shocks; Without LSRA; With Perfect Annuity Markets)

	Year													Average		
	1	5	10	15	20	25	30	40	50	60	80	100	150	01-25	26-50	51-75
(Closed Economy)																
%ch(National Wealth)	0.0	2.1	4.7	8.0	11.9	16.5	21.2	29.0	34.5	37.6	39.2	39.5	39.5	7.2	27.1	37.7
%ch(Labor)	3.0	3.0	3.2	1.9	4.4	3.9	4.0	4.9	5.4	5.5	5.4	5.4	5.4	2.8	4.7	5.5
%ch(GNP=GDP)	2.1	2.7	3.7	3.7	6.6	7.5	8.9	11.6	13.4	14.3	14.6	14.7	14.7	4.1	10.9	14.3
%ch(Consumption)	-2.6	-2.4	-2.2	-1.8	-0.6	1.8	3.3	6.1	8.4	9.7	10.5	10.6	10.6	-1.4	5.5	9.8
%ch(Gross Investment)	5.0	8.8	13.8	18.5	23.8	30.1	33.1	38.1	40.2	40.1	39.6	39.5	39.5	16.8	36.6	40.0
ch(Lump-Sum Transfer/GDP%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ch(Income Tax/GDP%)	-0.18	-0.17	-0.18	-0.09	-0.24	-0.20	-0.21	-0.26	-0.30	-0.30	-0.29	-0.29	-0.29	-0.15	-0.25	-0.30
ch(Interest Rate%)	0.23	0.07	-0.11	-0.43	-0.52	-0.85	-1.11	-1.48	-1.72	-1.85	-1.94	-1.95	-1.95	-0.31	-1.38	-1.86
%ch(Wage Rate)	-0.9	-0.3	0.4	1.7	2.1	3.5	4.7	6.4	7.6	8.3	8.7	8.8	8.8	1.3	6.0	8.3
ch(Private Wealth/GDP%)	0.0	5.8	13.0	21.9	32.6	45.3	58.2	79.6	94.6	102.9	107.5	108.1	108.2	19.8	74.2	103.3
ch(Gov't Wealth/GDP%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Small Open Economy)																
%ch(National Wealth)	0.0	1.6	4.0	7.0	10.8	15.2	19.9	28.9	36.2	40.7	43.9	44.3	44.4	6.4	26.8	41.1
%ch(Labor)	0.5	0.3	0.6	1.1	1.7	2.2	2.5	3.1	3.1	2.7	2.3	2.2	2.2	1.0	2.9	2.6
%ch(GNP)	0.4	0.7	1.6	2.9	4.4	6.1	7.7	10.8	13.0	14.1	14.7	14.8	14.9	2.7	10.1	14.2
%ch(GDP)	0.5	0.3	0.6	1.1	1.7	2.2	2.5	3.1	3.1	2.7	2.3	2.2	2.2	1.0	2.9	2.6
%ch(Consumption)	-1.3	-1.3	-1.2	-0.9	-0.3	0.6	1.6	4.1	6.4	7.9	9.0	9.3	9.3	-0.8	3.6	8.0
%ch(Gross Dom. Investment)	7.1	0.3	1.9	2.7	3.0	3.3	3.2	3.8	2.7	2.2	2.2	2.2	2.2	2.1	3.3	2.2
ch(Lump-Sum Transfer/GDP%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ch(Income Tax/GDP%)	-0.03	-0.03	-0.07	-0.12	-0.17	-0.23	-0.29	-0.39	-0.45	-0.46	-0.46	-0.46	-0.46	-0.11	-0.36	-0.46
ch(Net Foreign Assets/GDP%)	-1.4	3.6	9.2	16.2	25.0	35.8	47.6	70.7	90.8	104.3	114.1	115.4	115.5	14.8	65.6	105.4
ch(Private Wealth/GDP%)	0.0	4.5	10.9	19.3	29.7	41.7	54.5	79.2	99.2	111.7	120.2	121.4	121.6	17.7	73.5	112.6
ch(Gov't Wealth/GDP%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table A.11 (b) Efficiency Gains and Losses Corresponding to Table A.11 (a)

(Equivalent Variations in Wealth; In 1,000 Growth-Adjusted US Dollars)

	Year When Age 20 (Top) / Age in Year 1 (Bottom)																
	-88	-79	-69	-59	-49	-39	-29	-19	-9	1	11	21	41	61	81	101	120
	109	100	90	80	70	60	50	40	30	20	10	0	-20	-40	-60	-80	-99
(Closed Economy)																	
Without LSRA -- e1	0.0	0.0	0.3	0.8	-0.4	-34.3	-47.9	-49.3	-42.1	-56.3	-18.9	15.5	58.9	67.3	88.5	92.1	91.9
Without LSRA -- e3					-0.4	-50.4	-86.6	-84.8	-68.6	-63.3	-25.4	10.6	57.2	66.9	90.5	94.6	94.4
Without LSRA -- e5					-0.4	-60.6	-118.4	-132.4	-105.8	-72.9	-34.8	3.0	54.1	65.3	92.4	96.9	96.7
Without LSRA -- e8					11.2	-64.6	-165.2	-243.6	-187.7	-93.1	-58.8	-20.4	35.6	48.9	81.4	86.2	86.0
Without LSRA -- Average	0.0	0.0	0.3	0.8	-0.2	-49.2	-86.9	-92.2	-73.7	-64.9	-27.2	9.0	56.4	66.3	90.5	94.6	94.4
(Small Open Economy)																	
Without LSRA -- e1	0.0	0.0	0.0	0.1	0.3	-31.4	-42.4	-43.1	-34.0	-27.1	-2.8	21.2	49.2	53.0	66.2	67.3	67.3
Without LSRA -- e3					0.4	-45.8	-77.0	-71.4	-52.7	-32.7	-5.9	21.2	55.0	60.7	75.2	76.3	76.3
Without LSRA -- e5					0.9	-51.8	-100.4	-101.9	-75.2	-39.4	-9.2	22.3	64.5	72.5	88.6	89.7	89.7
Without LSRA -- e8					10.6	-23.0	-87.9	-85.8	-87.7	-49.5	-14.3	24.2	79.8	91.7	111.3	112.4	112.4
Without LSRA -- Average	0.0	0.0	0.0	0.1	0.7	-43.2	-74.3	-72.5	-54.5	-33.5	-6.2	21.7	57.0	63.0	77.8	78.9	78.9

Note: The hourly wage of a household is stochastic, and it changes its class according to a Markov Transition matrix. The efficiency gain of each age-wage cohort is a population-weighted average across wealth holdings and historical earnings. The efficiency gains are evaluated at the beginning of year 1 for current households and at the beginning of age 20 for future households. The numbers are growth adjusted but not discounted.

Table A.12 (a) The Phase-In Privatization of OASDI with Income Tax Rate Adjustments

(Changes from the Baseline Economy; In a Heterogeneous-Agent Economy with Working Ability Shocks; With LSRA; With Perfect Annuity Markets)

	Year													Average		
	1	5	10	15	20	25	30	40	50	60	80	100	150	01-25	26-50	51-75
(Closed Economy)																
%ch(National Wealth)	0.0	-2.8	-5.1	-6.2	-6.3	-5.8	-4.7	-1.9	0.6	2.1	2.9	2.9	2.5	-4.8	-2.5	2.2
%ch(Labor)	-2.4	-2.0	-1.2	-0.2	0.8	1.9	2.7	4.3	5.1	5.3	5.3	5.3	5.3	-0.5	3.8	5.2
%ch(GNP=GDP)	-1.7	-2.2	-2.4	-2.0	-1.4	-0.5	0.5	2.4	3.7	4.3	4.6	4.6	4.4	-1.8	1.9	4.3
%ch(Consumption)	0.8	-0.2	-0.9	-0.9	-0.5	0.2	1.1	3.1	4.8	5.7	6.2	6.2	6.4	-0.4	2.6	5.7
%ch(Gross Investment)	-10.6	-10.4	-9.3	-7.5	-5.5	-3.3	-1.3	2.0	3.3	3.4	3.0	3.1	2.5	-7.8	1.0	3.3
ch(Lump-Sum Transfer/GDP%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ch(Income Tax/GDP%)	0.05	0.00	-0.08	-0.16	-0.25	-0.32	-0.39	-0.49	-0.53	-0.54	-0.53	-0.54	-0.55	-0.13	-0.46	-0.54
ch(Interest Rate%)	-0.18	0.06	0.31	0.48	0.58	0.61	0.59	0.48	0.34	0.24	0.18	0.18	0.21	0.35	0.49	0.23
%ch(Wage Rate)	0.7	-0.2	-1.2	-1.8	-2.2	-2.3	-2.2	-1.8	-1.3	-0.9	-0.7	-0.7	-0.8	-1.3	-1.9	-0.9
ch(Private Wealth/GDP%)	0.0	33.4	32.1	34.0	38.3	44.0	50.5	62.9	72.3	77.3	80.1	79.8	81.0	34.2	59.9	77.6
ch(Gov't Wealth/GDP%)	0.0	-41.0	-46.0	-50.9	-55.6	-59.8	-63.3	-68.2	-70.6	-71.6	-72.1	-71.8	-74.2	-47.3	-66.8	-71.7
(Small Open Economy)																
%ch(National Wealth)	0.0	-6.9	-13.1	-17.0	-18.9	-19.2	-18.4	-14.9	-11.3	-9.2	-9.3	-10.4	-12.5	-13.5	-15.5	-9.3
%ch(Labor)	-5.8	-3.5	-1.4	0.5	2.2	3.5	4.4	5.8	6.3	6.2	6.1	6.3	6.5	-0.5	5.4	6.1
%ch(GNP)	-4.0	-4.5	-4.9	-4.7	-4.2	-3.3	-2.4	-0.4	1.0	1.6	1.5	1.3	0.8	-4.4	-0.9	1.5
%ch(GDP)	-5.8	-3.5	-1.4	0.5	2.2	3.5	4.4	5.8	6.3	6.2	6.1	6.3	6.5	-0.5	5.4	6.1
%ch(Consumption)	2.1	1.3	0.5	0.1	0.0	0.2	0.6	2.0	3.6	4.6	5.2	5.1	5.5	0.6	1.8	4.7
%ch(Gross Dom. Investment)	-79.1	2.7	3.8	5.0	6.0	6.5	6.6	7.3	6.4	6.0	6.2	6.4	8.3	1.2	6.8	6.0
ch(Lump-Sum Transfer/GDP%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ch(Income Tax/GDP%)	0.15	0.07	-0.01	-0.10	-0.18	-0.25	-0.32	-0.43	-0.49	-0.51	-0.51	-0.52	-0.53	-0.06	-0.40	-0.51
ch(Net Foreign Assets/GDP%)	15.8	-9.1	-32.0	-47.9	-57.7	-62.1	-62.5	-56.8	-48.1	-42.1	-42.0	-45.8	-52.1	-35.5	-57.2	-42.3
ch(Private Wealth/GDP%)	0.0	39.8	29.0	23.7	22.9	25.6	30.7	43.6	55.7	63.4	67.0	64.4	65.3	28.2	41.0	63.9
ch(Gov't Wealth/GDP%)	0.0	-58.6	-64.8	-70.2	-74.7	-78.3	-81.0	-84.5	-86.6	-88.5	-92.4	-92.9	-99.6	-65.1	-83.5	-89.3

Table A.12 (b) Efficiency Gains and Losses Corresponding to Table A.12 (a)

(Compensating Variations in Wealth; In 1,000 Growth-Adjusted US Dollars)

	Year When Age 20 (Top) / Age in Year 1 (Bottom)																
	-88	-79	-69	-59	-49	-39	-29	-19	-9	1	11	21	41	61	81	101	120
	109	100	90	80	70	60	50	40	30	20	10	0	-20	-40	-60	-80	-99
(Closed Economy)	delta_tr ($1000) =			**-39.8**													
After LSRA -- All	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-39.8	-39.8	-39.8	-39.8	-39.8	-39.8	-39.8
Before LSRA -- e1	0.0	0.0	-0.1	0.8	3.8	-31.2	-43.7	-43.1	-37.0	-28.1	-8.2	15.8	50.9	59.1	60.3	61.5	58.5
Before LSRA -- e3					4.5	-38.5	-69.9	-66.0	-49.8	-29.9	-7.8	18.7	58.9	68.8	70.1	71.3	68.8
Before LSRA -- e5					7.5	-36.2	-77.8	-76.7	-59.0	-31.0	-6.0	24.1	71.3	83.5	84.9	86.3	84.1
Before LSRA -- e8					43.2	94.9	25.8	75.7	-8.8	-27.1	1.2	36.4	93.5	108.9	110.6	112.2	111.1
Before LSRA -- Average	0.0	0.0	-0.1	0.8	5.7	-33.7	-62.7	-59.2	-48.2	-29.6	-7.1	20.0	61.4	71.7	73.0	74.3	71.8
(Small Open Economy)	delta_tr ($1000) =			**-54.88**													
After LSRA -- All	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-54.9	-54.9	-54.9	-54.9	-54.9	-54.9	-54.9
Before LSRA -- e1	0.0	0.0	0.0	-0.1	-0.1	-38.7	-54.0	-51.4	-39.8	-30.9	-2.6	23.6	52.9	56.9	69.3	70.4	70.9
Before LSRA -- e3					-0.2	-50.2	-89.4	-83.5	-61.1	-37.7	-6.0	23.4	58.8	64.5	78.5	79.7	80.2
Before LSRA -- e5					-0.7	-59.9	-114.2	-115.8	-86.1	-45.9	-9.8	24.5	68.2	76.3	92.1	93.3	93.9
Before LSRA -- e8					-17.6	-92.5	-136.2	-132.1	-112.5	-59.5	-15.9	25.9	83.3	95.3	113.8	114.9	115.7
Before LSRA -- Average	0.0	0.0	0.0	-0.1	-0.6	-50.6	-87.7	-84.8	-63.1	-38.7	-6.4	24.0	60.8	66.9	81.1	82.3	82.8

Note: The hourly wage of a household is stochastic, and it changes its class according to a Markov Transition matrix. The efficiency gain of each age-wage cohort is a population-weighted average across wealth holdings and historical earnings. The efficiency gains are evaluated at the beginning of year 1 for current households and at the beginning of age 20 for future households. The numbers are growth adjusted but not discounted.

Table A.13 (a) The Privatization of OASDI with Income Tax Rate Adjustments and Employer Matching

(Changes from the Baseline Economy; In a Heterogeneous-Agent Economy; Without LSRA; With Perfect Annuity Markets)

	Year													Average		
	1	5	10	15	20	25	30	40	50	60	80	100	150	01-25	26-50	51-75
(Closed Economy)																
%ch(National Wealth)	0.0	-2.7	44.3	42.3	39.3	37.0	35.4	34.5	34.7	35.3	36.5	36.7	36.8	26.5	34.9	35.6
%ch(Labor)	-1.5	-0.6	0.9	0.0	0.6	0.9	1.8	3.7	4.4	4.6	4.5	4.5	4.6	-0.1	3.1	4.6
%ch(GNP=GDP)	-1.1	-1.2	12.3	11.2	10.9	10.6	10.9	12.1	12.7	13.0	13.2	13.3	13.4	7.0	11.8	13.0
%ch(Consumption)	-2.4	-2.1	6.1	8.2	7.9	7.3	7.3	8.1	8.8	8.8	9.1	9.2	9.3	4.3	8.0	8.8
%ch(Gross Investment)	-12.0	-2.3	48.7	33.4	32.4	31.7	32.4	34.5	35.1	36.5	36.8	36.7	36.8	46.5	33.9	36.5
ch(Lump-Sum Transfer/GDP%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ch(Income Tax/GDP%)	0.51	0.37	0.58	0.62	0.54	0.50	0.40	0.23	0.16	0.13	0.13	0.13	0.12	0.52	0.28	0.13
ch(Interest Rate%)	-0.12	0.16	-2.43	-2.39	-2.23	-2.11	-1.98	-1.82	-1.79	-1.81	-1.87	-1.88	-1.88	-1.52	-1.88	-1.82
%ch(Wage Rate)	0.5	-0.6	11.3	11.2	10.3	9.6	8.9	8.1	8.0	8.0	8.4	8.4	8.4	7.0	8.4	8.1
ch(Private Wealth/GDP%)	0.0	-7.3	121.5	115.8	107.7	101.3	97.0	94.5	95.1	96.8	100.1	100.7	101.0	72.6	95.6	97.5
ch(Gov't Wealth/GDP%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table A.13 (b) Efficiency Gains and Losses Corresponding to Table A.13 (a)

(Equivalent Variations in Wealth; In 1,000 Growth-Adjusted US Dollars)

	Year When Age 20 (Top) / Age in Year 1 (Bottom)																
	-88	-79	-69	-59	-49	-39	-29	-19	-9	1	11	21	41	61	81	101	120
	109	100	90	80	70	60	50	40	30	20	10	0	-20	-40	-60	-80	-99
(Closed Economy)																	
Without LSRA -- e1	0.0	0.0	-0.5	-4.3	-10.2	-44.9	-43.5	-28.5	-18.5	-25.6	5.0	32.9	73.2	81.3	82.1	82.0	82.5
Without LSRA -- e3					-11.8	-64.1	-87.1	-70.0	-53.5	-33.1	0.1	29.8	73.1	82.3	83.2	83.0	83.5
Without LSRA -- e5					-17.6	-95.5	-138.2	-138.6	-104.3	-47.6	-10.1	21.5	69.1	80.1	81.1	81.0	81.4
Without LSRA -- e8					-120.0	-400.1	-379.5	-476.5	-270.2	-79.4	-32.5	-0.5	51.1	64.4	65.4	65.2	65.6
Without LSRA -- Average	0.0	0.0	-0.5	-4.3	-14.9	-73.3	-96.4	-87.6	-61.8	-36.3	-2.1	27.7	71.7	81.4	82.2	82.1	82.6

Note: The hourly wage of a household is stochastic, and it changes its class according to a Markov Transition matrix. The efficiency gain of each age-wage cohort is a population-weighted average across wealth holdings and historical earnings. The efficiency gains are evaluated at the beginning of year 1 for current households and at the beginning of age 20 for future households. The numbers are growth adjusted but not discounted.

Table A.14 (a) The Privatization of OASDI with Income Tax Rate Adjustments and Employer Matching

(Changes from the Baseline Economy; In a Heterogeneous-Agent Economy without Working Ability Shocks; With LSRA; With Perfect Annuity Markets)

	Year													Average		
	1	5	10	15	20	25	30	40	50	60	80	100	150	01-25	26-50	51-75
(Closed Economy)																
%ch(National Wealth)	0.0	-4.2	-7.3	-8.9	-9.3	-8.8	-7.8	-4.9	-2.2	-0.7	0.2	0.2	0.4	-7.0	-5.5	-0.6
%ch(Labor)	-4.6	-3.7	-2.8	-1.6	-0.5	0.5	1.5	3.2	4.0	4.3	4.4	4.3	4.4	-2.0	2.7	4.3
%ch(GNP=GDP)	-3.3	-3.8	-4.2	-3.9	-3.3	-2.4	-1.4	0.7	2.1	2.8	3.1	3.1	3.2	-3.6	0.2	2.8
%ch(Consumption)	0.4	-1.2	-2.2	-2.5	-2.2	-1.5	-0.7	1.5	3.3	4.4	5.0	5.0	5.0	-1.8	1.0	4.4
%ch(Gross Investment)	-17.0	-14.8	-13.2	-11.1	-8.8	-6.4	-4.4	-0.8	0.6	0.7	0.3	0.1	0.4	-11.7	-1.9	0.6
ch(Lump-Sum Transfer/GDP%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ch(Income Tax/GDP%)	0.64	0.54	0.44	0.34	0.24	0.15	0.08	-0.05	-0.11	-0.12	-0.12	-0.12	-0.12	0.38	-0.01	-0.12
ch(Interest Rate%)	-0.36	0.04	0.37	0.61	0.73	0.77	0.76	0.64	0.49	0.38	0.32	0.31	0.30	0.41	0.66	0.37
%ch(Wage Rate)	1.4	-0.2	-1.4	-2.3	-2.7	-2.9	-2.8	-2.4	-1.9	-1.5	-1.2	-1.2	-1.2	-1.6	-2.5	-1.4
ch(Private Wealth/GDP%)	0.0	29.5	25.4	25.6	29.1	34.5	40.9	53.8	63.8	69.2	72.1	72.4	72.0	27.4	50.8	69.4
ch(Gov't Wealth/GDP%)	0.0	-40.9	-45.4	-50.1	-54.5	-58.6	-62.2	-67.3	-69.9	-71.0	-71.5	-71.7	-70.9	-46.7	-65.8	-71.1

Table A.14 (b) Efficiency Gains and Losses Corresponding to Table A.14 (a)

(Compensating Variations in Wealth; In 1,000 Growth-Adjusted US Dollars)

	Year When Age 20 (Top) / Age in Year 1 (Bottom)																
	-88	-79	-69	-59	-49	-39	-29	-19	-9	1	11	21	41	61	81	101	120
	109	100	90	80	70	60	50	40	30	20	10	0	-20	-40	-60	-80	-99
(Closed Economy)	delta_tr ($1000) =			**-38.62**													
After LSRA -- All	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-38.6	-38.6	-38.6	-38.6	-38.6	-38.6	-38.6
Before LSRA -- e1	0.0	0.0	-0.3	-0.2	2.7	-31.2	-39.2	-34.7	-28.2	-21.2	-2.2	20.5	55.8	65.1	65.7	65.9	66.1
Before LSRA -- e3					3.2	-36.7	-71.4	-66.3	-48.2	-23.6	-2.4	23.1	62.7	73.4	74.0	74.1	74.3
Before LSRA -- e5					6.8	-40.8	-86.2	-83.9	-62.8	-28.6	-4.2	25.4	72.6	85.7	86.5	86.5	86.7
Before LSRA -- e8					-3.1	-21.0	-43.9	16.6	-33.0	-28.8	-0.4	35.1	92.5	109.1	110.1	109.9	109.9
Before LSRA -- Average	0.0	0.0	-0.3	-0.2	3.8	-36.2	-65.8	-60.3	-46.6	-24.3	-2.6	23.6	64.9	76.2	76.8	76.9	77.2

Note: The hourly wage of a household is stochastic, and it changes its class according to a Markov Transition matrix. The efficiency gain of each age-wage cohort is a population-weighted average across wealth holdings and historical earnings. The efficiency gains are evaluated at the beginning of year 1 for current households and at the beginning of age 20 for future households. The numbers are growth adjusted but not discounted.

References

[1] Altig, David, Alan Auerbach, Laurence Kotlikoff, Kent Smetters, and Jan Walliser (2001). "Simulating Fundamental Tax Reform in the United States." *American Economic Review*, 91, 3: 574-595.

[2] Auerbach, Alan (1996). "Tax Reform, Capital Allocation, Efficiency and Growth." In H. Aaron and W. Gale, Editors, *Economic Effects of Fundamental Tax Reform*, Brookings Institution Press: Washington, D.C.

[3] Auerbach, Alan and Laurence Kotlikoff (1987), *Dynamic Fiscal Policy*, Cambridge University Press.

[4] Barro, Robert J. (1997). *Macroeconomics (5th edition).* The MIT Press.

[5] Breyer, F (1989). "On the Intergenerational Pareto Efficiency on Pay-as-you-go Financed Pension Systems." *Journal of Institutional and Theoretical Economics*, 145: 643-58.

[6] Brown, Jeffrey R., Olivia S. Mitchell, James M. Poterba and Mark J. Warshawsky (2001). *The Role of Annuity Markets in Financing Retirement.* MIT Press: Cambridge, MA.

[7] Conesa, Juan and Dirk Krueger (1999), "Social Security Reform with Heterogeneous Agents," *Review of Economic Dynamics*, **2**, 757-795.

[8] De Nardi, Mariacristina, Selahattin Imrohoroglu, and Thomas J. Sargent (1999). "Projected U.S. Demographics and Social Security." *Review of Economic Dynamics*, 2, 3: 575-615.

[9] Diamond, Peter A. and Peter R. Orszag (2003). *Saving Social Security: A Balanced Approach*. Brookings Institution Press.

[10] Eaton, Jonathan and Harvey S. Rosen (1980a). "Taxation, Human Capital, and Uncertainty." *American Economic Review*, 70, (4), 705-15.

[11] Eaton, Jonathan and Harvey S. Rosen (1980b). "Optimal Redistributive Taxation and Uncertainty." *Quarterly Journal of Economics*, 95 (2): 357-64.

[12] Feldstein, Martin S (1974). "Social Security, Induced Retirement, and Aggregate Capital Accumulation." *Journal of Political Economy*, 82, 5: 905-26.

[13] Feldstein, Martin and Jeffrey Liebman. "Social Security," in Alan J. Auerbach and Martin Feldstein, editors, *Handbook of Public Economics*, volume 4, (Amsterdam: Elsevier), 2002.

[14] Geanakoplos, John, Olivia S. Mitchell and Stephen P. Zeldes, "Would a Privatized Social Security System Really Pay a Higher Rate of Return?" In *Framing the Social Security Debate: Values, Politics and Economics*. Eds. D. Arnold, M. Graetz, and A. Munnell. Brookings Institution, 1998: 137-157.

[15] Harberger, Arnold (1974). *Taxation and Welfare*. University of Chicago Press, Chicago.

[16] Hicks, John (1943). "The Four Consumer's Surpluses". *Review of Economic Studies*, 11:1, 31-41.

[17] Hicks, John (1945-46). "The Generalized Theory of Consumer's Surplus". *Review of Economic Studies*, 13:2, 68-74.

[18] Imrohoroglu, Ayse and Selahattin Imrohoroglu, and Douglas Joines (1995). "A Life Cycle Analysis of Social Security." *Economic Theory*, 6, 1: 83-114.

[19] Imrohoroglu, Ayse and Selahattin Imrohoroglu, and Douglas Joines (1999). "Social Security in an Overlapping Generations Economy with Land." *Review of Economic Dynamics*, 2, 3: 638-65.

[20] King, Robert G., Charles I. Plosser, and Sergio Rebelo (1988). "Production, Growth and Business Cycles: I. The Basic Neoclassical Model." *Journal of Monetary Economics*, 21, 2/3 (March/May): 195 - 232.

[21] Kotlikoff, Laurence J, Kent Smetters, Jan Walliser (2001). "Finding a Way Out of America's Demographic Dilemma." NBER Working Paper #8258.

[22] Mariger, Randall. "Social Security Privatization: What Are the Issues?" *National Tax Journal*, vol. 52, no. 4, December 1999, pp. 783-802

[23] Murphy, Kevin and Finis Welch, “Perspectives on the Social Security Crisis and Proposed Solutions,” *American Economic Review*, 1998, 88: 142 – 150.

[24] Nishiyama, Shinichi (2002), “Bequests, Inter Vivos Transfers, and Wealth Distribution,” *Review of Economic Dynamics*, **5**, 892-931.

[25] Nishiyama, Shinichi and Kent Smetters (2003), “Consumption Taxes and Economic Efficiency in a Stochastic OLG Economy,” Working Paper 2002-6, Congressional Budget Office, and *NBER Working Paper* 9492.

[26] Persson, Mats (1983). “The Distribution of Abilities and the Progressive Income Tax.” *Journal of Public Economics*, 22 (1): 73-88.

[27] Shiller, Robert. “Social Security and Institutions for Intergenerational, Intragenerational and International Risk Sharing.” *Carnegie-Rochester Conference Series on Public Policy*, 1999, 50, 165-204.

[28] Smetters, Kent (2004). “On the Potential for Pareto Improving Social Security Reform.” Mimeo, The Wharton School.

[29] Social Security Administration (2001), *Social Security Bulletin: Annual Statistical Supplement*, available at http://www.ssa.gov/statistics/supplement/2001/index.html.

[30] Varian, Hal R (1980). “Redistributive Taxation as Social Insurance.” *Journal of Public Economics*, 14 (1): 49-68.