1st version: July 2003

This version: August 2004

Optimal Design of Social Security Reforms

Juan C. Conesa

Universitat Pompeu Fabra, CREA and CREB-UB

Carlos Garriga

Florida State University and CREB-UB

ABSTRACT

We argue that a privatization of the social security system, going from a Pay-As-You-Go to a Fully Funded system, can be interpreted as the explicit recognition of an implicit debt and there is no efficiency gain in doing so. As a consequence, potential efficiency gains upon reforming the system come from the elimination of distortions and the optimal management of that implicit debt. Based on that argument, this paper studies the optimal design of a social security privatization in a Pareto improving way. The government decides endogenously how to finance the transition and the welfare of the initial generations alive becomes policy constraint. We find that the government can design a Pareto improving reform that exhibits sizeable welfare gains, arising because of a reduction in labor supply distortions. In contrast, the welfare gain from reducing savings distortions is relatively small. Our approach explicitly provides quantitative policy prescriptions towards the policy design of future and maybe unavoidable social security reforms.

*We thank very useful comments by Michele Boldrin, Fernando Broner, Tim Kehoe, Victor Rios-Rull, Jaume Ventura, and seminar participants at the Minneapolis Fed, Atlanta Fed, EUI, UPF, ITAM and NBER Summer Institute. Conesa acknowledges support from the Fundación Ramón Areces. Both authors acknowledge financial support from Ministerio de Ciencia y Tecnología, SEC2003-06080 and Generalitat de Catalunya, SGR00-016. The authors can be reached via e-mail at juancarlos.conesa@upf.edu, and cgarriga@fsu.edu.

1. Introduction

Efficiency considerations have often been used as arguments for reforming public Social Security systems, usually of a Pay-As-You-Go (PAYG) nature, in favor of Fully Funded systems (FF). As a consequence, research on the quantitative evaluation of social security reforms to assess their efficiency gains has been one of the main topics in this area.[1] We use Optimal Fiscal Policy tools in order to discipline the design of these reforms and to provide a quantitative evaluation of its macroeconomic and welfare implications. We contribute to the existing literature on the macroeconomic and welfare implications of social security reforms by providing an environment in which the reforms are endogenously chosen through a well defined welfare maximization problem, rather than exogenously specified.

We argue that changing the nature of social security (moving from a PAYG to a FF system) does not itself generate any efficiency gain. The social security administration has an implicit debt with those individuals who have contributed in the past to a PAYG social security system and are therefore entitled to future pensions. Moving towards a FF system just amounts to an explicit recognition of this implicit debt and does not generate any efficiency gain. Therefore, efficiency enhancing social security reforms call for fundamental fiscal reforms eliminating distortions and allowing the management of the implicit debt generated by the social security system.

In other words, if there were no distortions and the economy was dynamically efficient it is not feasible to redistribute resources across generations in a Pareto improving way. This classic result goes back to Diamond (1965) and Gale (1973), who studied the "Classical case" as compared to the "Samuelson case" of dynamic inefficiency. In the same spirit Rangel (1997) shows that the elimination of distortions could generate Pareto improvements. Alternatively, Feldstein (1995, 1998) shows that two conditions are required in order to increase the present value of consumption of all generations. First, the return on capital must exceed the implicit return in the unfunded system. Second, the marginal product of capital exceeds the social discount rate. Our benchmark economy will satisfy both conditions by construction. Similarly, the presence of distortions in our environment is what allows us to design reforms in a Pareto

[1] Feldstein and Liebman (2001) summarizes the discussion on transition to investment-based systems, analyzing the welfare effects and the risks associated to such systems.

improving way. We contribute by using optimal fiscal policy tools to explicitly solve for Pareto improving fiscal policies.

The relevant aspect in our exercise is how to generate and distribute the surplus with alternative tax policies eliminating the distortionary wedges affecting both the labor supply and the saving decisions. This point is especially important, because even if the contribution-benefit rules of the social security system were optimal, it is possible to generate Pareto improving reforms by reducing distortions. Therefore, since the efficiency gains come from eliminating distortions and not the nature of the social security system itself, it is possible to decentralize the same allocations with the same transfers to the elderly, but a different financing scheme. Under this alternative interpretation, our exercise deals with the optimal financing of a PAYG social security system rather than with the financing of the transition from PAYG to FF. Notice that our exercise focuses on the normative aspects of social security (i.e. its financing), while being neutral in terms of the positive aspects since the same allocation can be decentralized with or without transfers to the elderly. Thus, we abstract from a large and growing literature on positive theories of social security, starting with Samuelson (1974) focusing on dynamic inefficiency, Feldstein (1985) and Diamond (2004) pointing at myopic behavior, Cooley and Soares (1999) and Boldrin and Rustichini (2000) stressing the political economy aspects, Kubler and Krueger (2004) focusing on intergenerational risk-sharing or Boldrin and Montes (2004) focusing on intergenerational contracts.

In the quantitative macroeconomic literature, it is often emphasized that the analysis of standard overlapping generations models predicts that changing the PAYG nature of public social security systems towards a FF system might generate substantial efficiency and welfare gains in the long run. However, these long run efficiency and welfare gains come at the cost of substantial welfare losses for initial generations, casting doubts on the political viability of such a fundamental tax reform. This result arises because most of the reforms considered in the literature imply a complete or partial default on the implicit debt generated by the PAYG social security system.

Building on the seminal work of Auerbach and Kotlikoff (1987), there are several papers that study the transition associated to a social security privatization and find substantial efficiency and welfare gains in the long run. [2] In particular Huang, Imrohoroglu and Sargent (1997) show that a complete or partial privatization implies

[2] Theoretical frameworks that introduce dynastic considerations within the life-cycle framework, such as some sort of intergenerational links as in Fuster (1999) or Fuster, Imrohoroglu and Imrohoroglu (2004), might imply that the efficiency gains are much more moderate or even inexistent.

large short-run welfare losses, which cannot be compensated with the long-run gains. Conesa and Krueger (1999) show that in the presence of uninsurable labor income uncertainty the welfare losses of the initial cohorts are even larger, because the unfunded social security system provides partial insurance to individuals. Kotlikoff, Smetters and Walliser (1999) analyze different types of transitions and find that transition generations experience a 1 to 3 percent welfare decline, while future generations experience gains that are close to 20 percent. Using a different approach, Feldstein and Samwick (1998) find smaller but still positive transition costs. Conesa and Garriga (2003) show that eliminating compulsory retirement rules with the privatization can substantially reduce the welfare losses of the initial generations alive, but yet these are still substantial.

In contrast, the approach in this paper is completely different. The policies analyzed are not exogenously given but are endogenously selected through a well defined welfare maximization problem with appropriate constraints in the set of instruments. Moreover, entitlements to future payments are honored and everybody is made better-off by construction.

Demographic considerations play an important role in the social security debate. However, in order to focus on efficiency considerations we abstract from demographic changes. For example, see De Nardi et al. (1999) for a quantitative evaluation of the impact of demographic projections on the US social security imbalances.

The quantitative analysis of optimal fiscal policy in overlapping generations economies was pioneered by Escolano (1992) and has been recently considered by Erosa and Gervais (2002) and Garriga (1999). In particular, Garriga (1999) characterizes the optimal fiscal policy in an environment with participation constraints as the ones used in this paper. Following these papers, we will show the importance of different sets of tax instruments for generating the results.

Our main conclusions are:

1. The optimal management of the implicit social security debt generates substantial welfare gains. In the parameterized economy the equivalent variation of consumption for future newborns is 20% larger than in the economy with a PAYG social security system. Along the transition path, the size and distribution of the gains depends on the relative weight that the government places between present and future generations.

2. The optimal transition implies substantial tax cuts and increases in public debt at the beginning of the reform, but the increase in debt needed is much smaller than the implicit debt of the PAYG system in the benchmark economy.

3. Most of the welfare gains come from the elimination of distortions in the labor supply margin. If we allow the fiscal authority to rationalize the taxation of capital income as well, the additional welfare gains are relatively small.
4. The welfare costs of using distortionary instruments are large in the short run, but relatively small in the long run.

The rest of the paper is organized as follows. Section 2 describes the economic environment under the Status Quo policies. Section 3 describes how to view PAYG social security as an implicit debt and the neutrality of making explicit this debt. Section 4 discusses how the benchmark economy is parameterized. Section 5 shows how to specify the government problem. Section 6 discusses the results when the government can only affect the labor-leisure margin. Section 7 analyzes the case in which the government can affect the savings margin as well. Section 8 concludes. All the references are in Section 9.

2. The Status Quo Economic Environment

Households

The economy is populated by a measure of households who live for I periods. These households compulsory retire in period i_r. We denote by m_i the measure of households of age i. Preferences of a household born in period t depend on the stream of consumption and leisure this household will enjoy. Thus, the utility function is given by:

$$U(c^t, l^t) = \sum_{i=1}^{I} b^{i-1} u(c_{i,t+i-1}, 1 - l_{i,t+i-1}) \quad (1)$$

Each household owns one unit of time in each period that they can allocate for work or leisure. One unit of time devoted to work by a household of age i translates into e_i efficiency units of labor in the market.

Technology

The Production Possibility Frontier is given by an aggregate production function $Y_t = F(K_t, L_t)$, where K_t denotes the capital stock at period t and $L_t = \sum_{i=1}^{I} m_i e_i l_{i,t}$ is the aggregate labor endowment measured in efficiency units. We assume the function F displays constant returns to scale, is monotonically increasing, strictly concave and satisfies the Inada conditions. The capital stock depreciates at a constant rate d .

Government

The government influences this economy through the Social Security and the general budget. For simplicity we assume that these two programs operate with different budgets. Then, pensions (p_t) are financed through a payroll tax (t_t^p) and the social security budget is balanced. On the other hand, the government collects consumption taxes (t_t^c), labor income taxes (t_t^l), capital income taxes (t_t^k) and issues public debt (b_t) in order to finance an exogenously given stream of government consumption (g_t).

Thus the government budget constraints are given by:

$$t_t^p w_t \sum_{i=1}^{i_r-1} m_i e_i l_{i,t} = p_t \sum_{i=i_r}^{I} m_i \tag{2}$$

$$t_t^c \sum_{i=1}^{I} m_i c_{i,t} + t_t^l (1-t_t^p) w_t \sum_{i=1}^{i_r-1} m_i e_i l_{i,t} + t_t^k r_t \sum_{i=1}^{I} m_i a_{i,t} + b_{t+1} = g_t + (1+r_t) b_t \tag{3}$$

Market arrangements

We assume there is a single representative firm that operates the aggregate technology taking factor prices as given. Households sell an endogenously chosen fraction of their time as labor ($l_{i,t}$) in exchange for a competitive wage of w_t per efficiency unit of labor. They rent their assets ($a_{i,t}$) to firms or the government in exchange for a competitive factor price (r_t), and decide how much to consume and save out of their disposable income. The sequential budget constraint for a working age household is given by:

$$(1+t_t^c) c_{i,t} + a_{i+1,t+1} = (1-t_t^l)(1-t_t^p) w_t e_i l_{i,t} + (1+(1-t_t^k) r_t) a_{i,t} \tag{4}$$

Upon retirement households do not work and receive a pension in a lump-sum fashion. Their budget constraint is:

$$(1+t_t^c) c_{i,t} + a_{i+1,t+1} = (1-t_t^l) p_t + (1+(1-t_t^k) r_t) a_{i,t} \tag{5}$$

The alternative interpretation of a mandatory retirement rule is to consider different labor income tax rates for individuals of ages above and below i_r. In particular, a confiscatory tax on labor income beyond age i_r is equivalent to compulsory retirement. Both formulations yield the same results. However, when we study the optimal policy we prefer this alternative interpretation since it considers compulsory retirement as just one more distortionary tax that the fiscal authority can optimize over.

Definition 1: A market equilibrium in the status quo economy is a sequence of prices and allocations such that: i) consumers maximize utility subject to their corresponding budget constraints given the equilibrium prices, ii) firms maximize profits given prices, iii) the government and the social security budgets are balanced, and iv) markets clear.

3. PAYG Social Security as Implicit Debt

An unfunded social security system is an intergenerational redistribution scheme, or equivalently an implicit debt scheme. The young provide resources through contributions that are used to finance the benefits of the retired. Contributions made by the young generate an entitlement to a future benefit upon retirement, which constitutes an implicit debt of the social security administration towards them. Upon retirement, these new retirees sell their claims to social security to the new cohorts of workers.

Next, we show that the efficiency gains accruing from social security reform come from a rationalization of the fiscal system as a whole, but not from the nature of the social security system itself. Similarly, Rangel (1997) uses a two period overlapping generation model with linear technology to show that there exist Pareto neutral privatizations where the welfare of all generations remains unchanged. Consequently, Pareto improving movements are feasible if and only if there exist distortions in the way the social security system is financed or in the rest of the fiscal system.

Just to illustrate the argument lets redefine a Steady State equilibrium for an economy with a social security system as a Steady State equilibrium of an economy without social security and where the implicit debt is made explicit.

Proposition 1: Let $(\hat{t}, \hat{p}, \hat{B})$ be a fiscal policy, and let $\left\{(\hat{c}_j, \hat{l}_j)_{j=1}^{J}, \hat{K}\right\}$ be the associated Steady State allocation with asset distribution $(\hat{a}_j)_{j=1}^{J}$. Then, there exists a fiscal policy

$(\tilde{t}, 0, \tilde{B})$ and a distribution of assets $(\tilde{a}_j)_{j=1}^J$ such that $\left\{(\hat{c}_j, \hat{l}_j)_{j=1}^J, \hat{K}\right\}$ is the Steady State allocation corresponding to $(\tilde{t}, 0, \tilde{B})$.

Proof: Fix all prices and tax rates. Construct assets recursively from consumer budget constraints. Clearly, consumers FOC's are satisfied and the allocation is feasible. Finally, Walras' Law guarantees that the Government Budget Constraint holds.

Notice that according to this view a PAYG social security system is just a way of decentralizing a particular allocation in a market equilibrium, but there are alternative ways of decentralizing the same allocation with different social security arrangements or different levels of intergenerational redistribution.

In particular, as in the proposition, one could choose an alternative where all the distortions remain unchanged and retirement pensions are zero, i.e. the implicit debt of the PAYG social security system has been made explicit but all distortions remain unchanged. Next section will explicitly perform this exercise for our parameterized economy.

4. Parameterization of the Status Quo Economy

Demographics

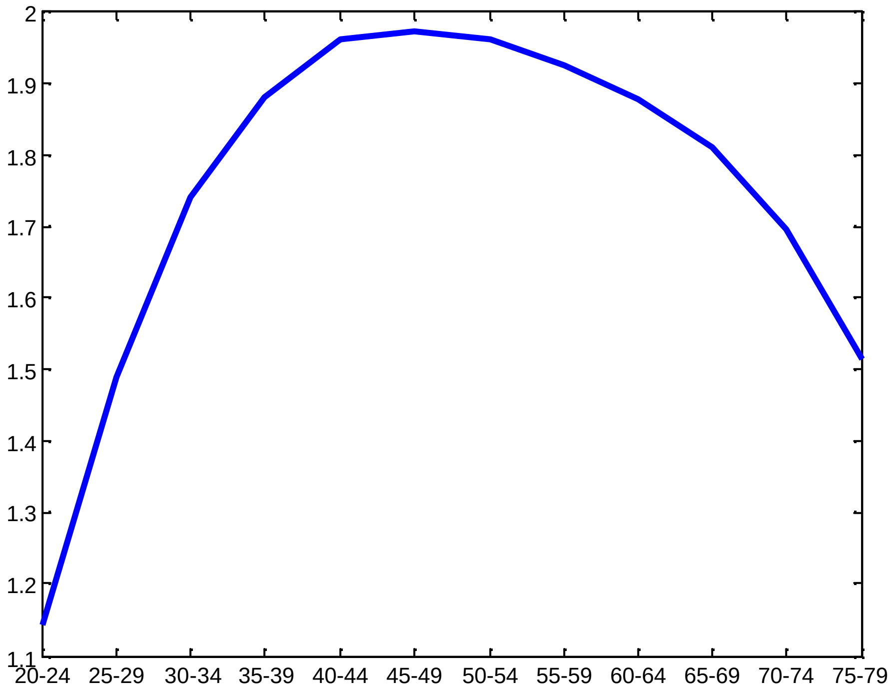
We will choose one period in the model to be the equivalent of 5 years. Given our choice of period we assume households live for 12 periods, so that the economically active life of a household starts at age 20 and we assume that households die with certainty at age 80. In the benchmark economy households retire in period 10 (equivalent to age 65 in years). Finally, we assume that the mass of households in each period is the same.

Endowments

The only endowment households have is their efficiency units of labor at each period. These are taken from the Hansen (1993) estimates, conveniently extrapolated to the entire lifetime of households.[3]

[3] In order to avoid sample selection biases we assume that the rate of decrease of efficiency units of labor after age 65 is the same as in the previous period.

Figure 1: Age-Profile of Efficiency Units of Labor from Hansen (1993)



Government

We assume that in the benchmark economy the government runs two completely independent budgets. One is the social security budget that operates on a balanced budget. The payroll tax is taken from the data and is equal to 10.5%, which is the Old-Age and Retirement Insurance, OASI (excluding Medicare). Our assumptions about the demographics together with the balanced budget condition directly determine the amount of the public retirement pension. It will be 31.5% of the average gross labor income.

The level of government consumption is exogenously given. It is financed through a consumption tax, set equal to 5%, a marginal tax on capital income equal to 33% and a marginal tax on labor income net of social security contributions equal to 16%. These tax rates are taken from the effective tax rates estimated by Mendoza, Tesar and Razin (1995). The effective distortion of the consumption-leisure margin is given by $(1\text{-}t^{l})(1\text{-}t^{p})/(1+t^{c})=1\text{-}0.3$, yielding an effective tax of 30%.

The government issues public debt in order to satisfy its period by period budget constraint.

Calibration: Functional Forms

Households' preferences are assumed to take the form:

$$\sum_{i=1}^{I} b^{i-1} \frac{(c_i^{g}(1-l_i)^{1-g})^{1-s}}{1-s} \tag{6}$$

where $b > 0$ represents the discount rate, $g \in (0,1)$ denotes the share of consumption on the utility function, and $s > 0$ governs the concavity of the utility function. The implied intertemporal elasticity of substitution is equal to $1/(1\text{-}(1\text{-}s)g)$.

Technology has constant returns to scale and takes the standard Cobb-Douglas form: $Y_t = K_t^{a} L_t^{1-a}$, where a represents the capital income share.

Calibration: Empirical Targets

We define aggregate capital to be the level of Fixed Assets in the BEA statistics. Therefore, our calibration target will be a ratio K/Y=3 in yearly terms. Also, computing the ratio of outstanding (federal, state and local) government debt to GDP we get the following ratio B/Y=0.5 in yearly terms. Depreciation is also taken from the data, which is a fraction of 12% of GDP. Another calibration target is an average of 1/3 of the time of households allocated to market activities. We will choose a curvature parameter in the utility function consistent with a coefficient of relative risk aversion in consumption of 2 (alternatively a consumption intertemporal elasticity of substitution of 0.5). Government consumption will be fixed to be 18.6% of output as in the data. Finally, the capital income share is taken to be equal to 0.3, as measured in Gollin (2002).

Calibration Results

In order to calibrate our economy we proceed as follows. First, we fix the curvature parameter in the utility function to be $s = 4$ and the capital share in the production function $a = 0.3$. Then the discount factor $b = 1.003$ is chosen to match a wealth to output ratio of 3.5, and the consumption share $g = 0.327$ is chosen in order to match an average of 1/3 of time devoted to working in the market economy. The depreciation rate is chosen so that in equilibrium depreciation is 12% of output.

Notice that $s = 4$ and $g = 0.327$ together imply a consumption intertemporal elasticity of substitution of 0.5 (CRRA of 2).

Table 1 summarizes the parameters chosen and the empirical targets that are more related to them.

Table 1: Calibration Targets and Parameter Values					
Empirical Targets	A/Y	IES	Av.Hours	wN/Y	Dep./Y
Empirical Values	3.5	0.5	1/3	0.7	0.12
Parameters	*b*	*s*	*g*	*a*	*d*
Calibrated Values	1.003	4	0.327	0.3	0.0437

Using the empirical tax rates and ratio of government consumption to GDP, we derive from the government budget constraint an implied equilibrium government debt of 50% of output. This figure is consistent with the average figure in the data. Therefore, the capital/output ratio is 3 as desired.

Given this parameterization, social security payments in the benchmark economy amount to 7.35% of GDP and the social security implicit debt is equal to 133% of GDP.

Social Security as Implicit Debt: an Illustration

Consider an alternative decentralization for the same Steady State allocation associated to the parameterized economy just described. We construct it following exactly the same steps as in Proposition 1. First, we leave all tax rates (including social security contributions) and prices as in the benchmark economy. Clearly, the Euler and Labor Supply conditions of the consumer's problem are satisfied for the same allocation $(\hat{c}_i, \hat{l}_i)$:

$$u_{\hat{c}_i} = b u_{\hat{c}_{i+1}} \left[1 + (1 - t^k)\hat{r}\right] \tag{7}$$

$$-\frac{u_{\hat{l}_i}}{u_{\hat{c}_i}} = \frac{(1-t^l)(1-t^p)}{1+t^c}\hat{w}e_i \tag{8}$$

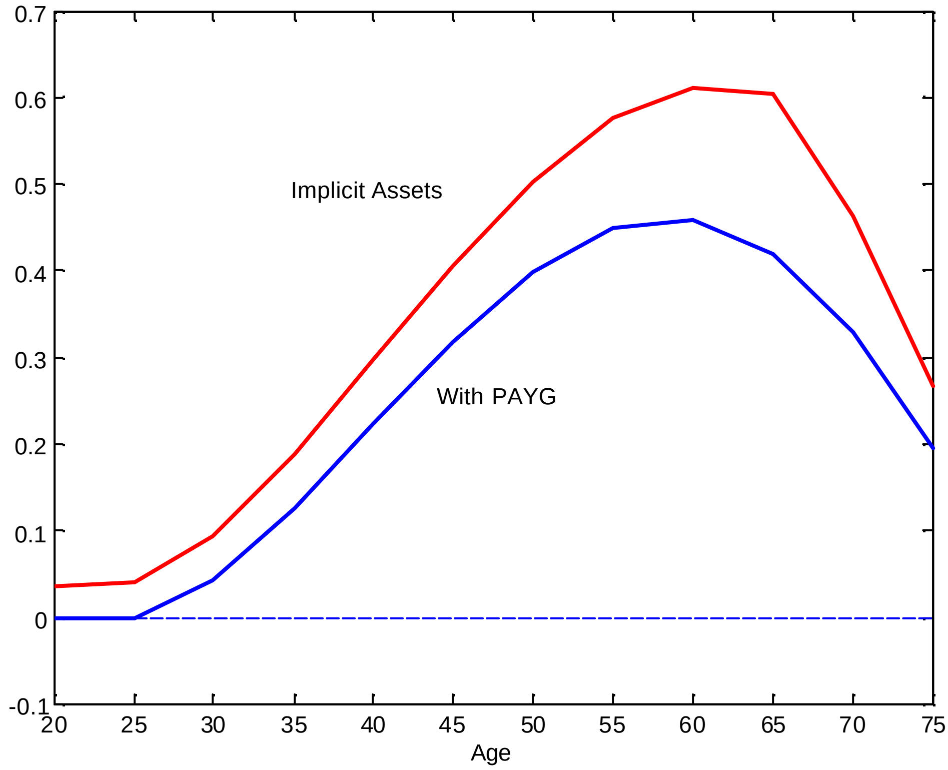
Next, we construct a sequence of assets in the following way:

$$\begin{aligned} \tilde{a}_I &= (1+t^c)\hat{c}_I / \left[1 + (1-t^k)\hat{r}\right] \\ \tilde{a}_i &= \frac{(1+t^c)\hat{c}_i + \tilde{a}_{i+1} - (1-t^l)(1-t^p)\hat{w}e_i\hat{l}_i}{1+(1-t^k)\hat{r}}, i = I-1, I-2, ..., 1 \end{aligned} \tag{9}$$

where the variables denoted with a ^ refer to the original allocation or prices and the variables denoted with a ~ refer to the newly constructed allocations.

This new sequence of assets, $\{\tilde{a}_i\}_{i=1}^{I}$, has been constructed such that the retirement pensions are set to zero. Figure 2 displays the original asset distribution (labeled in the figure as "With PAYG") and the new one constructed in the way we just explained (labeled in the figure as "Implicit Assets").

Figure 2: Implicit Assets of the PAYG Social Security System



If we sum this new asset distribution across cohorts and subtract capital, we obtain a new level of government debt. As discussed in Section 3, the difference between this new level of debt and the original one is the implicit debt of the social security system.

In fact, it would be straightforward to engineer a Pareto neutral social security privatization based on the previous equivalence. First, notice that the way the implicit assets are constructed the only thing we would be doing is giving to all currently alive consumers a lump sum transfer equal to the net present value of their future social security payments, i.e. their social security entitlements. Then, by construction their intertemporal budget constraint is not affected and their allocations would not change.

Furthermore, if every newborn generation would be given a transfer equal to the net present value of social security payments at birth (the level of assets corresponding to age 20 in the implicit assets), the intertemporal budget constraint would not change and therefore it would be optimal to choose the same allocation of consumption and leisure, together with a sequence of assets equal to the one just constructed. This transfer to newborns could take the form of a tax rebate for the youngest generation.

Neither the initial old nor any subsequent newborn generation would change behavior relative to the original allocation in a PAYG system. Moreover, since the allocation is feasible and the consumers' budget constraints are satisfied, the government budget constraint is also satisfied. We have just shown how to change the direction of intergenerational transfers without affecting allocations.

Notice that here the assumption of complete markets might potentially be important. If a particular age cohort is borrowing constrained, then a lump sum payment would alleviate its constraint, changing its behavior and therefore prices would change.

5. Optimal Reforms

We assume that in period t=1 the economy is in a steady state with a PAYG social security system, and no reform has been anticipated by any of the agents in the economy. The expected utility for each generation associated to remaining in an economy with an unfunded social security system is given by:

$$\bar{U}_j = \sum_{s=j}^{I} b^{s-j} u(\hat{c}_s, 1-\hat{l}_s) \tag{10}$$

where $\hat{c}_s, \hat{l}_s$ are steady state allocations of generation s.

At the beginning of period 2, the government implements a FF social security system and gives a one-period lump-sum transfer to all the initial generations alive who have contributed to the old PAYG system. The total amount of optimally chosen transfers is financed issuing new debt. To maximize the size of the welfare gains we let the government choose the level of debt issued and the optimal tax mix to finance the newly issued debt and the pre-existing level of government expenditure.

The government objective function is a utilitarian welfare function of all future newborn individuals, where the relative weight that the government places between present and future generations is captured by the geometric discount factor ?∈(0,1). Formally,

$$\sum_{t=2}^{\infty} l^{t-2} U(c^t, l^t) \tag{11}$$

where $U(c^t, l^t)$ represents lifetime utility of generation born in period t.

We use the primal approach to optimal taxation first proposed by Atkinson and Stiglitz (1980). This approach is based on characterizing the set of allocations that the government can implement for a given policy. The government chooses the optimal tax burden taking into account the decision rules of all individuals in the economy, and the effect of their decisions on market prices.

Therefore, the government problem amounts to maximizing its objective function over the set of implementable allocations together with the status quo constraints.[4] From the optimal allocations we can decentralize the economy finding the prices and the tax policy associated to the social security reform. We skip the derivation of the set of implementable allocations throughout the paper, since they are similar to formulations derived by Erosa and Gervais (2002) and Garriga (1999), and are relatively easy to derive by combining the consumer first-order conditions with their intertemporal budget constraint, see Chari and Kehoe (1999).

Conditional on our choice of weights placed on different generations[5], the set of constrained efficient allocations can be obtained through the following maximization problem:

$$\max \quad \sum_{t=2}^{\infty} l^{t-2} U(c^t, l^t)$$

$$s.t. \quad \sum_{i=1}^{I} m_{i,t} c_{i,t} + K_{t+1} - (1-d)K_t + G_t \leq F(K_t, \sum_{i=1}^{I} m_{i,t} e_i l_{i,t}), \; t \geq 2 \tag{12}$$

$$\sum_{i=1}^{I} b^{i-1}(c_{i,t+i-1} u_{c_{i,t+i-1}} + l_{i,t+i-1} u_{l_{i,t+i-1}}) = 0, \; t \geq 2 \tag{13}$$

$$\sum_{s=i}^{I} b^{s-i} \left[c_{s,s-i+2} u_{c_{s,s-i+2}} + l_{s,s-i+2} u_{l_{s,s-i+2}} \right] = u_{c_{i,2}} \left[(1+(1-t^k) r_2) \bar{a}_{i,2} + t_i \right], \; i = 2,...,I \tag{14}$$

$$\sum_{s=i}^{I} b^{s-i} u(c_{s,s-i+2}, 1 - l_{s,s-i+2}) \geq \bar{U}_i, \; i = 2,..., I \tag{15}$$

$$U(c^t, l^t) \geq \bar{U}_1, \; t \geq 2 \tag{16}$$

Constraint (12) is the standard period resource constraint. Constraint (13) is the implementability constraint for each generation born after the reform is implemented. Constraint (14) represents the implementability constraints for those generations alive at

[4] Throughout the paper we assume that the government can commit to its policies ignoring time consistency issues. Clearly, this is an important restriction that affects the results. The analysis of a time consistent reform goes beyond the scope of this paper.

[5] We are just identifying one Pareto improving reform, but it is clearly not unique. Placing different weights on generations or the initial old would generate a different distribution of welfare gains across agents.

the beginning of the reform, where t^k is the benchmark tax on capital income which is taken as given and $\overline{a}_{i,2}$ are the initial asset holdings of generation i. Notice that taking t^k as given is not an innocuous assumption, since that way we avoid confiscatory taxation of the initial wealth. Also, t_i represents the nonnegative lump sum transfer to the initial cohort i. Finally, constraints (15) and (16) guarantee that the policy chosen makes everybody better off than continuing with the status quo policy. In particular, given that the government objective function does not include the initial s generations Equation (15) will be binding.

Notice that this formulation imposes some restrictions, since it rules out steady-state "golden-rule" equilibria. Also, the initial generations alive at the beginning of the reform are not part of the objective function, and only appear as a policy constraint. An equivalent formulation would include the initial s generations in the objective function with a specific weight ?$_s$, where the weight is chosen to guarantee that the status quo conditions for each generation are satisfied.

The policy maker discounts the future at the exponential rate l. The Pareto improving nature of the reform implies that the rate l has to be big enough to satisfy the participation constraints of all future generations. In particular, if l were too low then the long run capital stock would be too low and then constraint (16) would be violated in the long run. In this case newborns would rather live in an economy with an unfunded social security system than in an economy with a fully funded system. That restricts the range of admissible values for l to values where the steady state solution of the government problem for a newborn is not worst off than in the benchmark economy.

Of course, within a certain range there is some discrectionality in the choice of this parameter, implying a different allocation of welfare gains across future generations. In order to impose some discipline we choose l so that the level of debt in the final steady state is equal to that of the status quo economy, so that all debt issued along the transition is fully paid back before reaching the new steady state. Our choice of the planner discount factor, the parameter $l = 0.9641$, implies the full repayment of the debt generated along the transition from the PAYG to the FF system. That does not mean that the ratio of debt to output will be the same in the final steady state, since output does change.

Further Constraints on the Ramsey Problem

Imposing restrictions in the set of fiscal instruments amounts to imposing additional constraints on the Ramsey allocations.

In particular, a regime we will investigate is the one in which capital income taxes are left unchanged relative to the benchmark. Then, reformulating this constraint in terms of allocations we need to impose:

$$\frac{u_{c_{1,t}}}{u_{c_{2,t+1}}} = \frac{u_{c_{2,t}}}{u_{c_{3,t+1}}} = \dots = \frac{u_{c_{I-1,t}}}{u_{c_{I,t+1}}} = b\left[1+(1-t^{k})(f_{k,t+1}-d)\right],\ t \geq 2 \qquad (17)$$

Next, Section 6 describes the results when this constraint is imposed in the Ramsey problem. Later, Section 7 will compare these results with an environment in which this constraint is not present.

6. Results leaving capital income taxes unchanged

Given that the nature of our exercise is inherently dynamic we focus directly on the design of a Pareto efficient transition in an environment where the government is restricted to use distortionary taxes, debt, and one period lump-sum transfers to the initial old as the only fiscal instruments.

First, we explore time paths of the main macro aggregates and the welfare effects associated to a reform in which the Ramsey problem only uses labor income taxes. Later we will compare the results with an environment in which the Ramsey problem also maximizes over capital income taxes. We do so in order to decompose the welfare gains that come directly from the elimination of distortions inherent to the financing of PAYG systems (i.e. payroll taxes), as compared to the gains coming from rationalization of other distortions (i.e. capital income taxes).

We find that the government chooses to partially compensate some of the generations alive at the start of the reform with lump-sum transfers. In addition, the optimal reform implies substantial tax cuts during the initial periods of the reform in order to compensate the welfare losses of the initial generations due to the loss of the retirement pension. However, the government sets tax rates that are not equal across cohorts.

Why would the government choose to tax discriminate? The critical insight is that when individuals exhibit life cycle behavior labor productivity changes with age and the response of consumption, labor and savings decisions to tax incentives varies with age as well. On the one hand, older cohorts are less likely to substitute consumption by savings as their life span shortens. On the other hand, they are more likely to respond negatively to labor income taxes than younger cohorts born with no assets. The different elasticities over the life cycle depend on the level of wealth. The government finds optimal to target these different behaviors through tax discrimination.

The optimally chosen level of transfers to the initial old is reported in Table 2:

Table 2: Transfers to Initial Generations (% Entitlements)

20-64	**65-69**	**70-74**	**75-79**
0	0.46	0.64	0.82

Notice that the government only needs to give transfers to the currently retired cohorts, and that these transfers are only a fraction of the social security entitlements under the PAYG system. In total, these transfers amount to only 25% of the total entitlements, which are 133% of GDP in the status quo economy. The reason is that individuals (more so the young) will benefit from lower tax rates and higher wages in the future and that is enough to compensate them from the loss of social security pensions.

Figure 3: Evolution of Average Taxes

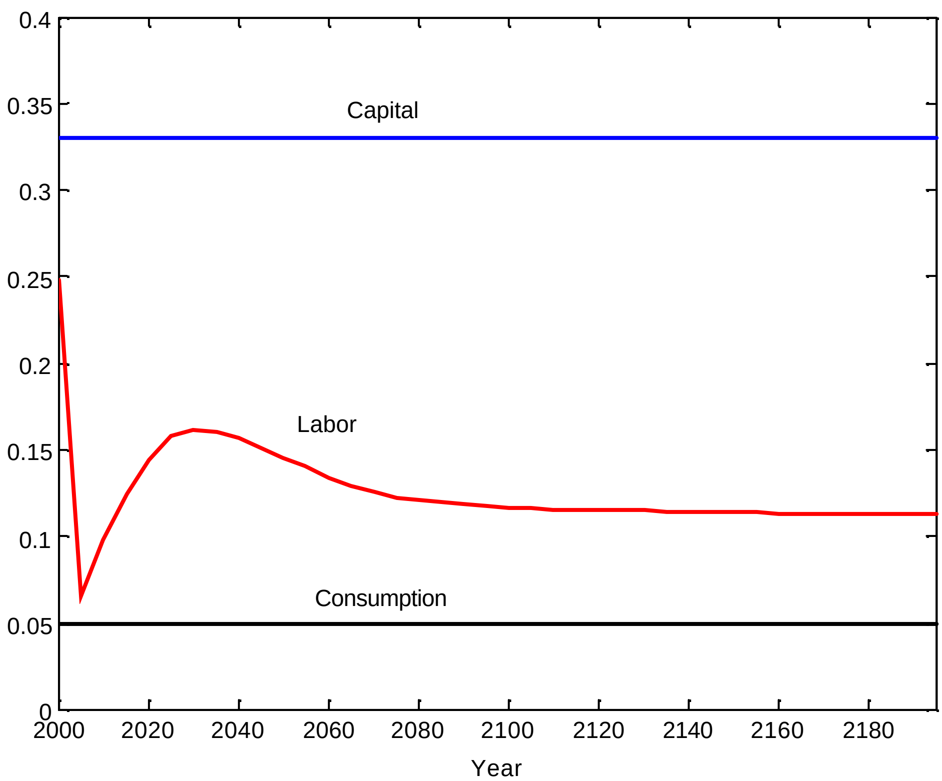


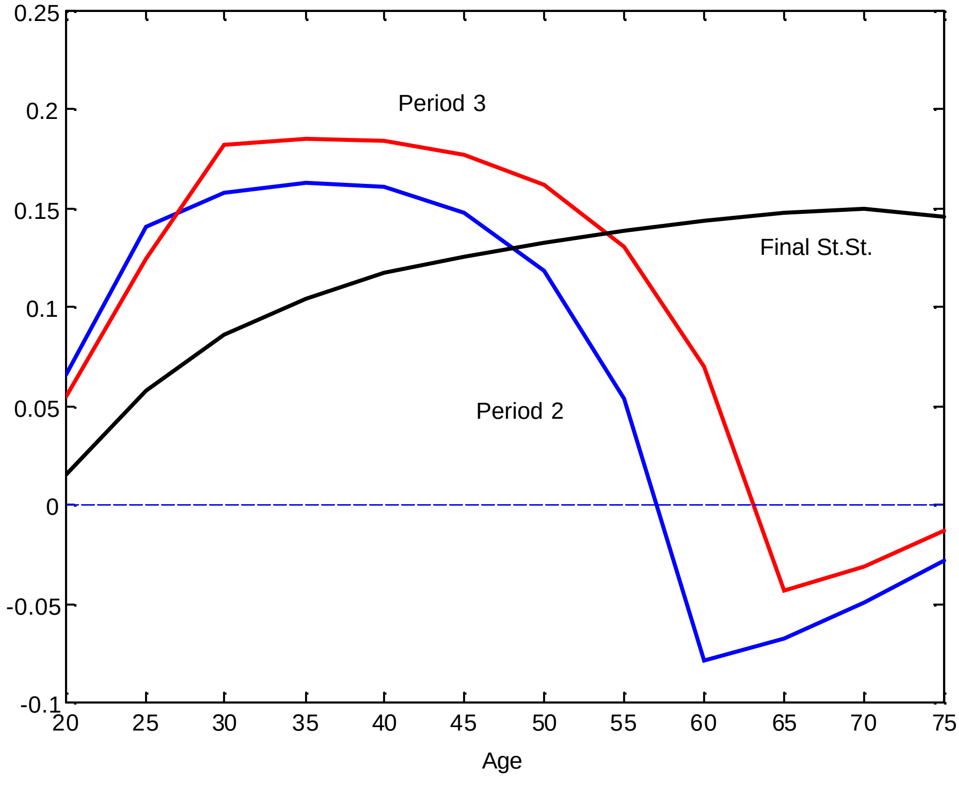
Figure 2 describes the evolution of the average optimal taxes along the reform. We decentralize the resulting allocation leaving consumption taxes unchanged, even though it is possible to decentralize the same allocation in alternative ways. In particular, we could set consumption taxes to zero and increase labor income taxes so that they are consistent with the optimal wedge chosen by the government.

In displaying the results we will arbitrarily label the year 2000 to be the Steady State of the benchmark economy and the reform is announced and implemented the following period, i.e. in 2005. Remember that a period in the model is 5 years.

Labor income taxes are substantially lowered the first period following the reform, but then they are increased to repay the initial debt issued and reach a new long run equilibrium around 12% on average.

Figure 3 displays its distribution across age at different points in time.

Figure 4: Labor Income Taxes across Different Cohorts at Different Time



The labor income tax rate varies substantially across cohorts in the initial periods of the reform. The government finds optimal to use different tax rates to compensate the potential welfare losses accruing to each cohort associated to the privatization.

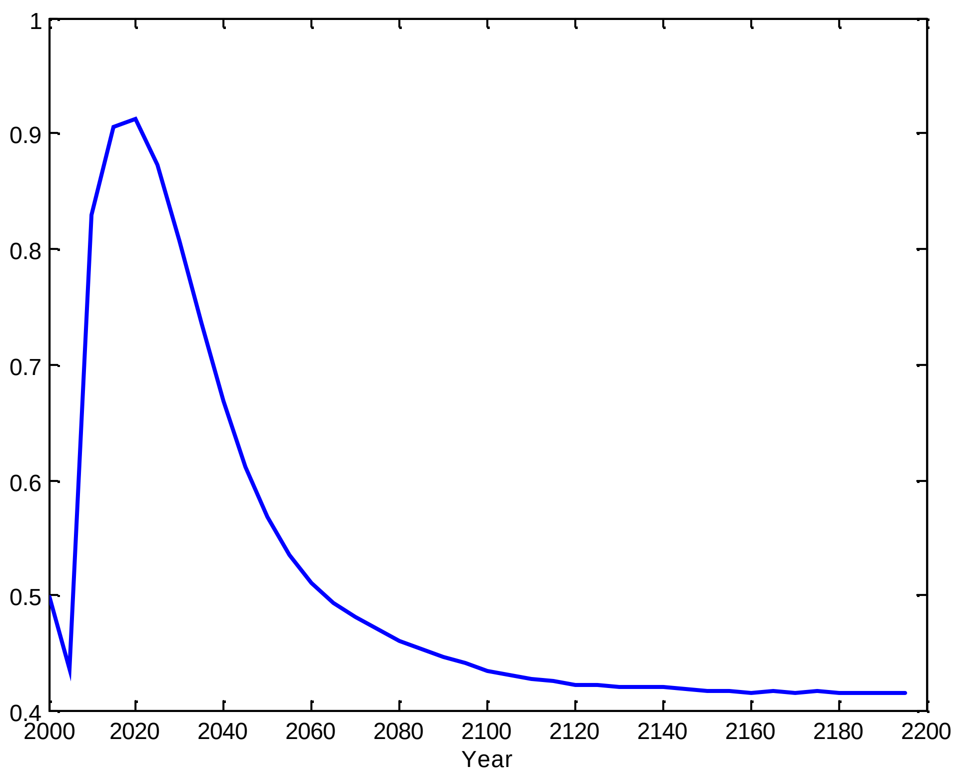
In the final Steady State the optimal labor income tax schedule follows a hump shape mostly increasing as a function of age. In fact, this is a standard result in which labor income taxes track the shape of the efficiency units of labor (notice that this implies progressive labor income taxes). In the initial periods of the reform (t=2,3), however, this shape is much more pronounced, since the government finds optimal to subsidize the labor income of the elderly as a compensatory device. If the government could not use lump-sum transfers it would choose to heavily subsidize labor income as a compensatory scheme.

In subsequent periods the shape of the labor income taxes slowly converges towards its final steady state. We observe that tax discrimination is especially important in the initial periods of the transition path.

The initial tax cuts, together with the lump-sum transfers to the initial old, necessarily imply that government debt has to increase in the initial periods following the reform.

Next, Figure 5 displays the evolution of government debt over GDP associated to the social security reform.

Figure 5: Evolution of Debt to GDP Ratio

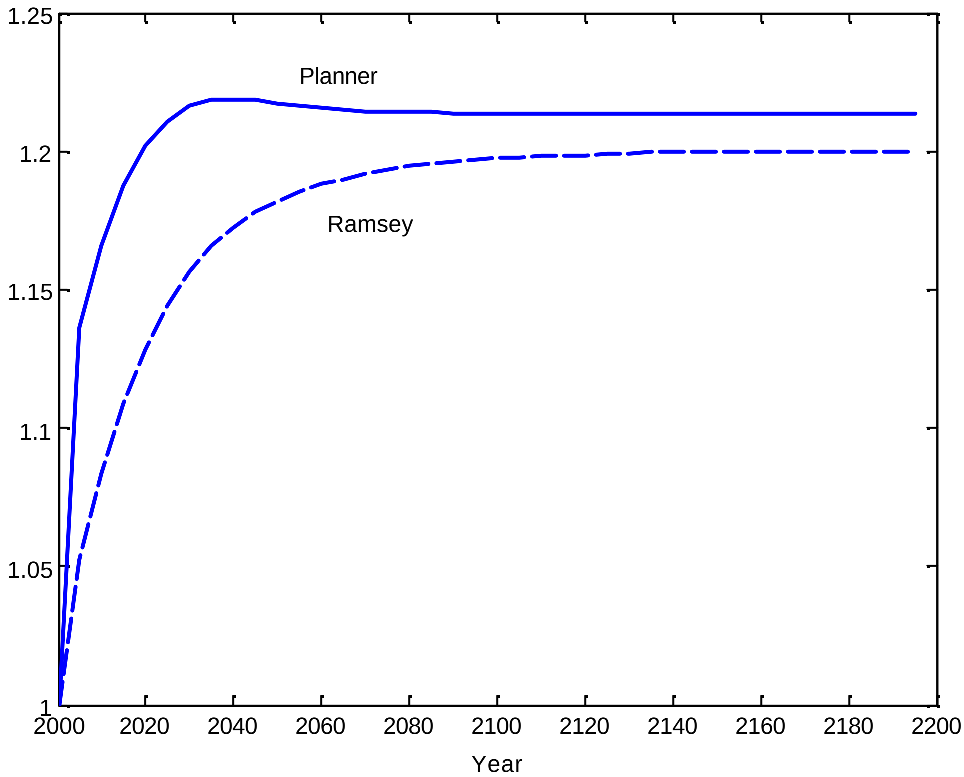


The increment in debt is substantially lower than the total implicit debt of the social security system (133% of GDP). Notice that a privatization of the social security system leaving all distortions unaffected would require lump-sum transfers and an increase in debt once and for all exactly equal to the whole implicit debt. This reform would be Pareto neutral. In contrast, implementing the optimal distortions allows a lower level of indebtedness and it is the key source to generate important welfare gains.

As we can observe in Figure 5, the privatization generates an initial increase in government debt (up to 90% of GDP), but then this debt is progressively eliminated. In the long run the level of government debt is equal to that of the benchmark economy, but not as a fraction of output since output is different. This implies that a substantial fraction of the initial debt issued will be repaid by the generations alive at the beginning of the reform. A different path of debt and welfare gains would result if we allowed for some of the welfare gains to accrue to the initial generations alive.

Overall, such a reform generates substantial welfare gains for newborn generations, while leaving cohorts initially alive indifferent by construction. The welfare gains accruing to newborns are plotted in Figure 6.

Figure 6: Welfare Gains of Newborn Generations



Notice that the welfare gains associated to the reform just discussed, labeled as

"Ramsey" in Figure 6, are substantial. Measured as equivalent variation in consumption the welfare gains are equivalent to future newborns enjoying 20% more consumption than the newborns in the status quo economy with a PAYG social security system.

The parameter l controls the relative weight that the government places between present and future generations. A different value for this parameter or letting the initial old enjoy some of the welfare gains of the reform would result in a different distributional pattern of welfare gains.

Finally, it is worth noting that the observed difference between the welfare numbers just discussed and the welfare gains labeled as "Planner" are a measure of the welfare cost of distortionary taxation, since "Planner" displays the welfare gains associated to the first-best allocation. For the parameterized value of ? it is clear that the planner can front load much more the welfare gain on the initial generations than when distortionary taxes have to be used to compensate the status quo generations. It is important to remark that in the long run the welfare cost of distortionary taxation is substantially smaller than along the transition path.

7. Results with an unconstrained set of fiscal instruments

Now we turn to the case in which the Ramsey problem is not constrained in the set of fiscal instruments. That way both capital and labor income taxes are optimally chosen for each cohort at each point in time. Clearly, in this environment the allocations result in higher welfare. Yet, the relevant question is how big are they relative to the previous case. This way we will be able to tell apart the welfare gains coming from reducing distortions in the labor supply margin (those directly involved in the financing of the social security system) and those coming from the rationalization of the savings distortionary wedge.

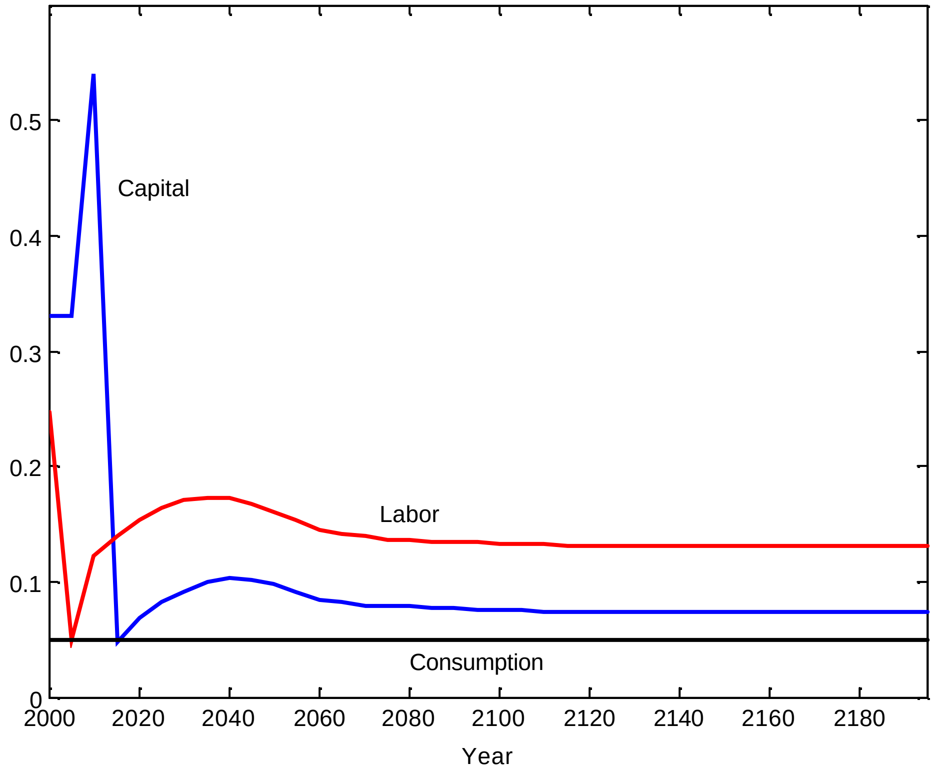
We find that in this environment the level of initial transfers needed to compensate the initial retirees are smaller. In particular, only 18% of the initial social security entitlements, as compared to the 25% of the previous case. This was to be expected since the government might find optimal to partially compensate welfare losses by lowering the capital income taxes on the initial wealth held by the old cohorts of households.

The optimally chosen level of transfers to the initial old is reported in Table 3.

Table 3: Transfers to Initial Generations (% Entitlements)			
20-64	**65-69**	**70-74**	**75-79**
0	0.21	0.49	0.81

The evolution of the average tax rates is reported in Figure 7. Labor income taxes are lowered on impact and follow a time path quite similar to that studied in the previous section.

Figure 7: Evolution of Average Taxes



After the initial period of increasing capital income taxes (we will later discuss why this happens), the government finds optimal to lower capital income taxes as well. In fact, these taxes are lowered to 5% on average and slowly converge to a long-run level of 7.4%. The reason why it is optimal to have capital income taxes different from zero in the long run is that preferences are not separable in consumption and leisure (see Erosa and Gervais (2001) and Garriga (1999) for a detailed analytical and intuitive discussion of the properties of optimal fiscal policy in life cycle economies).

Figure 8: Capital Income Taxes across Different Cohorts at Different Time

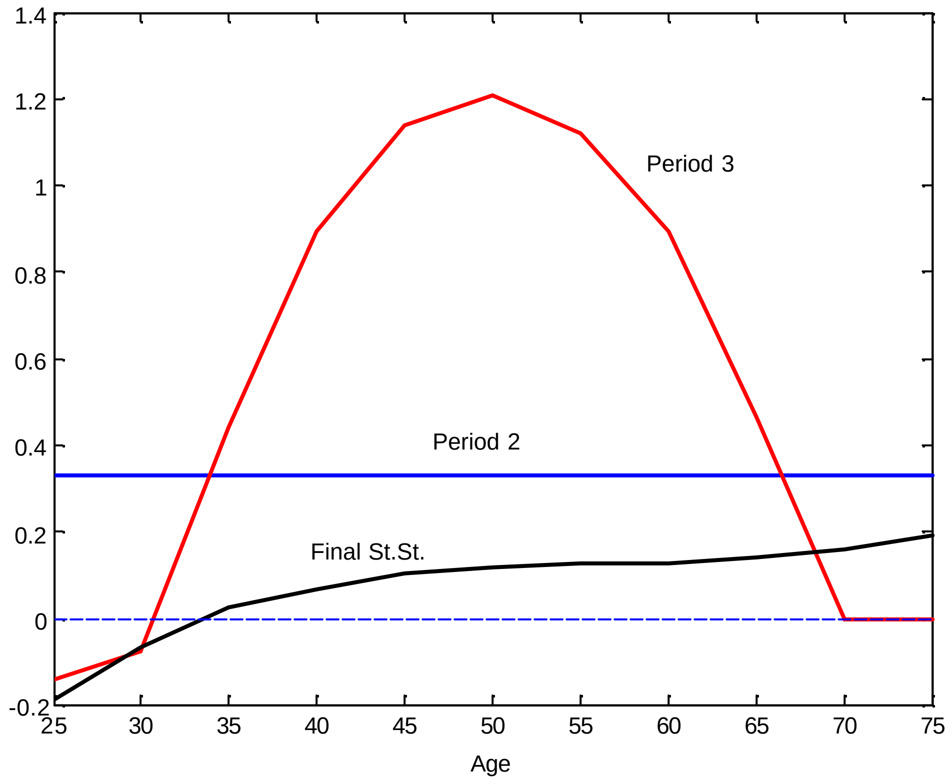


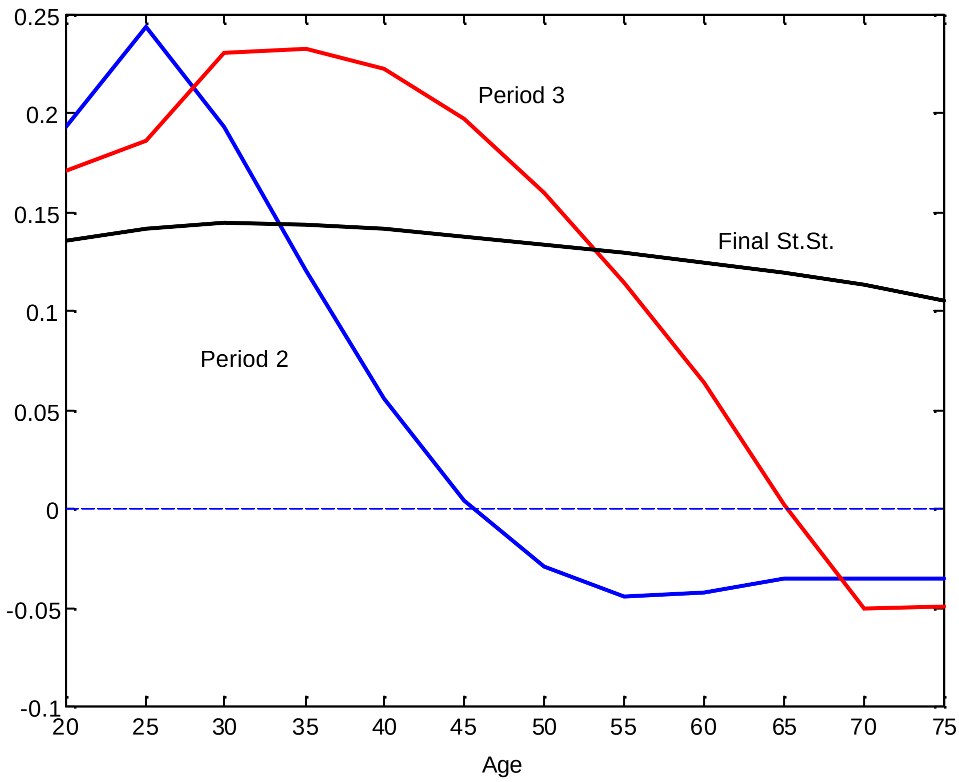
Figure 8 displays the distribution of optimal capital income taxes for different cohorts at different points in time. In the initial period of the reform (period 2) the government takes as given the initial capital income tax, we did that to prevent the government from confiscating initial wealth in a non-distortionary fashion. However, in period 3 the planner heavily subsidizes the capital income of the young, while capital income taxes of the middle age and the elderly are quite substantial. The reason is that the middle age will enjoy a favorable tax treatment of their labor income, so that the fiscal authority finds optimal to tax their initial wealth. This feature would not arise if we allowed for some of the welfare gains to accrue to the initial generations alive.

In an environment in which the government would be constrained not to use lump-sum compensatory transfers to the initial generations the government would instead choose to heavily subsidize the capital income of the old as a compensatory device.

Finally, notice that the final steady state implies very small capital income taxes on average and increasing in age (with subsidies to the younger generations).

Next, Figure 9 displays the differences in labor income taxes for the initial periods of the reform and the long-run steady state.

Figure 9: Labor Income Taxes across Different Cohorts at Different Time

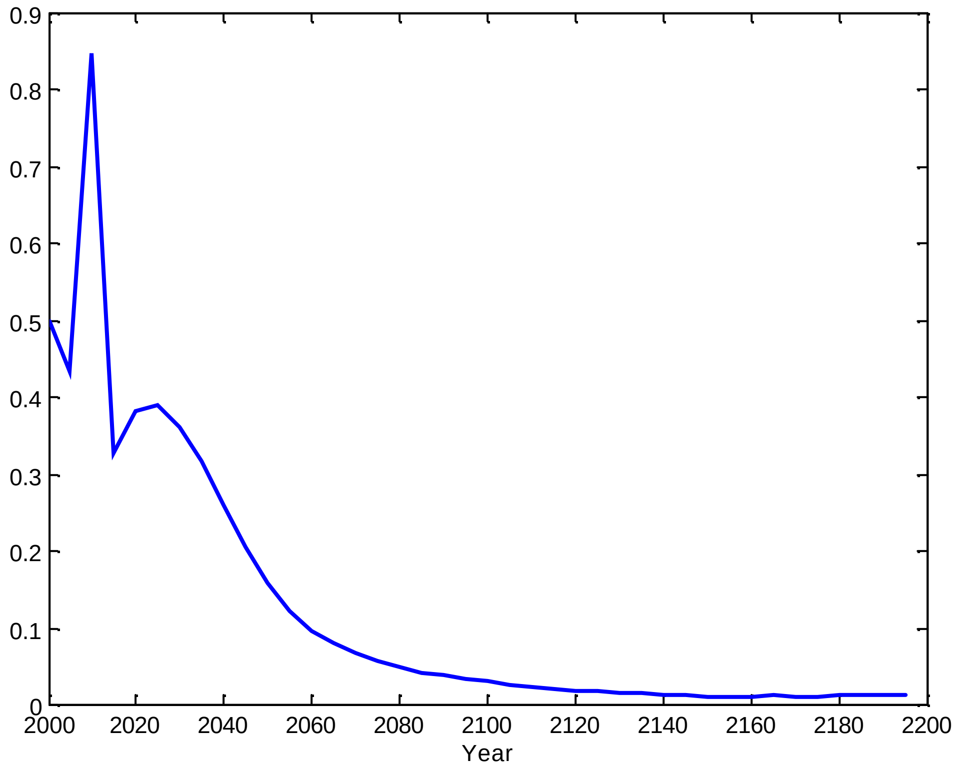


The optimal labor income tax roughly follows the same pattern as in the previous section, even though there are some differences. There are lower labor income subsidies to the initial old, since the fiscal authority can also use capital income tax cuts to compensate the welfare losses. Also, the long run schedule changes a bit relative to the previous case.

In steady state, the capital income tax schedule is slightly increasing in age, while the implied labor income tax schedule is hump-shaped but mostly decreasing. This result contrasts with the previous section, where labor income taxes were mostly increasing.

Next, Figure 10 displays the evolution of government debt over GDP associated to the optimal policy.

Figure 10: Evolution of Debt to GDP Ratio



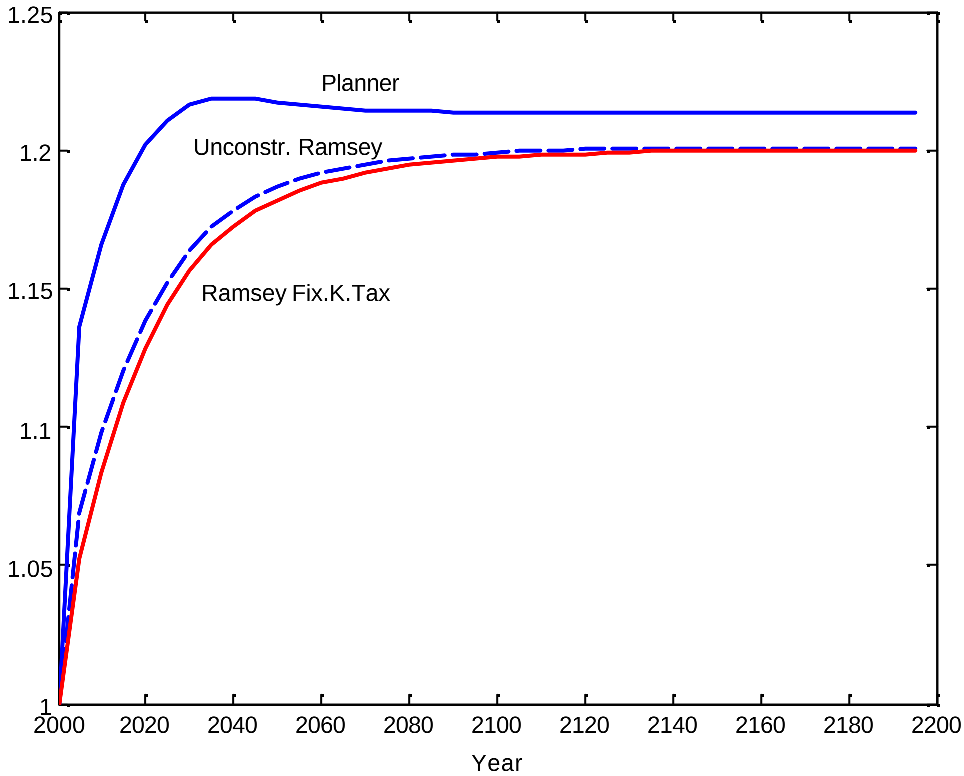
As we can observe in Figure 10, this privatization implies a lower need to issue debt, since the initial compensatory transfers are smaller.

In particular, the optimal level of debt increases up to 85% immediately after the start of the reform. Later it is gradually repaid until it converges to its final steady state value.

Notice that the optimal level of debt in the long run is almost zero. The final level of debt depends on the discount factor l chosen and on the fiscal instruments available to the government. We are keeping this parameter constant in order to have comparable results when we only change the tax instruments available. Notice that this parameter was chosen so that in the previous section all debt issued along the transition was repaid. Having more fiscal instruments results in a lower level of government debt.

The welfare gains accruing to newborns are plotted in Figure 11.

Figure 11: Welfare Gains of Newborn Generations



Notice that the welfare gains associated to the reform just discussed, labeled as "Unconstr. Ramsey" in Figure 11, are substantial. Yet, when we compare with the welfare gains obtained for the constrained case studied in the previous section, labeled as "Ramsey Fix K Tax", we observe that the difference is relatively small. In particular, they are almost the same in the long run.

From that experiment we conclude that most of the welfare gains accruing to a privatization come from the reduction of labor supply distortions, which are the distortions inherent in the financing of the Social Security system.

The constraint in the set of instruments generates a different pattern for the distribution of labor income taxes along the transition path as well as in the long run. However, this constraint does not seem to be quantitatively important in terms of welfare. With restrictions on the instruments, the government can use labor income taxes to shift the tax burden across ages in a way that the allocations and hence welfare are not substantially affected.

Finally, it is important to remark that all the welfare gains can be generated without privatizing the social security system. Following the same logic used in Section 3, it is possible to decentralize the same allocation in an environment where the government would keep the transfers from the PAYG system as in the benchmark economy, and it would implement the optimal financing. In this case, since allocations are unchanged, all the previous figures would remain unchanged with the exception of the path of government debt. The difference would be that the level of debt is higher reflecting the increased financial needs of the government.

8. Conclusions

It is a common prediction of standard overlapping generations models that changing the PAYG nature of public social security systems towards a Fully Funded system might generate substantial efficiency and welfare gains in the long run. Moreover, given the demographic projections it might be unavoidable to engage in such reforms. However, these long run efficiency and welfare gains come at the cost of substantial welfare losses for initial generations, casting doubts on the political viability of such a fundamental tax reform.

In contrast, we argue that a privatization of the social security system can be interpreted as the explicit recognition of an implicit debt and there is no efficiency gain in doing so. As a consequence, potential efficiency gains upon reforming the system come from the elimination of distortions and the optimal management of that implicit debt. Based on that argument, this paper studies the optimal design of a social security privatization in a Pareto improving way, using an optimal fiscal policy approach. The government decides endogenously how to compensate the initial generations alive from the loss of future pensions and how to finance the transition from a PAYG system to a FF system, in an environment where welfare of the initial generations alive becomes policy constraint. Therefore, our analysis maximizes over fiscal policies along a reform rather than studying the implications of exogenously chosen reforms.

We find that the government can design a Pareto improving reform that exhibits sizeable welfare gains. Our approach explicitly provides quantitative policy prescriptions towards the policy design of future and maybe unavoidable social security reforms.

Finally, we observe that the welfare gains come from the reduction of distortions in the labor supply margin, and that little is gained by changing the structure of capital income taxation as part of a potential reform.

9. References

Auerbach, A. and L. Kotlikoff (1987), Dynamic Fiscal Policy, Cambridge University Press.

Atkinson, A.B. and J. Stiglitz (1980), Lectures in Public Economics, McGraw-Hill, New York.

Boldrin, M. and A. Rustichini (2000), "Political Equilibria with Social Security", *Review of Economic Dynamics* 3(1), 41-78.

Boldrin, M. and A. Montes (2004), "The Intergenerational State: Education and Pensions", Federal Reserve Bank of Minneapolis Staff Report 336.

Chari, V.V. and P.J. Kehoe (1999), "Optimal Fiscal and Monetary Policy", in J.B. Taylor and M. Woodford, eds., Handbook of Macroeconomics, Vol. 1C. Elsevier Science, North-Holland, 1671-1745.

Conesa, J.C. and C. Garriga (2003), "The Status Quo Problem in Social Security Reforms", *Macroeconomic Dynamics* 7(5), 691-710.

Conesa, J.C. and D. Krueger (1999), "Social Security Reform with Heterogeneous Agents", *Review of Economic Dynamics* 2(4), 757-795.

Cooley, T.F. and J. Soares (1999), "A Positive Theory of Social Security Based on Reputation", *Journal of Political Economy* 107(1), 135-160.

De Nardi, M., S. Imrohoroglu and T.J. Sargent (1999), "Projected U.S. Demographics and Social Security", *Review of Economic Dynamics* 2(3), 576-615.

Diamond, P. (1965), "National Debt in a Neoclassical Growth Model", *American Economic Review* 55(5), 1126-1150.

Diamond, P. (2004), "Social Security", *American Economic Review* 94(1), 1-24.

Erosa, A. and M. Gervais (2002), "Optimal Taxation in Life-Cycle Economies", *Journal of Economic Theory* 105(2), 338-369.

Escolano, J. (1992), "Optimal Taxation in Overlapping Generations Models", mimeo.

Feldstein, M. (1985), "The Optimal Level of Social Security Benefits", *Quarterly Journal of Economics* 10(2), 303-320.

Feldstein, M. (1995), "Would Privatizing Social Security Raise Economic Wellbeing?", NBER Working Paper 5281.

Feldstein, M. (1998), "The Effect of Privatizing Social Security on Economic Welfare", appendix to the introduction in: Feldstein, M. ed., Privatizing Social Security, University of Chicago Press.

Feldstein, M. and J.B. Liebman (2002), "Social Security", in Auerbach, A.J. and M. Feldstein (eds.) Handbook of Public Economics, vol. 4, 2245-2324. Amsterdam, London and New York: Elsevier Science, North-Holland.

Feldstein, M. and A. Samwick (1998), "The Transition Path in Privatizing Social Security", in: Feldstein, M. ed., Privatizing Social Security, University of Chicago Press.

Fuster, L. (1999), "Is Altruism Important for Understanding the Long-Run Effects of Social Security?", *Review of Economic Dynamics* 2(3), 616-637.

Fuster, L., A. Imrohoroglu and S. Imrohoroglu (2003), "A Welfare Analysis of Social Security in a Dynastic Framework", *International Economic Review* 44(4), 1247-1274.

Gale, D. (1973), "Pure Exchange Equilibrium of Dynamic Economic Models", *Journal of Economic Theory* 6(1), 12-36.

Garriga, C. (1999), "Optimal Fiscal Policy in Overlapping Generations Models", mimeo.

Gollin, D. (2002), "Getting Income Shares Right", *Journal of Political Economy* 110(2), 458-474.

Hansen, G.D. (1993), "The Cyclical and Secular Behaviour of the Labour Input: Comparing Efficency Units and Hours Worked", *Journal of Applied Econometrics* 8(1), 71-80.

Huang, H. S. Imrohoroglu and T.J. Sargent (1997), "Two Computations to Fund Social Security", *Macroeconomic Dynamics* 1(1), 7-44.

Kotlikoff, L. J., K. Smetters and J. Walliser (1999), "Privatizing Social Security in the US – Comparing the Options," *Review of Economic Dynamics* 2(3), 532-574.

Kubler, F. and D. Krueger (2003), "Pareto Improving Social Security when Financial Markets are Incomplete!?", mimeo.

Mendoza, E., A. Razin and L.L. Tesar (1994), "Effective Tax Rates in Macroeconomics: Cross-Country Estimates of Tax Rates on Factor Incomes and Consumption", *Journal of Monetary Economics* 34(3), 297-323.

Rangel, A. (1997), "Social Security Reform: Efficiency Gains or Intergenerational Redistribution", mimeo.

Samuelson, P.A. (1975), "Optimum Social Security in a Life-Cycle Growth Model", *International Economic Review* 16(3), 539-544.