

On the Distributional Effects of Social Security Reform*

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How will the distribution of welfare, consumption, and leisure across households be affected by social security reform? This paper addresses this question for social security reforms with a two-tier structure by comparing steady states under a realistic version of the current U.S. system and under the two-tier system. The first tier is a mandatory, defined-contribution pension offering a retirement annuity proportional to the value of taxes paid, whereas the second tier guarantees a minimum retirement income. Our findings, which are summarized in the Introduction, do *not* in general favor the implementation of pay-as-you go versions of the two-tier system for the U.S. economy. *Journal of Economic Literature* Classification Numbers: D3, E6. © 1999 Academic Press

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1. INTRODUCTION

I urge all Americans to reflect on the significance of the Social Security Act signed 50 years ago and to celebrate its accomplishments.

—Ronald Reagan¹

Although celebrations have been somewhat rare among young Americans, many people have in recent years joined Ronald Reagan in reflecting on the significance of the U.S. social security system. Much of the reflection has been prompted by concerns over the future solvency of the system. The basic issue is that changing demographics, changing health care costs, and the expansion of social security benefits in past decades are projected to cause future social security tax rates to increase substantially if current health and retirement income benefit formulas remain unchanged.²

Concerns over solvency have coincided with proposals for fundamental social security reform. These proposals attempt to address the issues of equity and efficiency in addition to the solvency issue. A key question to ask of these reform proposals is the following: What are, in quantitative terms, the distributional effects of social security reform? We focus on distributional effects for three main reasons. First, distributional effects are potentially quite large for some agents, given the size and scope of the U.S. social security system. Second, exactly who wins and who loses from a proposed reform is key to determining whether a particular proposal will potentially be adopted. Finally, a detailed investigation of distributional effects is required, as such effects are not summarized by a present-value calculation of benefits received and taxes paid. This is because social security systems distort labor decisions and potentially change insurance possibilities, in addition to redistributing income across households.

This paper investigates social security reforms with a two-tier structure. The first tier is a mandatory, defined-contribution pension scheme, whereas the second tier guarantees a minimum “floor” income in retirement to those whose social security pensions would otherwise fall below this floor level. Social security reforms with these properties have recently been advocated by the World Bank (see World Bank, 1994) and have been implemented in a number of Latin American countries.³ Thus, our analysis of the replacement of the U.S. system with a two-tier system, should be of interest to the World Bank economists advocating two-tier systems, as well as to economists whose focus is not the U.S. economy.

¹ *Social Security Bulletin* (1985, vol. 48, p. 5).

² See Steurle and Bakija (Chap. 3, 1994) for a review of these projections.

³ Chile, Colombia, Mexico, and Peru all have systems with these features. See Cerda and Grandolini (1997) and World Bank (1994).

A number of reform proposals directed at the U.S. economy (e.g., Boskin *et al.*, 1986; Ferrara, 1997) have incorporated a two-tier structure. Thus, our analysis should serve as a useful point of reference for thinking about the potential economic effects of a number of proposals with this feature. Furthermore, as we focus on the specific details of the proposal advocated for the United States by Michael Boskin, our analysis has direct implications for this specific proposal. The core features of the “Boskin proposal” are summarized by Boskin *et al.* (p. 19, 1986) as follows:

The core of my proposal is to separate our national retirement policies—primarily Social Security, Medicare, and their related programs—into two distinct parts. One part—sometimes called the annuity or insurance part—would provide actuarially equivalent insurance (i.e., identical returns to each dollar of taxes paid by everyone) for disability, catastrophic hospital care, and survivors and retirement annuities. The other—sometimes referred to as the welfare or the transfer part—would guarantee a minimally adequate level of retirement income for all citizens.

The “annuity” portion of benefits just described is to be financed either on a pay-as-you-go basis or on a fully funded basis from proportional taxes on labor earnings. The “transfer” portion of benefits, which we subsequently call the floor benefit, is to be financed out of general revenues.

There are a number of distinct ways in which alternative social security systems, such as the Boskin proposal, can have economic effects. In particular, there can be redistributive, distortionary, and insurance effects. Redistributive effects arise from redistributing income within and across generations. The U.S. social security system redistributes income across generations via the use of pay-as-you-go financing and redistributes income within generations, as benefits are not proportional to taxes paid. Changes in the amount of redistribution across generations can have potentially large effects on the capital stock within life-cycle models. Distortionary effects can arise, even under complete markets, when the present value of marginal benefits received does not equal the value of marginal taxes paid. Since old-age benefits in the United States are a concave function of an average of past earnings, the marginal benefit to an additional unit of taxes paid will differ widely, even among households within the same age group.⁴ The literature on social security has emphasized the impact of these distortions on labor decisions.⁵ Insurance effects can arise, in the presence of incomplete markets, in a number of ways. We mention one of these that arises in our analysis. When there is random variation in an individual’s labor productivity that is not insured, then an old-age bene-

⁴See Hurd and Shoven (1983) and Boskin *et al.* (1986) for calculations of differential returns to different households.

⁵See Aaron (1982) and Thompson (1983) for a review of this literature.

fit that is not proportional to social security tax payments could effectively provide partial insurance.

To analyze the distributional effects of implementing the Boskin proposal in place of current U.S. arrangements, we adopt the life-cycle framework. The particular model we use is rich enough to analyze the redistributive, distortionary, and insurance effects discussed above.⁶ In particular, the model allows agents to make labor-leisure decisions. This is important in order to capture the distortionary effects of social security systems. In addition, the model allows agents to differ within an age group in ability levels. This permits a rich analysis of welfare changes within age groups (i.e., intragenerational distributional effects). Within this framework distributional effects can be analyzed during the transition period as well as after the transition is over. We believe that both types of analysis are important. However, we choose to abstract from transition in order to focus with higher resolution on intragenerational distributional effects after the transition is over.⁷

The main results of the paper arise from steady-state comparisons of the U.S. system and the Boskin proposal, each under pay-as-you-go financing.⁸ The main results are summarized below:

1. The steady-state values of aggregate capital, labor, output, and consumption under the U.S. system are quite similar to those under versions of the Boskin proposal. This is due to the fact that there is no change in the amount of intergenerational redistribution, as both systems have the same social security tax rate and both are financed on a pay-as-you-go basis. As aggregate consumption and labor are so similar, the only way for the Boskin proposal to improve welfare for agents at all ability levels at birth is from a superior allocation of consumption and labor, either over the life cycle or across states of nature.

2. When the floor benefit is set to zero, agents with high abilities at birth have a welfare gain worth a 10–15% increase in consumption each pe-

⁶The model we use is quite similar to that used by Huggett (1996) and by Huggett and Ventura (1997) to study the distribution of wealth and the distribution of savings in the U.S. economy. These models build upon the work of Auerbach and Kotlikoff (1987), Hubbard and Judd (1987), Imrohoroglu *et al.* (1995), and others.

⁷Kotlikoff (1996), Huang, *et al.* (1997), and Kotlikoff *et al.* (1997) analyze transitional effects of changes in social security. In Kotlikoff (1996), agents are identical within a generation and there is a labor-leisure choice. In Huang *et al.* (1997), agents are heterogeneous within a generation, but there is no labor-leisure choice. In Kotlikoff *et al.* (1997), labor hours are endogenous and agents are heterogeneous within a given cohort, but they face no idiosyncratic uncertainty.

⁸We assume that the amount of government debt outstanding in steady state is the same in both systems and is set, for simplicity, to zero. This amounts to assuming a particular transition policy that we do not model.

riod, whereas agents with low abilities at birth have a welfare loss worth a 15–35% decrease in consumption. A key and intuitive reason for this finding is the elimination of *intragenerational* redistribution present in the U.S. social security system. Recall that under the Boskin proposal with a zero benefit floor, social security benefits are strictly proportional to contributions. As the floor benefit increases, both high-ability and low-ability agents can gain substantially relative to the U.S. system, but median-ability agents always experience a welfare loss. By one steady-state welfare measure that attaches equal weight to the utility of all agents at birth, the aggregate gains derived from implementing the Boskin proposal are never positive. This is mainly due to the fact that at birth the majority of the agents in the economy are close to median ability.

3. When only the old-age part of the U.S. system is replaced by a two-tier system, holding health and medical benefits constant across both systems, the results are qualitatively the same, even though the magnitudes of welfare gains and losses are smaller. Thus, high-ability and low-ability agents can still gain, but median-ability agents always experience a welfare loss. In all versions of the Boskin proposal that we consider, the majority of the agents suffer a welfare loss. This is the case as (i) the majority of the agents are close to median ability, (ii) the U.S. system has some redistribution to median ability agents through its concave old-age benefit formula, (iii) two-tier systems have built into them a lack of redistributive flexibility toward median-ability agents (i.e., two-tier systems predominantly redistribute toward low-ability agents), and (iv) any efficiency gains from lower distortions on labor supply are not sufficient to improve welfare for agents with median ability levels.

4. Under the Boskin proposal with a low floor benefit, average hours worked are more than 5% higher for agents between ages 20 and 40. This is because benefits are proportional to the total *value* at retirement of all social security taxes paid plus interest. Under the U.S. system the old-age benefit depends on average indexed earnings over the preretirement period and not on the *timing* of these earnings. This finding suggests that social security systems that credit tax payments with interest could have interesting career choice implications as the choice of career alters the shape of the age–earnings profile.

5. As the floor benefit is increased, the labor supply of low-ability agents decreases significantly. This is due to the fact that these agents will receive the floor benefit with certainty. For these agents, social security tax payments provide no marginal benefit.

The paper is organized into five sections. Section 2 describes the model economies and the social security systems we analyze. Section 3 describes how parameters are set in the model economies. Section 4 presents the

results. Section 5 concludes by presenting the advantages of two-tier systems as stated by their proponents and stating what our results have to say about these claims.

2. MODEL ECONOMIES

In what follows we describe two different model economies that are identical in the structure of preferences, endowments, and technology but differ in the nature of the social security arrangement employed.

2.1. *Environment*

We consider an overlapping generations economy. Each period a continuum of agents is born. Agents live a maximum of N periods. The population grows at a constant rate n . All agents face a probability s_j of surviving up to age j , conditional on surviving up to age $j - 1$. These demographic patterns are stable, so that age j agents make up a fraction μ_j of the population at any point in time.⁹

All agents have identical preferences over consumption and labor, and these are given by the following utility function:

$$E \left[\sum_{j=1}^N \beta^j \left(\prod_{i=1}^j s_i \right) u(c_j, 1 - l_j) \right]. \quad (1)$$

The period utility function $u(c, 1 - l)$ is of the constant relative risk-aversion class and is compatible with our focus on steady states:

$$u(c, 1 - l) = \frac{[c^\nu (1 - l)^{1-\nu}]^{(1-\sigma)}}{(1 - \sigma)}. \quad (2)$$

Each agent is endowed with 1 unit of labor time each period. The value of an agent's period labor endowment in efficiency units is $e(z, j)$, which depends on age j and an idiosyncratic shock z . The shock z lies in a set Z and follows a Markov process. Labor productivity shocks are independent across agents. This implies that there is no uncertainty over the aggregate labor endowment, even though there is uncertainty at the individual agent level. The function $e(z, j)$ is described in detail in Section 3.

At any time period t there is a constant returns-to-scale production technology that converts capital K and labor L into output Y . The technology improves over time because of labor-augmenting technological change. The technology level A_t grows at a constant rate, $A_{t+1} = (1 + g)A_t$. Each period capital depreciates at rate δ .

$$Y_t = F(K_t, L_t A_t) = AK_t^\alpha (L_t A_t)^{1-\alpha}. \quad (3)$$

⁹The weights μ_j are normalized to sum to 1, where $\mu_{j+1} = (s_{j+1}/(1+n))\mu_j$.

2.2. An Agent's Decision Problem

The decision problem of an agent under each of the two social security arrangements that we consider can be described by specifying the following elements $(x, y, u(x, j, y), \Gamma(x, j), G(x, j, y, z'))$:

(x, j) state variables.

y control variables.

$u(x, j, y)$ period utility of an age j agent in state x using control y .

$\Gamma(x, j)$ current period budget set as a function of the state (x, j) .

$G(x, j, y, z')$ law of motion determining next period's state x' as a function of the state x , age j , control y , and the shock z' the agent receives next period.

The decision problem of an agent can then be expressed (after some convenient transformations that will be discussed shortly) for each social security system that we consider as the following dynamic programming problem. In the problem below the value function is set equal to zero after the last period of life, $V(x, N+1) = 0$:

$$V(x, j) = \max_{(y)} u(x, j, y) + \beta(1+g)^{v(1-\sigma)} s_{j+1} E[V(x', j+1) | x], \quad (4)$$

subject to $y \in \Gamma(x, j)$ and $x' = G(x, j, y, z')$.

2.2.1. Social Security System 1: U.S. System

States and controls: $x = (a, \bar{e}, z)$, $y = (l, a')$

Budget set:

$$\begin{aligned} \Gamma(x, j) = \{ (l, a') : c \geq 0, a' \geq 0, l \in [0, 1]; \\ c + a'(1+g) \leq a(1+r(1-\tau)) \\ + (1-\tau-\theta)le(z, j)w + b(x, j) \} \end{aligned} \quad (5)$$

Law of motion:

$$\begin{aligned} G(x, j, y, z') &= (a', \bar{e}', z') \quad (6) \\ \bar{e}' &= \begin{cases} [\bar{e}(j-1) + \min\{we(z, j)l, e_{\max}\}]/j & j < R \\ \bar{e} & j \geq R. \end{cases} \quad (7) \end{aligned}$$

In the model economies where social security benefits are determined by the U.S. system, an individual agent's state variable is $x = (a, \bar{e}, z)$. The state $x = (a, \bar{e}, z)$ of an age j agent describes the agent's asset holdings a , average past earnings \bar{e} , and idiosyncratic shock z . The state determines the current period budget set $\Gamma(x, j)$. The budget set specifies that consumption c plus assets a' carried over to the next period are no greater

than current period resources. These resources come from labor earnings $e(z, j)wl$, the value of current period assets $a(1+r)$, and a social security benefit $b(x, j)$. Agents face a common real wage w per efficiency unit of labor and a real interest rate r on asset holdings. There is an income tax τ as well as a social security tax θ on labor earnings. The period utility $u(x, j, y)$ is obtained from the underlying utility function $u(c, 1-l)$ after substituting out consumption, using the current period budget set. The budget set also imposes the restriction that agents face a borrowing constraint in that net asset holdings a' cannot be negative.

Social security benefits $b(x, j)$ are allowed to depend on age j as well as the state x , although benefits will depend on the state x only through the level of average past earnings \bar{e} . This formulation is capable of capturing a number of features of the U.S. social security system, such as the fact that benefits are paid out as an annuity after a "retirement" age R and the fact that benefits are a concave function of average past earnings. Average past earnings \bar{e} is calculated on an indexed basis, so that average earnings in the economy are the same in all years after indexing. This is accomplished in the model economies by transforming the wage rate as described below. Note that the calculation of average earnings only credits earnings below some maximum level e_{\max} . This follows the way in which averaged indexed earnings are calculated in the U.S. social security system.

In the above dynamic programming problem, we assume that the economy is in a constant growth equilibrium in which the real interest rate is constant and in which the real wage grows at the rate of technological progress. To facilitate the computation of equilibrium, we transform variables to eliminate the effects of growth. We transform individual asset holdings, consumption, social security benefits, and wages by dividing by the technology level (A_t). This transformation accounts for the unusual term $(1+g)a'$ in the budget set as well as the term $(1+g)^{v(1-\sigma)}$ in the objective of the dynamic programming problem. To eliminate the effects of growth, we transform aggregate capital and labor inputs as well as government consumption by dividing by $A_t N_t$, where N_t is the number of people in the economy.

2.2.2. Social Security System 2: Boskin Proposal

States and controls: $x = (a_1, a_2, z)$, $y = (l, a'_1)$

Budget set:

$$\begin{aligned} \Gamma(x, j) = \{ & (l, a'_1): c \geq 0, a'_1 \geq 0, l \in [0, 1]; \\ & c + a'_1(1+g) \leq a_1(1+r(1-\tau)) \\ & + (1-\tau-\theta_j)le(z, j)w + b(x, j) \} \end{aligned} \quad (8)$$

Law of motion:

$$G(x, j, y, z') = (a'_1, a'_2, z') \quad (9)$$

$$(1+g)a'_2 = \begin{cases} (a_2 + \theta l e(z, j)w)(1+r) & j < R \\ a_2 & j \geq R. \end{cases} \quad (10)$$

Under the Boskin proposal the state variable $x = (a_1, a_2, z)$ accounts for privately held assets a_1 , the shock z , as well as an accounting variable a_2 representing the accumulated value of social security taxes paid. At birth the accounting variable is set equal to zero. The period budget set is of the same form as under the U.S. system described previously. The key difference lies in how social security benefits are related to taxes paid. The benefit function $b(x, j)$ specifies that benefits are paid out after a retirement age R . These benefits are given by an "annuity payment" $b(a_2, j)$, which is constant in real terms and is proportional to total taxes paid a_2 up to the retirement age, or a floor level \underline{b} , whichever is greater.¹⁰ As the floor will be set proportional to output per person in the economy, it is possible that immediately after retirement the annuity component of benefits could be larger than the floor and that later on the opposite could be true. The social security tax rate θ_j is set equal to a constant value θ for agents below the retirement age and equal to zero above the retirement age.

$$b(x, j) = \begin{cases} 0 & j < R \\ \max\{\underline{b}, b(a_2, j)\} & j \geq R. \end{cases} \quad (11)$$

2.3. Equilibrium

The definition of equilibrium for either social security scheme under pay-as-you-go financing is given below. At a point in time agents are heterogeneous in their age j and their individual state x . The distribution of age j agents across individual states x is represented by a probability measure ψ_j defined on subsets of the individual state space X . So let $(X, B(X), \psi_j)$ be a probability space where $X = [0, \infty) \times [0, \infty) \times Z$ is the state space under both security systems and $B(X)$ is the Borel σ -algebra on X . Thus, for each set B in $B(X)$, $\psi_j(B)$ represents the fraction of age j agents whose individual states lie in B as a proportion of all age j agents. These agents then make up a fraction $\mu_j \psi_j(B)$ of all agents in the economy, where μ_j is the fraction of age j agents in the economy. The distribution of age 1

¹⁰In Boskin *et al.* (Chap. 8, 1986), the floor benefit is determined by an income means test. Our formulation differs as the floor benefit is independent of labor and asset income in retirement. However, the majority of agents receiving floor benefits in our model economies have essentially zero labor and asset income in retirement.

agents across individual states is determined by the exogenous initial distribution of labor productivity shocks, since all agents start out with no assets. The distributions for age $j = 2, 3, \dots, N$ agents is then given recursively as follows:

$$\psi_{j+1}(B) = \int_X P(x, j, B) d\psi_j. \quad (12)$$

The function $P(x, j, B)$ is a transition function which gives the probability that an age j agent transits to the set B next period, given that the agent's current state is x . The transition function is determined by the optimal decision rule on asset holding and by the exogenous transition probabilities on the labor productivity shock z .¹¹

DEFINITION. A steady-state equilibrium is $(c(x, j), a(x, j), l(x, j), w, r, K, L, G, T, TR, \theta_j, b(x, j), \tau)$ and distributions (ψ_1, \dots, ψ_N) such that

1. $c(x, j)$, $a(x, j)$, and $l(x, j)$ solve the dynamic programming problem.
2. Competitive input markets: $w = F_2(K, L)$ and $r = F_1(K, L) - \delta$.
3. Markets clear:
 - (i) $\sum_j \mu_j \int_X (c(x, j) + a(x, j)(1 + g)) d\psi_j + G = F(K, L) + (1 - \delta)K$.
 - (ii) $\sum_j \mu_j \int_X a(x, j) d\psi_j = (1 + n)K$.
 - (iii) $\sum_j \mu_j \int_X l(x, j)e(z, j) d\psi_j = L$.
4. Distributions are consistent with individual behavior:

$$\psi_{j+1}(B) = \int_X P(x, j, B) d\psi_j \text{ for } j = 1, \dots, N - 1 \quad \text{for all } B \in B(X).$$

5. The government budget constraint is satisfied:

$$G = \tau(rK + wL) + T - TR$$

$$T = \left[\sum_j \mu_j (1 - s_{j+1}) \int_X a(x, j)(1 + r(1 - \tau)) d\psi_j \right] / (1 + n)$$

$$TR = 0 \quad \text{for U.S. system}$$

$$TR = \sum_{j \geq R} \mu_j \int_{\{x: \underline{b} > b(a_2, j)\}} (\underline{b} - b(a_2, j)) d\psi_j \quad \text{for Boskin proposal.}$$

¹¹The transition function is $P(x, j, B) = \text{Prob}(\{z': (a(x, j), \bar{e}', z') \in B\} | z)$ under the U.S. system and $P(x, j, B) = \text{Prob}(\{z': (a(x, j), a'_2, z') \in B\} | z)$ under the Boskin proposal. The relevant probability is the conditional probability that describes the behavior of the Markov process z .

6. Social security budget balance:

$$w \sum_j \theta_j \mu_j \int_X l(x, j) e(z, j) d\psi_j = \sum_{j \geq R} \mu_j \int_X b(x, j) d\psi_j \quad \text{for U.S. system}$$

$$w \sum_j \theta_j \mu_j \int_X l(x, j) e(z, j) d\psi_j = \sum_{j \geq R} \mu_j \int_X b(a_2, j) d\psi_j$$

for Boskin proposal.

In the above definition conditions 1–4 are fairly standard. Thus, we focus on the remaining two conditions. Condition 5 states that in each period government consumption G equals income taxes plus the aggregate value of all accidental bequests T , which the government taxes fully, less the aggregate transfers TR paid out. There are transfers TR financed out of general revenues under the Boskin proposal, but there are no such transfers under the U.S. system. Transfers under the Boskin proposal equal the amount that social security annuity benefits fall below the floor benefit level when summed over the population. Condition 6 says that social security is financed on a pay-as-you-go basis with a payroll tax under both the U.S. system and the Boskin proposal. Under the Boskin proposal it is only the annuity component of benefits of current retirees that is financed with the payroll tax.

3. CALIBRATION

In this section we explain how we select the parameters of the model economy. First, we specify preference, technology, and demographic parameters. Second, we parameterize the labor endowment process. Last, we parameterize each social security system.

3.1. *Preferences, Technology, and Demographics*

The preference parameters (β, σ, ν) are set using a model period of 1 year. We follow the work of Rios-Rull (1996) in our settings of these parameters. The discount factor β is set equal to the estimate in Hurd (1989). This value of the discount factor, together with declining values of the survival probability, is capable of generating a hump-shaped profile of consumption over the life cycle. The parameters (σ, ν) determine the elasticity of intertemporal substitution of consumption. This elasticity is $(1/1 - \nu(1 - \sigma))$ and equals 0.75 for the parameter values listed in Table I. This is in the range of values estimated in the microeconomic studies reviewed in

TABLE I
Model Parameters

β	σ	ν	A	α	δ	g	N	n	s_j
1.011	2.0	0.33	0.895944	0.36	0.06	0.021	81	0.012	U.S. 1994

Auerbach and Kotlikoff (1987) and in Prescott (1986).¹² In infinitely lived agent models, the leisure parameter ν is often set so that one-third of discretionary time is devoted to market work in steady state.¹³ In life-cycle economies, there is no simple relationship between the leisure parameter ν and the fraction of time devoted to market work. However, we find, as does Rios-Rull (1996), that with the parameter values listed in Table I, agents under age 65 devote, on average, 31–32% of their time to market work. This occurs even though market work varies with age over the life cycle.

The technology parameters (A, α, δ, g) are set as follows. Capital's share of output α is set following the estimate in Prescott (1986). The technology level A can be normalized freely, so we set its value such that, whenever the capital-to-output ratio equals 3.0, the wage rate equals 1.0. Using $\alpha = 0.36$, this choice implies the value for A in Table I. The depreciation rate δ is set equal to the estimate in Stokey and Rebelo (1995). The rate of technological progress g is set to match the average growth rate of GDP per capita from 1959–94.¹⁴

The demographic parameters (N, s_j, n) are set using a model period of 1 year. Thus, agents are born at a real-life age of 20 (model period 1) and live up to a maximum real-life age of 100 (model period 81). We set the population growth rate n equal to the average U.S. population growth rate 1959–94 as reported in the *Statistical Abstract of the U.S.* (1995, Table 2, p. 8). The survival probabilities are set equal to the Social Security Administration's survival probabilities for men for the year 1994.¹⁵

In the model economies we set government consumption equal to a fixed fraction of output. When government consumption is defined as federal, state, and local government consumption, then government consumption, averaged 19.5% of output from 1959 to 1994 according to the *Survey of Current Business* (1994, Table 1, and 1995, Table 1.1). Thus, we set $G/Y = 0.195$ in the model economies. The tax rate τ is set endogenously to cover these consumption expenditures after accounting for the revenue coming

¹²See Rios-Rull (1996) for an analysis of the importance of this parameter in producing realistic capital–output ratios in life-cycle models.

¹³Ghez and Becker (1975) and Juster and Stafford (1991) estimate this fraction.

¹⁴The GDP data are from the *Survey of Current Business* (1996, Table 2, p. 110). The population data are from the *Statistical Abstract of the U.S.* (1995, Table 2, p. 8).

¹⁵We thank Jagadeesh Gohkale for providing us with these data.

from estate taxation. Under the Boskin plan the tax rate is set so as to finance the same *path* of government consumption as under the U.S. Social Security system. Of course, the tax rate is also set to pay for additional social security benefits for those agents whose annuity benefit is below the floor benefit level.

3.2. Labor Endowments in Efficiency Units

We consider a labor endowment process where the natural log of the labor endowment of an age j agent in efficiency units (y_j) regresses to the mean log endowment of age j agents (\bar{y}_j) at rate γ . This process, as well as the labor endowment function $e(z, j)$, are as follows:

$$y_j - \bar{y}_j = \gamma(y_{j-1} - \bar{y}_{j-1}) + \epsilon_j, \quad (13)$$

where $\epsilon \sim N(0, \sigma_\epsilon^2)$, $y_1 \sim N(\bar{y}_1, \sigma_{y_1}^2)$, and

$$e(z, j) = \exp^{(z + \bar{y}_j)}, \quad (14)$$

where $z \equiv y_j - \bar{y}_j$

The parameters of the labor endowment process are set as follows. First, we set the profile of mean log endowment to match the U.S. cross-sectional labor endowment efficiency profile estimated by Hansen (1993).¹⁶ This profile is given in Fig. 1.

Second, we need to set values for the parameters $(\gamma, \sigma_\epsilon^2, \sigma_{y_1}^2)$. Since the wage rate w per efficiency unit of labor is common to all agents, the labor endowment process is equivalent to an individual-specific wage process. This suggests setting these parameters using data on (i) the magnitude and persistence of individual-specific wage shocks and (ii) the concentration of wages. Unfortunately, we do not have data on the magnitude and persistence of shocks to log wages, even though there are studies measuring the concentration of wages. Thus, we will consider indirect methods for setting these parameters.

We consider two specifications for the wage process. In the “no idiosyncratic shock” specification, agents are born with differences in ability levels that are perfectly preserved over their lives. Thus we set $(\gamma, \sigma_\epsilon^2) = (1.0, 0.0)$. The remaining parameter, $\sigma_{y_1}^2$, is chosen so that the Gini coefficient of the wage distribution matches recent estimates of the Gini coefficient of wages in U.S. cross-section data. In this regard, Ryscavage (1994) reports a wage Gini coefficient for all earners equal to 0.345 in 1989. We

¹⁶Hansen estimates median wage rates in cross-sectional data for males in different age groups. We use his values for the center of the age group and linearly interpolate to get the remaining values. We set the labor endowment in efficiency units of agents at a real-life age of 75 to zero.

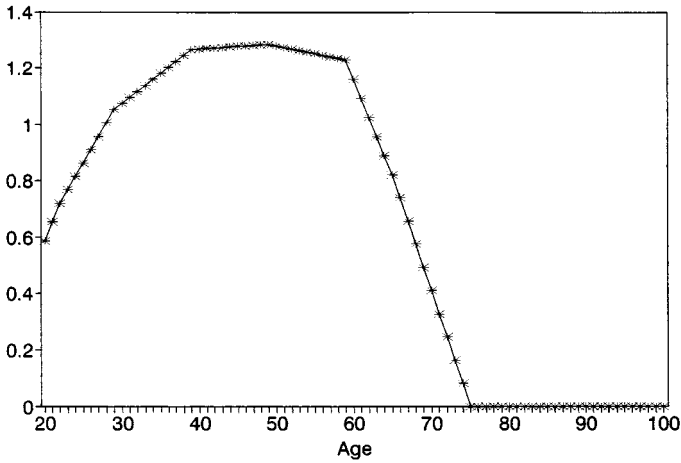


FIG. 1. Wage profile. Source: Hansen [8].

therefore choose $\sigma_{y_1}^2 = 0.376$ so that the wage Gini equals 0.35 for agents in our model economy under age 65.¹⁷

In the “idiosyncratic shock” specification agents experience idiosyncratic shocks in each period of life. We use the following procedure to set parameter values. First, we set $\sigma_{y_1}^2 = 0.27$.¹⁸ Second, for alternative choices of σ_ϵ^2 , we select values for γ that produce a wage Gini coefficient for agents under age 65 equal to 0.35. Finally, for each of these pairs $(\gamma, \sigma_\epsilon^2)$ we compute equilibria in model economies with the U.S. social security system and simulate earnings data from these economies. We use the artificial data created by the model economies to estimate by ordinary least squares the parameters of a regression to the mean process for earnings.¹⁹ We select the pair $(\gamma, \sigma_\epsilon^2)$ that replicates the value of the regression to the mean parameter estimated in the literature on *labor earnings*.

On the basis of this procedure we choose $(\gamma, \sigma_\epsilon^2) = (0.985, 0.015)$. Table II shows that these values replicate the recent estimate of γ from Hub-

¹⁷We approximate each wage model with a finite number of discrete values. The shock z in each model takes on 21 evenly spaced values between $-4\sigma_{y_1}$ and $4\sigma_{y_1}$. Transition probabilities are calculated by integrating the area under the normal distribution conditional on the value of z .

¹⁸We note that this choice implies that the earnings Gini coefficient of the youngest agents in the model economies equals 0.306. This is above the estimates reported by Shorrocks (1980), who reports a value of 0.268. We take this as a lower bound, as households with zero earnings are excluded from the sample.

¹⁹The estimation of the parameters $\hat{\gamma}$ and $\hat{\sigma}_\epsilon^2$ is made for agents 20–64 years old. Agents with zero earnings are excluded from the sample. Values in parentheses correspond to standard errors.

TABLE II
Estimates for the Earnings Process

Wage σ_ϵ^2	Wage γ	Earnings $\hat{\gamma}$	Earnings $\hat{\sigma}_\epsilon^2$	R^2
0.010	0.992	0.9804 (0.0004)	0.0659	0.8999
0.015	0.985	0.9634 (0.00047)	0.0868	0.8703
0.020	0.978	0.9432 (0.00055)	0.1116	0.8328

bard *et al.* (1995). These authors report estimates for γ equal to 0.96, 0.95 and 0.96 for households with less than 12 years of education, 12–15 years of education, and 16 or more years of education, using annual earnings data from 1982–1986.

3.3. Social Security

Under the U.S. system, we set benefits as follows:

$$b(x, j) = \begin{cases} 0 & j < R \\ b + b(\bar{e})/(1 + g)^{j-R} & j \geq R. \end{cases} \tag{15}$$

In this specification benefits are paid begining at a retirement age $R = 46$ (a real-life age of 65). At a point in time, all agents past the retirement age receive the common benefit b in addition to an earnings-related benefit $b(\bar{e})$. The earnings-related benefit is paid out as a constant real annuity. As we transform variables by dividing by the technology level, the extra term $(1 + g)^{j-R}$ appears in the denominator, even though this component of benefits is constant in real terms for a given person after retirement.

We calibrate the common benefit b based on the hospital and medical component of social security benefits. These benefits are paid to all qualifying members of the U.S. social security system, regardless of earnings history. Over the period 1990–94 the hospital and medical payment per retiree averaged 7.72% and 4.70% of GDP per person over age 20.²⁰ Thus, the common benefit is set at $b = 0.1242Y$, where Y is GDP per capita. We note that the model economies we study abstract from the health risk that this component of social security benefits helps to insure. Clearly, a more detailed model would include these risks as well as benefit payments that are contingent upon the realization of health shocks.

²⁰Statistical Supplement of the Social Security Bulletin (1996, Tables 8.A.1 and 8.A.2) and Economic Report of the President (1996, Tables B1 and B30).

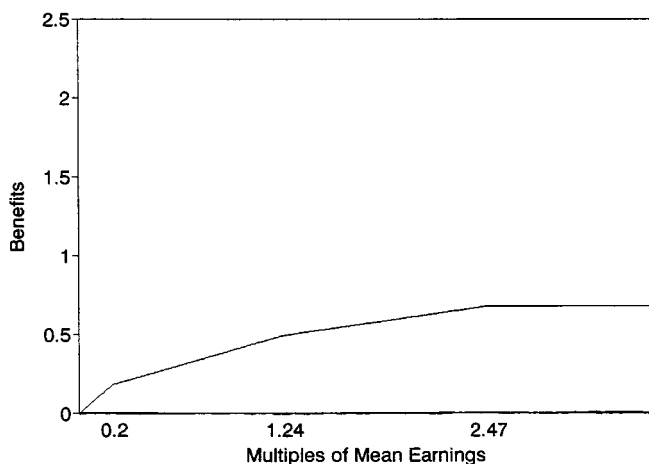


FIG. 2. Social security benefits and earnings-related components.

The earnings-related benefit is calibrated to the old-age social security benefit formula applicable in the same period. The relationship between average past earnings (\bar{e}) and old-age benefits in the model economy is given in Fig. 2. As Fig. 2 shows, the earnings-related component is a concave function of average past earnings.

We calculate the earnings-related benefit $b(\bar{e})$ as follows. In the United States the old-age benefit is called the primary insurance amount (PIA). The PIA is related to a retiree's averaged indexed monthly earnings (AIME). In 1994 the PIA equaled 90% of the first \$422 of AIME, 32% of the next \$2123 of AIME, and 15% of AIME over \$2545. The values at which these percentages change are called *bend points*. We calculate these bend points relative to average earnings in each year 1990–94. The bend points occurred on average at 0.20 and 1.24 times average earnings.²¹ After amendments to Social Security legislation in 1977, bendpoints have been increased automatically in proportion to average earnings.

Recall that only earnings up to some maximum earnings level e_{\max} are used in computing the variable average past earnings \bar{e} . Thus, we also need to set this parameter. As the maximum creditable earnings in the U.S. social security system averaged 2.47 times average earnings over the period 1990–94, we set e_{\max} equal to 2.47 times average earnings per person.²²

Under the Boskin proposal benefits are determined by the greater amount of an annuity payment $b(a_2, j)$, which is constant in real terms and is proportional to the value of taxes paid a_2 up to the age of retirement,

²¹ *Social Security Bulletin* (1993, 1994).

²² *Social Security Handbook* (1995); *Social Security Bulletin* (1993, 1994).

and a floor benefit \underline{b} :

$$b(x, j) = \begin{cases} 0 & j < R \\ \max\{\underline{b}, b(a_2, j)\} & j \geq R. \end{cases} \tag{16}$$

We set the benefit parameters as follows. First, the age of receipt of retirement benefits R as well as the social security tax rate θ are set equal to the values in the model economy with the U.S. social security system. Second, a number of values for the floor benefit level varying from zero times output per person ($\underline{b} = 0.0Y$) to 0.35 times output per person ($\underline{b} = 0.35Y$) are considered. Third, the proportionality factor C determining the annuity benefit must be set, where $b(a_2, j) = Ca_2/(1 + g)^{j-R}$. Given the transformation of variables, transformed benefits shrink for a given person over time at rate g , even though untransformed benefits are constant in real terms. The proportionality factor C is then set so that benefit payments to current retirees equal current social security tax payments (condition 6 in the definition of equilibrium).

4. Results

Our results are presented in two subsections. We first present some general features of the model economies. We then analyze the distributional effects which are the focus of the paper. Details of how the results are computed are described in the Appendix.

4.1. General Features

Tables III and IV below describe some general features of the model economies. Several points are worth noting here. First, for low retirement

TABLE III
General Features—No Idiosyncratic Shocks

	K/Y	L	Fraction of time working	r	Income Gini	Percentage of retired agents at floor level
U.S. system	2.91	0.396	0.314	6.4	0.40	—
Boskin proposal						
$\underline{b} = 0.0Y$	2.96	0.411	0.330	6.2	0.39	0.0
$\underline{b} = 0.15Y$	2.94	0.407	0.324	6.2	0.40	15.6
$\underline{b} = 0.25Y$	2.89	0.401	0.315	6.5	0.40	41.0
$\underline{b} = 0.35Y$	2.81	0.391	0.307	6.8	0.41	59.2

TABLE IV
General Features—Idiosyncratic Shocks

	K/Y	L	Fraction of time working	r	Income Gini	Percentage of retired agents at floor level
U.S. system	3.06	0.413	0.312	5.8	0.43	—
Boskin proposal						
$\underline{b} = 0.0Y$	3.11	0.434	0.329	5.6	0.43	0.0
$\underline{b} = 0.15Y$	3.08	0.429	0.322	5.7	0.43	12.7
$\underline{b} = 0.25Y$	3.02	0.421	0.312	6.0	0.44	39.1
$\underline{b} = 0.35Y$	2.95	0.413	0.306	6.2	0.44	58.8

floor levels, aggregate capital (K) and labor (L) inputs under the U.S. system are below those in the Boskin proposal, whereas for relatively high floor levels ($\underline{b} = 0.35Y$), the opposite pattern is true. However, we note that economic aggregates as well as factor prices do not differ dramatically across steady states. Intuitively, one reason for this is that the amount of intergenerational redistribution is similar in the U.S. system and the versions of the Boskin proposal we study. Intergenerational redistribution is quite similar, as social security tax rates are identical across steady states and as the financing of benefits is always on a pay-as-you-go basis.

Second, we observe that under the Boskin proposal increases in the floor benefit always reduce aggregate capital and labor inputs. The reduction in aggregate capital is related to the increase in the income tax rate needed to finance transfer benefits for an increasing percentage of agents whose retirement annuity income falls below the floor level.²³ Notice that for $\underline{b} = 0.35Y$ this percentage is about 60% in both the idiosyncratic shock and the no idiosyncratic shock case. One reason for the reduction in aggregate labor input is simply that when floor benefit levels are raised, low-ability agents reduce the fraction of time spent working (see Section 4.2.2). This occurs as low ability agents who will receive the floor benefit with certainty get no marginal benefit for an additional unit of social security taxes paid.

It is important to point out that the model economies are able to approximate some distributional features of the U.S. economy. In particular, Table IV shows that under the U.S. system the model economy is able to approximate the U.S. income Gini coefficient estimated by Ryscavage

²³For instance, transfers needed to finance $\underline{b} = 0.35Y$ are on the order of 1.3–1.4% of GDP in the no idiosyncratic case. This results in income tax rates going from 18.7% in the zero floor situation to 22.3% for $\underline{b} = 0.35Y$.

(1995).²⁴ For a discussion of the extent to which similar model economies can match features of the distribution of wealth and savings, see Huggett (1996) and Huggett and Ventura (1997).

4.2. *Distributional Effects of Reform*

The analysis of distributional effects focuses first on the changes in welfare, and then on changes in the distribution of consumption and labor over the life cycle produced by versions of the Boskin proposal.

4.2.1. *Compensating Variations*

We analyze welfare effects by calculating compensating variations for agents born with different ability levels. Our compensating variations list the negative of the percentage that consumption must be increased or decreased by each period over a lifetime to leave a given agent as well off in the Boskin proposal as in the U.S. system. Thus, our measure is negative if an agent experiences a welfare loss under the Boskin proposal and is positive if an agent experiences a welfare gain.

Figure 3 shows welfare gains at different log ability levels at birth. Recall that in our economies agents are born at a real-life age of 20. An ability level of 1 is the lowest, whereas an ability level of 21 is the highest. Recall from Section 3.2 that these ability levels are evenly spaced on a log scale and vary from four standard deviations below the mean ($-4\sigma_{y_1}$) to four standard deviations above the mean ($4\sigma_{y_1}$). As log ability is normally distributed and centered at an ability level of 11, most agents have ability levels close to the median ability.

Figure 3a–b clearly shows that high ability agents are the big winners and low ability agents are the big losers under the Boskin proposal with a floor level of zero. Under a floor of zero, the magnitudes of the welfare changes for agents with low and high ability levels are quite striking. High-ability agents experience a gain in consumption ranging from 10% to 15% each period, whereas low-ability agents experience a welfare loss worth a 15–35% decrease in consumption each period. In Section 4.2.2 we will document the changes in the profiles of consumption and labor over the life cycle that generate the distributional effects in Fig. 3a–b. With higher settings of the floor benefit, low-ability and high-ability agents experience a welfare gain, but agents with median ability levels always suffer a welfare loss. Thus, the distributional effects display the U-shape shown in Fig. 3a–b.

²⁴The concept of income used is labor plus asset income before taxes, plus social security transfers. Using data from the Consumer Population Survey and an equivalent definition of income, Ryscavage (1995) reports that the income Gini coefficient averaged 0.43 for the period 1990–1995.

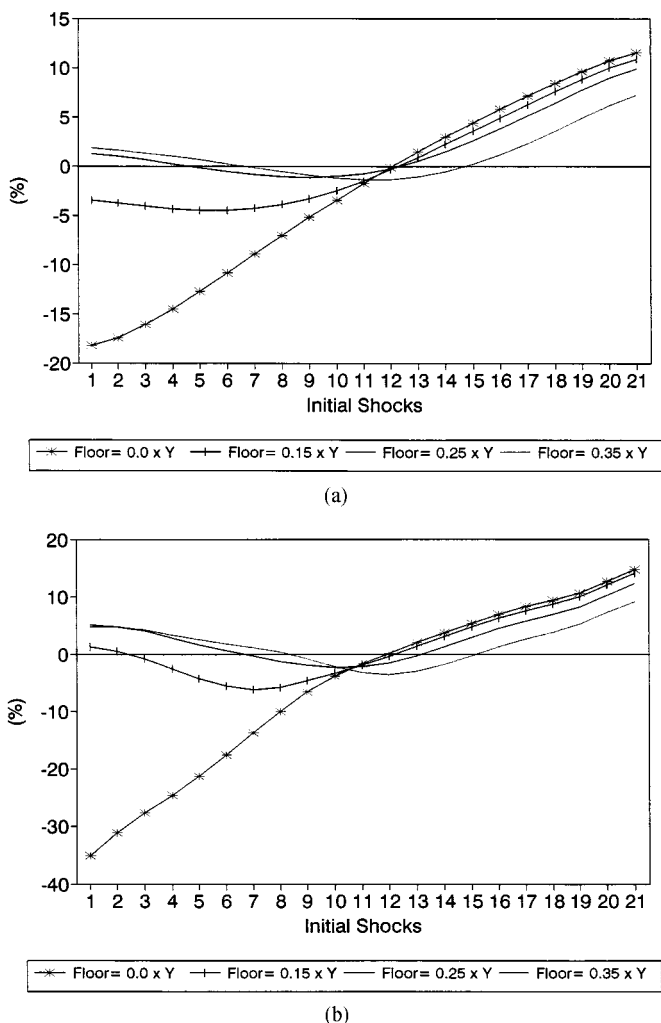


FIG. 3. (a) Compensating variations. Idiosyncratic uncertainty. U.S. system vs. Boskin proposal. (b) Compensating variations. No idiosyncratic uncertainty. U.S. system vs. Boskin proposal.

It is interesting to try to develop some intuition for which features of the economy determine these distributional effects. The candidates are changes in redistribution, changes in distortions, and changes in insurance, as well as the general equilibrium effects on factor prices that these three effects bring about. We find that differences in factor prices are not responsible for much of the observed patterns. We have verified that when factor prices are

held constant at their values under the U.S. system, the results are almost indistinguishable from those in Fig. 3a–b. This exercise could be thought of as a calculation of welfare changes using an open economy assumption. We believe that differences in distortions are not responsible for much of the pattern in Fig. 3.²⁵ We have verified that when we fix hours worked over the life cycle for *all* agents and calculate equilibria under both social security systems, the compensating variations are quite similar to those in Fig. 3. This occurs when we fix the labor profile to be perfectly flat over the working life or when we fix the labor profile to the average profile calculated under the U.S. system. These experiments amount to choosing specific—and sometimes time-varying—period utility functions for the utility of consumption. In this way we eliminate any possible distortionary effects of social security on labor, as labor supply is completely exogenous.²⁶

We conjecture that differences across equilibria in redistribution are quite important in explaining the patterns in Fig. 3. Under the Boskin proposal with a zero floor, benefits are proportional to the accumulated value at retirement of taxes paid. Thus, low-ability agents lose both the redistribution coming from the concave old-age benefit schedule as well as from the common benefit coming from hospital and medical insurance under the U.S. system. This accounts for the welfare loss of low-ability agents and the welfare gains of high-ability agents. At higher floor levels the income tax must be raised to pay for higher floor benefits. This reduces the welfare gains of the high-ability agents who are paying these taxes but who unlikely to ever be at the floor benefit level. Low-ability agents can experience a welfare gain as the higher floor income level in retirement offsets any negative effects of the higher income taxes needed to pay for these floor benefits. Figure 3a–b indicates that median-ability agents (e.g., ability level 11) do not gain from participating in any version of the Boskin proposal.

We now provide one possible aggregate measure of steady-state welfare gains to adopting the Boskin proposal in place of the U.S. system. To do this we create a social welfare measure that is a weighted average of the utilities of different agent types at birth, where the weights are the fraction of the different agent types at birth.²⁷

Using this measure of welfare, compensating variations are calculated and presented in Table V. One interpretation of this compensating variation

²⁵We believe that labor is not particularly important for the pattern in Fig. 3, despite the fact that we document in Section 4.2.2 that labor supply over the life cycle changes quite markedly across the social security systems we investigate.

²⁶All of the calculations we discuss in this paragraph are available from the authors upon request.

²⁷More formally, the welfare notion is $\sum_z p(z)V^i(0, 0, z, 1)$, where $p(z)$ denotes the fraction of age 1 agents receiving shock z , and $i = \{\text{U.S. system, Boskin proposal}\}$.

TABLE V
Aggregate Welfare Gains and Agents with Welfare Losses at Birth

Model economy	No idiosyncratic shocks		Idiosyncratic shocks	
	Welfare gains (%)	Agents w/ losses (%)	Welfare gains (%)	Agents w/ losses (%)
$\underline{b} = 0.0Y$	-3.5	57.9	-2.4	72.5
$\underline{b} = 0.15Y$	-1.9	72.5	-1.3	72.5
$\underline{b} = 0.25Y$	-0.9	80.5	-0.3	72.1
$\underline{b} = 0.35Y$	-1.5	80.5	-0.9	88.3

is the percentage gain or loss (in terms of consumption each period) that an agent receives living under the Boskin proposal relative to living under the U.S. system, given that the ability level at birth is uncertain. Table V shows that, despite important welfare gains for some agents shown in Fig. 3, the aggregate welfare measure is never positive for the floor levels considered.²⁸ Table V also shows that at birth the majority of agents in the economy experience a welfare loss by adopting any version of the Boskin proposal.

One plausible conjecture is that the welfare results in Fig. 3 and Table V are both due to a lack of redistributive flexibility toward agents with median earnings ability built into the Boskin proposal and not because labor distortions are more onerous under the Boskin proposal. In particular, in adopting the Boskin proposal, median-ability agents lose the common hospital and medical transfer built into the U.S. system, as well as some of the redistribution from the concave benefit formula relating old-age benefits to average earnings. In the Boskin proposal they either do not receive floor benefits at all or receive these only in the last few years of life.

We now examine if changing only the old-age component of social security, while maintaining the hospital and medical transfers in both systems, alters our previous results qualitatively or quantitatively. The results of this exercise are presented in Fig. 4 and Table VI.²⁹ Qualitatively, the compensating variations in Fig. 4 are similar to those reported previously. However,

²⁸One caveat is necessary to interpret properly the welfare gains in Table V. Comparisons of welfare gains in the idiosyncratic shock economy to those in the no idiosyncratic shock economy do not provide a measure of insurance possibilities in the Boskin proposal relative to the U.S. system. One reason for this is because the variance of the ability shocks differs at birth in these two economies.

²⁹To carry out the calculations, the payroll tax in the U.S. system is split into two parts ($\theta_1 + \theta_2 = \theta$). The first part is obtained as the one that finances the common transfer b in the U.S. system. Once the taxes are found, they are kept constant in the calculations for the Boskin proposal. Notice that since θ_1 finances the common transfer, θ_2 is the rate at which labor earnings accumulate in the social security scheme. Benefits at retirement are then equal to $\max\{\underline{b}, b + b(a_2, j)\}$.

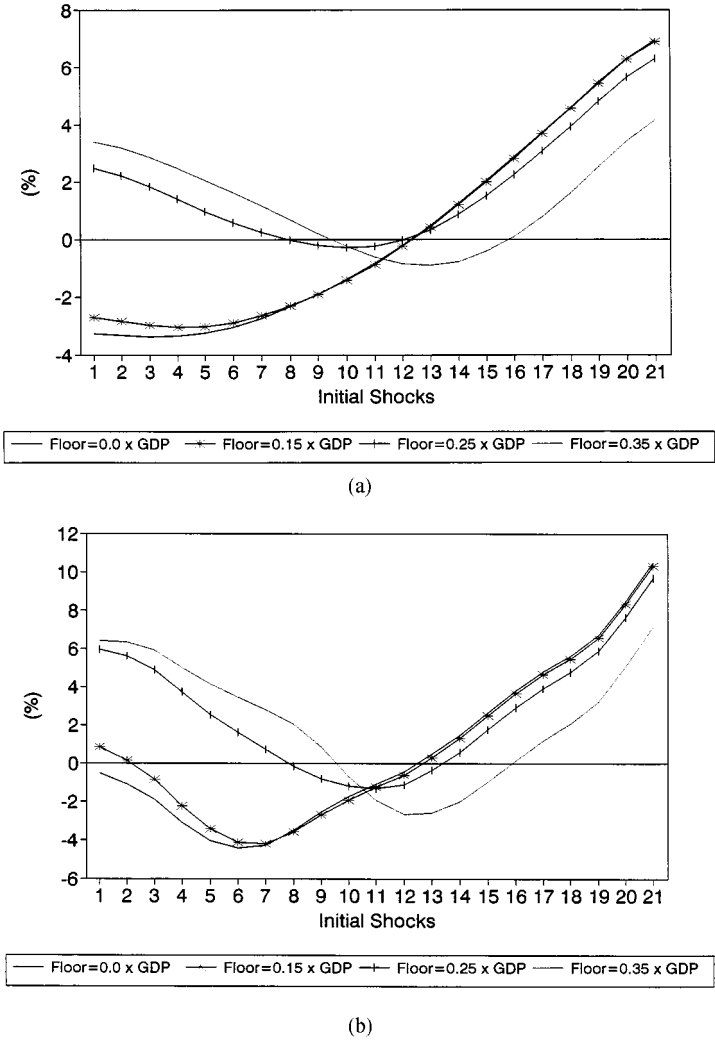


FIG. 4. (a) Compensating variations. Idiosyncratic uncertainty. U.S. system vs. Boskin proposal (w/medical benefits). (b) Compensating variations. No idiosyncratic uncertainty. U.S. system vs. Boskin proposal (w/medical benefits).

the *magnitudes* of welfare gains and losses are quite different. We see that (i) the striking welfare losses of low-ability agents at the lowest level of the floor benefit are no longer present and (ii) the large welfare gains for high-ability agents are reduced.

Table VI shows that keeping the common transfer of medical and hospital benefits in the Boskin proposal reduces significantly but typically does

TABLE VI
Aggregate Welfare Gains and Agents with Welfare Losses at Birth
(Medical and Hospital Benefits Held Constant)

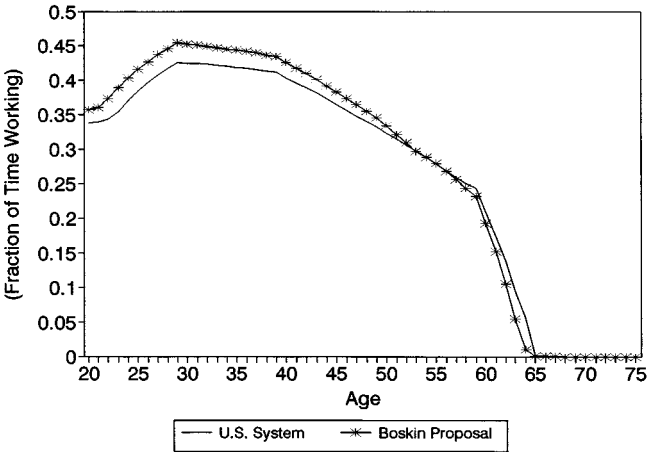
Model economy	No idiosyncratic shocks		Idiosyncratic shocks	
	Welfare gains (%)	Agents w/ losses (%)	Welfare gains (%)	Agents w/ losses (%)
$\underline{b} = 0.0Y$	-1.3	72.5	-0.80	72.6
$\underline{b} = 0.15Y$	-1.3	72.6	-0.81	72.6
$\underline{b} = 0.25Y$	-0.3	76.1	0.16	64.5
$\underline{b} = 0.35Y$	-0.4	69.0	-0.15	69.0

not reverse the sign of the aggregate welfare losses shown previously. In just one particular situation (the case of idiosyncratic shocks and a floor benefit set at $\underline{b} = 0.25Y$), the Boskin proposal dominates the U.S. system in terms of the aggregate welfare measure. However, it is important to note that for all versions of the Boskin proposal that we have explored, the majority of the agents suffer a welfare loss at birth relative to the U.S. system. We believe that this is due to (i) a lack of redistributive flexibility toward median ability agents built into two-tier systems such as the Boskin proposal, (ii) the fact that the U.S. system redistributes toward median ability agents through its concave old-age benefit formula, and (iii) the fact that most agents in the economy are close to median ability levels. It is interesting to note that the majority of the agents suffer a welfare loss despite the arguments by proponents (e.g., Boskin *et al.* (p. 147, 1986)) that there are potential efficiency gains that arise from reducing the labor distortions of the social security tax. This potential efficiency gain is claimed to arise as marginal social security benefits are more tightly related to marginal taxes paid. Evidently, any potential efficiency gains will not make this proposal popular without more attention to changes in redistribution to median-ability agents.

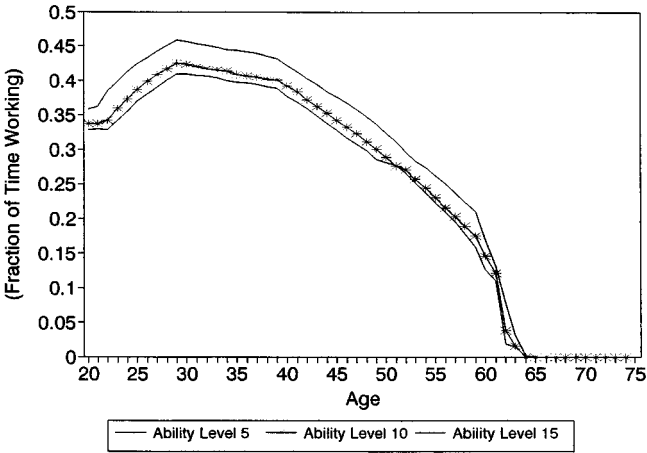
4.2.2. Consumption and Labor Profiles

We now document how the cross-sectional profiles of consumption and labor differ under the U.S. system and the Boskin proposal. These profiles are graphed in in Figs. 5a–c and 6a–c for the case of no idiosyncratic uncertainty.

In Fig. 5a agents allocate on average 35–40% of their time to market work when young under the U.S. system. This percentage declines sharply as agents approach age 65. The patterns we calculate for the U.S. system are quite similar to those calculated by Rios-Rull (1996) in a related model that abstracted, among other things, from the structure of the U.S. social security system. Rios-Rull demonstrated that the average fraction of time



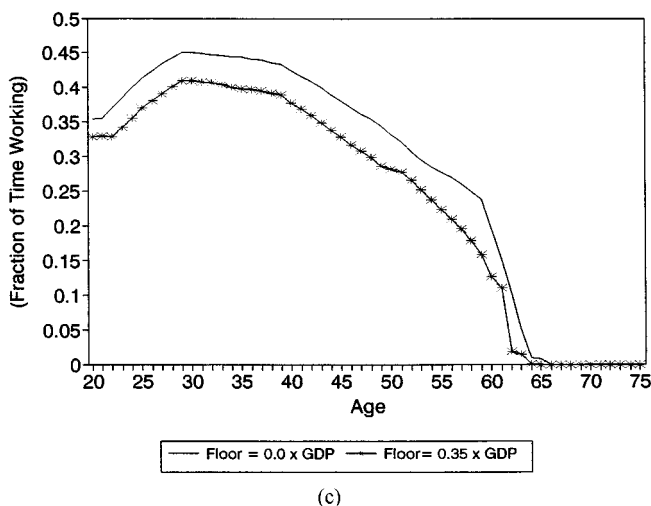
(a)



(b)

FIG. 5. (a) Average labor hours: No idiosyncratic uncertainty. U.S. system vs. Boskin proposal (floor = 0). (b) Labor hours profile. No idiosyncratic uncertainty (floor = $0.35 \times Y$). (c) Labor hours of low-ability agents. No idiosyncratic uncertainty (ability level 5).

allocated to market work at different stages of the life cycle in his model roughly approximated the average labor hour pattern he calculated using U.S. data from the Current Population Survey. He argued that the pattern in his model was determined by the variation in the efficiency of labor time over the life cycle. As we follow Rios-Rull in using the efficiency profile calculated by Hansen (1993), previously presented in Fig. 1, and in using similar magnitudes for the elasticity of intertemporal substitution, the

FIGURE 5—*Continued*

patterns in our model with social security and in his model without social security turn out to be similar.

A notable feature of Fig. 5a is that there is a significant difference in the cross-sectional pattern of labor under the Boskin proposal with a zero floor as compared to the U.S. system. The average fraction of time worked is more than 5% higher early in life under the Boskin proposal as compared to the U.S. system. A natural conjecture is that this is largely due to differences in work incentives under the two systems. Under the Boskin proposal with a zero floor, benefits are proportional to the accumulated future value of taxes paid up to the time of retirement, whereas under the U.S. system benefits depend on average indexed earnings, not the *timing* over the life cycle of these earnings. Thus, agents under the Boskin proposal have a higher return on a unit of social security tax payments early in life as compared to a unit of tax payments later in life, as these payments effectively pay interest (see Section 2.2.2).

Figure 5b graphs the distribution of labor hours across ability levels over the life cycle under the Boskin proposal with a floor benefit equal to 35% of average income in the economy. Fig. 5b demonstrates that with a high benefit floor level ($\underline{b} = 0.35Y$), even in the absence of idiosyncratic uncertainty, agents with high ability work more than their low-ability counterparts. The reasons for this phenomenon are as follows. When the floor level is increased, the marginal returns to social security tax payments differ across agents. For high-ability agents the logic described above still applies, as these agents will be above the floor level with certainty. However, agents with low ability levels will receive an annuity benefit that puts them below

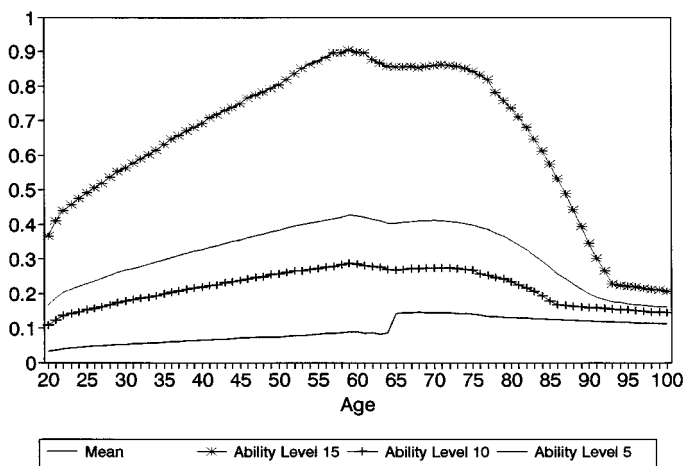
the floor level with certainty. Thus, they will receive a zero marginal return on all social security tax payments. This reduces labor supply over the life cycle for these agents, as can be seen in Fig. 5b.

The negative effects of higher floor benefit levels on labor hours supplied by low-ability agents can be further confirmed in Fig. 5c. This figure graphs, for a relatively low ability level, the distribution of labor hours under the Boskin proposal with the lowest and the highest benefit floors (zero and 35% of per capita income, respectively). We observe here that low-ability agents reduce labor hours significantly, relative to the zero floor situation.

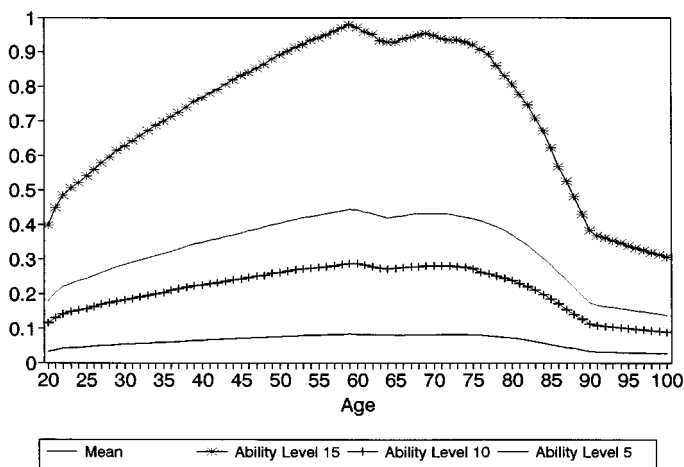
Figure 6a–c graphs the cross-sectional patterns of consumption. Several features are worth noting here. First, low-ability agents experience an upward jump in consumption at the retirement age in the cases of the U.S. system and Boskin proposal with $\underline{b} = 0.35Y$. This is explained by the presence of the borrowing constraint, which prevents these agents from borrowing early in life in order to smooth the quite important increase due to the old-age and health-related social security benefits (recall that benefits are not proportional to contributions). Second, notice that the cross-sectional pattern of consumption for low ability agents differs dramatically between the U.S. system and the Boskin scheme with a zero benefit floor, as with the latter (i) social security transfers are proportional to taxes paid, and (ii) the common transfer is lost. These features dictate that the jump in consumption at age 65 mentioned above is not observed in the version of the Boskin plan with a zero retirement floor, as Fig. 6b demonstrates. The fall in consumption after the retirement age relative to the U.S. system case, in conjunction with the lower amount of leisure enjoyed by low-ability agents under a zero floor, accounts for the quite dramatic welfare losses for these agents documented in Fig. 3.

5. CONCLUSION

This paper has focused on the potential distributional effects of replacing the current U.S. social security system with a two-tier system that we refer to as the Boskin proposal. This is a difficult question to answer for a number of reasons, of which we will mention five. First, social security systems affect consumers by redistributing income, distorting the labor–leisure decision, and changing insurance possibilities when markets are incomplete. Thus, distributional effects are not well summarized by a calculation of the present value of taxes paid and benefits received. Second, a complete analysis of distributional effects would focus on the agents who are alive at the time of transition as well as those who are born after the transition is over. Third, as the current U.S. system is not in a situation in which current tax rates and benefit formulas appear to be financially feasible over time,



(a)



(b)

FIG. 6. (a) Consumption profile (U.S. system). No idiosyncratic uncertainty. (b) Consumption profile (Boskin proposal). Zero floor; no idiosyncratic uncertainty. (c) Consumption profile (Boskin proposal). Floor = $0.35 \times \text{GDP}$; no idiosyncratic uncertainty.

a deeper analysis requires the consideration of time-varying tax rates and benefit formulas as well as projected changes in demographics. Fourth, a meaningful quantitative analysis of distributional effects requires a model that at a minimum can reproduce some of the distributional facts of the U.S. economy. Fifth, a meaningful comparison of alternative social secu-

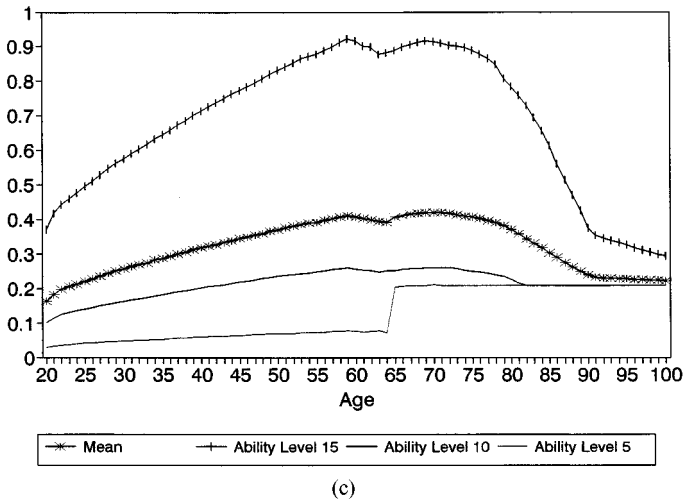


FIGURE 6—Continued

ity systems involves modeling the precise relationship between individual earnings and tax payments and the social security benefits received.

Our strategy for analyzing distributional effects is twofold. First, we have chosen to simplify the problem by abstracting from transitional issues, time variation in demographics, and social security tax rates and benefit formulas, as well as differences in survival probabilities driven by gender or income. These abstractions allow us to extract cleanly a number of key insights that we conjecture would also be present, but in a more complicated fashion without these abstractions. Second, we use a particular version of the life-cycle model that is calibrated to match a number of distributional and aggregate features of the U.S. economy as our laboratory for evaluating distributional effects. Within this framework we are able to capture the redistributive, distortionary, and insurance effects of social security systems as well as model some of the precise details of how benefits are related to earnings and taxes paid. We know of no other existing work that captures these features and allows a rich analysis of intragenerational distributional effects.

One of the main conclusions of our analysis is that the majority of the people in our model economies are made worse off under any version of the Boskin proposal under pay-as-you-go financing we have considered. Simply put, the Boskin proposal is quite unpopular. Our analysis suggests that the main reason that two-tier systems are unpopular is that the current U.S. system redistributes toward median-ability agents through the concave old-age benefit schedule and that these agents lose this redistribution in two-tier systems. The floor benefit just does not redistribute enough

to median-ability agents for any level of the floor to make two-tier systems more popular. This is true even taking into consideration any beneficial effects from reduced labor distortions under the two-tier system. Even though we have not modeled either the political economy of social security reform or transitional issues, the fact that two-tier systems are quite unpopular suggests to us that they are unlikely to be adopted in any more complete model.

Proponents of two-tier proposals have put forth a number of arguments for why such systems would seem to be a good idea. Boskin *et al.* (p. 147, 1986) states that his two-tier proposal "would be simpler, fairer, and more efficient than the Social Security system under current law." The argument that it is simpler (Boskin *et al.* (p. 144, 1986) is that the "two-tier approach also offers the advantages of easy-to-comprehend annual financial reports that will facilitate both the administration of the program and personal financial planning." The main arguments that it is fairer are that (i) one- and two-earner families would be treated symmetrically under the two-tier system, since the spousal benefit to single-earner families would be eliminated (see Boskin *et al.* (Chap. 7, 1986) and that (ii) floor benefits (i.e., benefits beyond those justified by equivalent returns on social security tax payments) to the elderly would have to be paid out of general revenues and thus compete with all other social priorities (see Boskin *et al.* (p. 140, 1986). The main argument that two-tier systems are more efficient (Boskin *et al.* (pp. 146–147, 1986) is that in "the two-tier plan I propose, incremental contributions . . . would provide an actuarially identical return to each contributor in terms of his future benefits, as compared to the hodgepodge of uncertain returns expected under the current system. Thus, the labor market distortion of piling the payroll tax on top of the income tax would be reduced."

Given the arguments by Boskin that two-tier systems are simpler, fairer, and more efficient than the current U.S. system, why are all of the two-tier systems we analyze so unpopular? Our answer is that any potential efficiency gains coming from reduced labor distortions are just swamped by redistributions away from agents with median ability who make up the bulk of the population. Thus, a system that is more efficient is not necessarily one that is more popular. Of course, in our analysis we have abstracted from many things that could potentially be important. For example, in our analysis agents understand perfectly both the U.S. system and the Boskin proposal. Furthermore, agents have unlimited mental capacity to use to figure out how to best make consumption, labor, and saving plans over their lifetimes. Thus, there can be no gain in our analysis in the simplicity of one system relative to another. In addition, we abstract from multimember households, so we cannot address some of the fairness issues mentioned by Boskin. We await future research to see if our main finding on the lack of popularity of two-tier systems applied to the U.S. economy is overturned.

We close the paper with a question: Why have two-tier social security systems been adopted in several countries (e.g., Chile, Colombia, Mexico, and Peru) when we find no strong reasons for adopting them for the U.S. economy? To begin to answer this question, one would need to know a great deal more about these countries and, in particular, their previous social security systems than we do.

APPENDIX

Equilibria to the model of the U.S. system are computed using the following algorithm.

1. Guess values for capital, labor, transfers, and tax rates: K , L , T , τ , and θ .
2. Factor prices are then $w = AF_2(K, L)$ and $r = AF_1(K, L) - \delta$.
3. Calculate optimal decision rules: $a(x, j)$, $l(x, j)$, and $c(x, j)$.
4. Calculate values of K , L , T , τ , and θ that are implied by the optimal decision rules in step 3 and the budget constraints governing social security and government consumption.
5. If the guessed values from step 1 equal the implied values in step 4, then this is a steady-state equilibrium. Otherwise, update the guess in step 1 and repeat these steps.

We now describe how to carry out steps 3 and 4. In step 3 we put a grid on the state space X . We then start in the last period N of an agent's life and solve for the control variables y for each grid point in the state space X , setting $V(x, N + 1) = 0$. Given the maximizing values of controls y on gridpoints, we then can determine values for the value function $V(x, N)$ on gridpoints. We use linear interpolations to get the period N values of the value function and decision rules off of these gridpoints. This procedure can then be repeated to solve for value functions and decision rules for assets and labor for all earlier periods.

We now discuss how we solve the maximization problem for each period at each grid point. We employ the following procedure, which does *not* restrict control variables to lie on a grid:

1. For each gridpoint x , we obtain the best next period asset by first bracketing the optimum searching over asset gridpoints. Once an interval in the asset space containing the optimum has been found, the asset decision rule is computed, using a golden section search procedure. See Press *et al.* (Chap. 10, 1994) for a description of this search procedure and the particular implementation used. Associated with every trial of a' , either in

the bracketing stage or in the golden section search stage, there is a corresponding *intertemporal* labor decision. We use a golden section search procedure to maximize over the labor decision, conditional on asset choice. We search only over labor values between the level that would be maximizing abstracting from marginal social security benefits from working more (i.e., the standard intratemporal labor decision), and the level ($l = 1$) corresponding to working all of the time, as the maximum must lie in this interval.

2. We put a grid of 101, 4, and 21 points on values of (a, \bar{e}, z) . The gridpoints on \bar{e} correspond to zero, the two “bend points” of the social security benefit schedule and a point consistent with the maximum social security benefits. The spacing of the shocks was discussed in Section 3.2. The spacing between points on the asset grid increases with asset levels. More specifically, asset gridpoints are placed according to $a_1 = 0$, $a_k = b(k^{2.35})$, $k = 2, \dots, 101$, where $b = \bar{a}/(101^{2.35})$ and \bar{a} is an upper bound imposed on the asset space.

To calculate values of the variables in step 4 we simulate time paths of consumption, asset holdings, labor, and social security transfers for a large number of agents. The artificial sample is constructed using the Markov process, followed by the idiosyncratic shocks to labor productivity, together with the probability distribution that determines shocks at birth. We then add up asset holdings and labor in efficiency units in each age group and weigh each group by their population percentage to calculate aggregate capital and labor inputs, and all of the relevant aggregates. In these calculations we simulate 20,000 agents per cohort. In doing so, decision rules off gridpoints are obtained by interpolating decision rules on gridpoints. Simulations using larger numbers of agents change neither the values of these aggregates nor the distributional properties of the model economies that we have reported.

When we calculate equilibria under the Boskin proposal, we again follow steps 1–5. The only changes are that we iterate on (K, L, T, τ) and the proportionality factor C (defined in Section 3.3) that determines social security benefits in the Boskin proposal. The social security tax rate θ and the path of government consumption are set equal to those values obtained under the U.S. system. To implement this procedure we put a grid of $(101, 40, 21)$ points on (a_1, a_2, z) . The spacing of the gridpoints on both (a_1, a_2) is determined by the spacing used on a_1 previously.

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