

# Transitional and Long Run Effects of Reforming Social Security in Brazil

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## Abstract

Brazilian PAYG system has been under financial stress and needs to be reformed. I use a computational general equilibrium model, with 55 overlapping generations to simulate macroeconomic and welfare impacts of alternative social security reforms. My simulations conclude that even partial reforms that only switch the tax base from labor to consumption are able to produce significant positive long run effects. Short run effects of reform will vary widely depending on which tax base is chosen to finance remaining retirement benefits. Under a variety of possible transitional schemes, there is no tax path that is strictly preferred by every generation.

**Key Words:** Social Security; Welfare; General Equilibrium; Macroeconomics; Overlapping Generation

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## 1. Introduction

The Brazilian social security budget has been running a deficit of 1% of the GDP since the early 1990's. This deficit is mainly a result of the Constitution of 1988, which enlarged the program without a parallel and substantial increase on the social security tax revenues. The objective of this paper is to look, first, at the long run macroeconomic and welfare implications of reforming social security in Brazil. Secondly, it studies the several alternatives of reforming the PAYG, and its transitional impacts on the well being of the generations alive during the transition. I use a general equilibrium model with 55 overlapping generations, adapted to Brazilian institutions and deep parameter values, to look into these problems.

It is well known that, in the absence of uncertainty, the impact of a social security program on labor supply, capital accumulation and individual welfare will depend on the magnitude of the replacement, yield and retirement effects, as defined by Kotlikoff (1979) and Feldstein (1974). In addition, general equilibrium effects complicate the analysis up to a point where computation is required to find the net impact of social security reforms on individual welfare.

The first important finding of this paper is that, under a wide range of parametric assumptions that match Brazilian characteristics for the life cycle wage profile, technological and preference parameters, the elimination of the PAYG system may bring

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large welfare improvements<sup>1</sup>. In addition, the welfare gains are still substantial in the long run when the retirement benefits are diminished to only 30% of the status quo level. This means that reforms that keep a minimum retirement benefit in order to insure bad income draws, as done by Chile, Mexico and Argentina, among others, are still able to get sizeable welfare increases. Moreover, even when the only reform is a switch in the tax base financing social security, it is possible to obtain substantial rise in welfare. That is the case when the retirement benefits are financed by a consumption tax instead of the benchmarking labor tax.

The second type of findings in this paper relates to transitional issues. In the majority of the reforms in this paper, individuals will earn retirement benefits that are proportional to their contributions to the system. Hence, the aggregate retirement benefits smoothly decrease, reaching zero when the last contributor dies. Meanwhile, the social security tax is eliminated instantaneously for most of the simulated reforms. The way the remaining benefits are financed, either by adjusting some other tax or by running a deficit, will imply completely different distribution of the welfare impact across the living generations. The switch in the tax base and the elimination of benefits will cause large intergenerational redistribution.

Under the assumed parametric settings, the initial elderly will suffer most from a switch to consumption tax since they have higher marginal propensity to consume over their lifetime income. A switch to capital tax put the largest welfare losses over the middle aged and the elderly individuals, since these groups earn most of their income from

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<sup>1</sup> Elimination and privatization of social security are interchangeable terms in this paper. Privatization here refers to the shift from unfunded PAYG programs to funded programs with individual accounts.

assets. A switch to labor tax works as a gradual elimination of the payroll tax, and hence it is the most equitable alternative. The accumulation of debt in order to finance the retirement benefits is a way of transferring the welfare losses toward unborn individuals, since the tax adjustment will eventually be done, and will hit mostly the future generations.

General equilibrium effects are very important to understand the welfare impacts across generations. For example, the elderly would rather have a transition financed by debt in the first years than staying at the status quo system. This is due to the positive short run impact of the reform in the level of the interest rate, and so on the returns on the assets they own. Since they will be dead by the time of the tax adjustment, the welfare gain under the remaining of lifetime will be substantial. Comparatively, the initial youths prefer reforms that lead to fast capital accumulation, and higher real wages.

The actual implementation of a given type of reform will be a matter of building political coalitions. If voters do not care about the utility level of their offspring, the short run macroeconomic impacts of the reform will define the preferences and the political support over the spectrum of optional tax policies. In fact, if agents were myopic the welfare gains and losses predicted by the model would be an indication of political outcome. Simulations that use the actual Brazilian demographic distribution show that none of the proposed reform is strictly preferred by every agent. Every transitional tax path is preferred by at least one generation alive at the moment the reform starts. The status quo PAYG enjoys substantial political support from middle aged and elderly

individuals when I rule out debt accumulation and pre-announcement from the menu options<sup>2</sup>.

This paper is divided into seven sections. Section 2 presents the model. Section 3 presents the criterion for calibrating the initial steady state. Section 4 describes the alternative experiments. Section 5 studies the long run effects of eliminating the social security tax and the system of retirement benefits. Section 6 goes through the macroeconomic and welfare analysis of the transition. Section 7 concludes the paper.

## 2. The Model

This section gives an overview of the 55-overlapping generation, general equilibrium model used in the simulations of the social security reforms, which is an adaptation of Auerbach & Kotlikoff (1987) to the Brazilian social security system<sup>3</sup>. Consumers maximize preferences over a 55-year life cycle. They become eligible for retirement benefits at age 45, get their first retirement benefit at 46, and die at 56 years old. For an individual born in time  $t$  and aged  $j$  years old, the time additive utility function takes the form

$$U(c_{t+j,j}, l_{t+j,j}) = (1/1-1/g) \sum_{j=1}^{55} (1+d)^{-j} \{ [c_{t+j,j}^{(1-1/r)} + al_{t+j,j}^{(1-1/r)}]^{1/(1-1/r)} \}^{1-1/g} \quad (1)$$

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<sup>2</sup> Other authors have used similar procedures to analyze social security privatization in Brazil, but either with simplified parametric assumptions or assuming exogenous labor supply. Malvar (1999) uses a similar model to look at the short and long run macroeconomic effects of privatizing social security. She does not fully incorporate Brazilian characteristics in her benchmark and looks at a smaller set of reforms than I do. Barreto and Oliveira (2000) also deal with the macroeconomic effects of social security privatization in Brazil by using a model where the labor supply is treated exogenously.

<sup>3</sup> The AK model has the disadvantage of disregarding the important aspect of the insurance role of a sure retirement income. However, such simplification makes the programming simple enough to allow the analysis of transition. Alternatively, other general equilibrium models incorporate life duration uncertainty but do not look into transitional aspects of the reform (e.g., De Nardi et al., 1998 and Huang et al., 1997).

where  $c_{t+j,j}$  is her consumption of an aggregate consumption good and  $l_{t+j,j}$  is her leisure demand. The household budget constraint depends on the current and future values of the interest rate and wage rate. In addition, it will depend on the future path of consumption, capital, and labor taxes. The model assumes that there is no uncertainty about such paths and no borrowing constraints.

$$PVB_t + \sum_{j=1}^{55} \left\{ \prod_{s=1}^j [(1+r_{t+s}(1-\mathbf{t}_{k,t+s}))^{-1}] [w_{t+j}e_j(1-l_{t+j,j})(1-\mathbf{t}_{L,t+j}) - c_{t+j,j}(1+\mathbf{t}_{C,t+j})] - \sum_{j=1}^{55} \left\{ \prod_{s=1}^j [(1+r_{t+s}(1-\mathbf{t}_{k,t+s}))^{-1}] [w_{t+j}e_j(1-l_{t+j,j})\mathbf{q}_{t+j}] \geq 0 \right. \right. \quad (2).$$

The parameter  $\mathbf{t}_{C,t}$  is the proportional consumption tax,  $\mathbf{t}_{K,t}$  is the proportional capital tax and  $\mathbf{t}_{L,t}$  is the proportional labor tax. In addition, the retirement benefits are financed through a labor tax,  $\mathbf{q}_t$ . The variable  $PVB_t$  is the present value of lifetime social security benefits of generation “t” (born in year “t”)<sup>4</sup>, such that:

$$PVB_t = \mathbf{h}_t + \sum_{j=1}^{55} \left\{ \prod_{s=1}^j [1+r_{t+s}(1-\mathbf{t}_{k,t+s})]^{-1} [w_{t+j}e_j(1-l_{t+j,j})\mathbf{I}_j\mathbf{q}_{t+j}] \right. \quad (3).$$

The first term, in the right hand side, is a component that does not depend on the labor tax paid to finance the system. The second term means that one dollar of labor tax paid at age j will give back to the individual  $\mathbf{I}_j$  in future benefits (measured at the dollar value of time T = t + j). Hence,  $\mathbf{I}_j$  is the perceived age-dependent link between contributions and benefits. From equations (3) and (4), the modified consumer budget constraint then becomes:

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<sup>4</sup> The term  $e_j$  captures a job-experience productivity factor, represented by a second-degree polynomial on experience.

$$\begin{aligned}
\mathbf{h}_t - \sum_{j=1}^{55} \left\{ \prod_{s=1}^j [1+r_{t+s}(1-\mathbf{t}_{k,t+s})]^{-1} \right\} [w_{t+j} e_j (1-l_{t+j,j})(1-\mathbf{l}_j) \mathbf{q}_{t+j}] + \\
+ \sum_{j=1}^{55} \left\{ \prod_{s=1}^j [1+r_{t+s}(1-\mathbf{t}_{k,t+s})]^{-1} \right\} [w_{t+j} e_j (1-l_{t+j,j})(1-\mathbf{t}_{L,t+j}) - c_{t+j,j} (1+\mathbf{t}_{C,t+j})] \geq 0
\end{aligned} \tag{4}$$

The consumer maximizes (1) subject to the budget constraint (4) and to the constraint that the demand for leisure cannot be larger than one for each individual<sup>5</sup>. Solving the consumer problem for consumption and leisure, one can get a contemporaneous expression relating consumption and leisure for the individual born in time  $t$ <sup>6</sup>:

$$l_{t+j} = \left[ \frac{w_{t+j}^*}{\mathbf{a}} \mathbf{J}_{t+j} \right]^{-r} c_{t+j} \tag{5},$$

where 
$$\mathbf{J}_{t+j} = \left[ \frac{(1-(1-\mathbf{l}_j) \mathbf{q}_{t+j} - \mathbf{t}_{L,t+j})}{(1+\mathbf{t}_{C,t+j})} \right] \tag{6},$$

and 
$$w_{t+j}^* = w_{t+j} e_j + \mathbf{m}_{t+j} \tag{7},$$

for every time  $t$  and age  $j$ .

Additional algebra allows one to get the individual consumption and leisure profile over the life cycle:

$$c_{t+j} = \left[ \frac{1+r_{t+j}(1-\mathbf{t}_{k,t+j})}{1+\mathbf{d}} \right]^g \left[ \frac{(1+\mathbf{t}_{C,t+j-1})}{(1+\mathbf{t}_{C,t+j})} \right]^g \left[ \frac{v_{t+j}}{v_{t+j-1}} \right] c_{t+j-1} \tag{9},$$

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<sup>5</sup> In algebraic terms,  $l_{t+j} \leq 1$ , which I call the labor force non participation constraint. The Lagrangian multiplier  $\mathbf{m}$  associated to this constraint will take a positive value when the individual is effectively retired from the labor force.

<sup>6</sup> To simplify notation, I only use the time subscript for every variable. For example,  $l_{t+j}$  represents the demand for leisure by a  $j$ -year-old individual in time  $t+j$ .

$$l_{t+j} = \left[ \frac{1+r_{t+j}(1-t_{k,t+j})}{1+d} \right]^g \left[ \frac{(1+t_{c,t+j-1})}{(1+t_{c,t+j})} \right]^g \left[ \frac{v_{t+j}}{v_{t+j-1}} \right] \left[ \frac{w_{t+j}^*}{w_{t+j-1}^*} \right]^{-r} \left[ \frac{J_{t+j}}{J_{t+j-1}} \right]^{-r} l_{t+j-1} \quad (10),$$

where 
$$v_{t+j} = [1 + \mathbf{a}^r (w_{t+j}^*)^{1-r} (\mathbf{J}_{t+j})^{1-r}]^{[(r-g)/(1-r)]} \quad (11).$$

The social security labor tax at time “t” is determined endogenously from the social security balanced budget, in such way that

$$\mathbf{q}_t \sum_{j=1}^{55} w_{t,j} L_{t,j} / (1+n)^{j-1} = \sum_{i=1}^9 B_{t,45+i} / (1+n)^{45+i} \quad (12).$$

Individuals are eligible for the benefits in the year they turn 46. The retirement benefit in year t of a j-year old cohort,  $B_{t,j}$ , will have two components: a time-dependent fraction called the “replacement rate”,  $R_t$ , which does not depend on the age of the individual, and the average index of monthly earnings,  $AIME_{t,j}$ , which will be a function of time and age.

$$B_{t,j} = R_t \cdot AIME_{t,j} \quad (13).$$

The average index of earnings of an individual age j in year t is calculated based on two indicators: the labor income earned when the individual was 33 to 35 years old,  $B_{t,j}^{LS}$ , and the labor income earned at the edge of the eligibility for the benefits, between ages 43 and 45,  $B_{t,j}^{OA7}$ :

$$B_{t,j}^{LS} = \sum_{i=1}^3 w_{t-j+32+i} e_{32+i} L_{t-j+32+i,32+i} \quad (14)$$

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<sup>7</sup> In Brazil, eligibility to retirement benefits is reached through two mutually exclusive ways: one based on the number of years of contributions (35 years for men and 30 years for women) and other strictly based on age (65 years). In this representative agent set up, I assume only the old age eligibility criterion, but artificially incorporate some aspects of the contribution-based criterion in the formula of calculation of benefits.

$$B_{t,j}^{OA} = \sum_{i=1}^3 w_{t-j+42+i} e_{42+i} L_{t-j+42+i,42+i} \quad (15)$$

$$AIME_{t,j} = \frac{1}{6} \{ B_{t,j}^{LS} + B_{t,j}^{OA} \} \quad (16).$$

At any time  $t$ , the government tax revenue consists of three possible tax instruments: a proportional consumption tax rate  $\mathbf{t}_{C,t}$ , a proportional labor tax  $\mathbf{t}_{L,t}$  and a proportional capital tax  $\mathbf{t}_{K,t}$ . The aggregate tax revenue is given by

$$T_t = \mathbf{t}_{C,t} \cdot C_t + \mathbf{t}_{K,t} r_t K_t + \mathbf{t}_{L,t} \cdot w_t L_t \quad (17),$$

where  $C_t$ ,  $K_t$  and  $L_t$  are respectively the aggregate consumption, capital and labor supply in time  $t$ , as defined below.

Assuming there is no Ponzi Game, the government budget constraint (excluding social security) will be:

$$\sum_{t=0}^N [\prod_{s=0}^t (1 + r_s ((1 - \mathbf{t}_{k,s}))^{-1})] T_t = \sum_{t=0}^N [\prod_{s=0}^t (1 + r_s (1 - \mathbf{t}_{k,s}))^{-1}] G_t + D_0 \quad (18)$$

where  $D_0$  is the stock of outstanding debt at the initial year and  $G_t$  is the government consumption.

The model has a single production sector that is assumed to behave competitively, by using capital and labor subject to a constant-returns-to-scale production function. Capital is assumed to be homogeneous and the depreciation rate is assumed to be zero. The production function is assumed to have a Cobb-Douglas form such that

$$Y_t = \Phi K_t^k L_t^{1-k} \quad (19)$$

where  $Y_t$  is the net national income,  $K_t$  is the capital stock and  $L_t$  is the aggregate labor supply at time  $t$ , while  $\Phi$  is the technological constant. Aggregate labor is such that

$$L_t = \sum_{j=1}^{55} \left( \frac{1}{1+n} \right)^j e_j L_{t,j} \quad (20)$$

that is, the sum of effective labor supplied by each individual cohort alive in year  $t$ . The supply of capital by households at time  $t$ ,  $K_t$ , will be a function of the sum of accumulated assets of consumers indexed  $j$  minus the stock of government debt at  $t$ :

$$K_t = \sum_{j=1}^{55} \left[ \frac{1}{1+n} \right]^j A_{t,j} - D_t \quad (21),$$

where  $A_{t,j}$  is the stock of assets owned by the cohort aged  $j$  in year  $t$ .

### 3. Calibrating the Initial Steady State

The lack of good estimates for the deep parameters of the utility function in Brazil forced the adoption of parameter values found for developed countries, especially for the intertemporal elasticity of substitution (0.35), the intratemporal elasticity of substitution between leisure and consumption (1.3) and the time discount rate (1.5). The other parameters of the utility function were used as instruments for calibration of the initial steady state. From Brazil, I adopted the estimated share of labor income (0.5), and the estimated life cycle wage profile<sup>8</sup>. In addition, the social security link ( $I_t$ ) is assumed to be close to one for the three years preceding eligibility, and zero otherwise. Results however will not be sensitive to changes in such a parameter.

The steady state equilibrium when the social security system follows a PAYG rule is meant to reproduce key macroeconomic statistics of the Brazilian economy. Table 1

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<sup>8</sup> This was obtained by running WLS regressions from a series of years of PNAD, a household survey. Details are found in Ferreira (2001).

summarizes the main characteristics of the initial steady state. The endogenous social security tax is 10.38%. The capital-output ratio is 2.55. The ratio of the government debt over the GNP is 36%. The national saving rate is 4.9% of GNP. Under the initial steady state calibration, the marginal productivity of capital (17%) is much larger than the population growth (1.9%).

#### **4. An overview of the alternative reforms**

In this section, I present the different experiments simulated in the paper, which are summarized in Table 2. In experiment A, the social security labor tax is reduced to zero in year  $T=1$ . At the same time, the replacement rate  $R_t$  goes to zero instantaneously, which implies a 100% cut in retirement benefits. Capital, labor and consumption tax rates are made endogenous, in order to balance the government budget in every year of the transition.

In experiments B, C, D and E, the social security tax is zeroed in year  $T=1$ , but the retirement benefits are phased out to zero over a 55-year period. The idea is to preserve the claims to retirement benefits for the individuals alive in year  $T=1$ . In effect, the replacement rate  $R_t$  is kept at 100% until year 9, when the youngest retiree of year  $T=0$  dies. In year  $T = 10$ ,  $R_t$  starts falling at a constant rate until it reaches zero in  $T = 55$ .

While benefits are gradually eliminated, in year  $T=1$  one specific tax rate is chosen to replace the old social security tax for financing the remaining benefits. The chosen tax rate is made endogenous, while the other three tax rates are kept at the same level as they were at  $T=0$ . In all of these four experiments, the endogenous tax rate returns to its initial level, in some year  $T^*$ , which depends on the experiment. In  $T^* + 1$ , every tax rate is

made endogenous, constrained to generate the same revenue share as in  $T=0$ <sup>9</sup>. In experiment B, C and D, the consumption, capital and labor tax rates are set temporarily endogenous. In Experiment E, the government runs a deficit for seven years, and then the tax rates are adjusted instantaneously in order to balance the budget.

Experiments F and G assume that the social security reform is previously announced. In other words, the replacement rate  $R_t$  is kept constant until  $T=19$ . In year  $T=20$ ,  $R_t$  is abruptly reduced to zero. The social security tax is endogenously determined to balance the social security budget. In effect, as soon as the replacement rate goes to zero,  $q_t$  falls to zero. In experiment F, the three tax rates are made endogenous in  $T=1$  in order to balance the government budget (excluding social security). In experiment G, the tax rates are set exogenous at the initial steady state level until year  $T=20$ , and the government is allowed to run a budget surplus. In  $T=21$ , the tax rates are set endogenous in order to balance the budget.

Experiments H to K refer to partial reforms in the PAYG system. In exercise H, the replacement rate  $R_t$  is phased out until reaching 30% in  $T=60$ . The last three exercises assume that the replacement rate is kept at 100%, and the only change is the elimination of the social security tax and replacement by some other tax. In Experiment I, the social security tax is zeroed in  $T=1$  and the consumption tax rate becomes endogenous in order to balance the government budget. In Experiment J, an “income tax” is levied to replace

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<sup>9</sup> Capital tax revenue is kept at 26.2%, consumption tax revenue at 38.43% and labor tax at 35.37% of the total revenue (excluding social security).

the social security tax<sup>10</sup>. In Experiment K, the labor tax is replaced by a tax on capital income in T=1.

## 5. Discussing Long Run Impacts of the Reform<sup>11</sup>

The PAYG system has two key components: the compulsory accumulation of “social security assets” (which yield a below-market interest rate) and the taxation of labor earnings as a way to finance such scheme. Privatizing the system leads to a substantial welfare improvement, under the assumed parameterization, and assuming that the government runs a balanced budget during the whole transition<sup>12</sup>. An individual born in T=150 will be 30% better off than under the old PAYG<sup>13</sup>. The national income is 21% larger and aggregate consumption increases by 26%. The stock of domestic capital increases by 36%.

The rationale behind such substantially positive welfare effects is the difference between the low implicit return on the social security “assets” and the high return on savings. The fact that the PAYG system assumed is not actuarially fair, having a below-market implicit rate of return, is determinant for understanding why its elimination will imply on

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<sup>10</sup> In particular, “income tax” is defined as a proportional tax on both capital and labor tax income. The portion of the capital and labor taxes is endogenously determined in order to match the new revenue requirements, according to the equation below:

$$T_t = \mathbf{t}_{C,t} \cdot C_t + (\mathbf{t}_{K,t} + \mathbf{t}_{L,t}) r_t K_t + (\mathbf{t}_{L,t} + \mathbf{t}_{L,t}) w_t L_t.$$

<sup>11</sup> Table 3 describes the path of national income during the 150 years following the reform announcement, for each of the 11 alternative reforms. Table 4 presents the welfare gain (or loss) of the agents born between T=1 and T=150. The analysis of this section is entirely based on these two Tables.

<sup>12</sup> The labor tax falls from 30.4% to 16.3%, the consumption tax falls from 15% to 11.6% and the capital tax falls from 13% to 10.7%.

<sup>13</sup> One measure of these utility differences is the equivalent percentage increase in full lifetime resources (assets plus the present value of earnings based on working full time) needed in the original PAYG regime to produce each cohort’s realized level of utility under the specified alternative regime. I will use the concept of rest of life (ROL) wealth equivalent, instead of lifetime wealth equivalent.

more wealth accumulation than before. As a result of larger accumulation of lifetime wealth, general equilibrium effects will lead to larger aggregate capital and higher marginal productivity of labor in the long run.

In addition, the distortions in the labor supply resulting from the payroll taxation are eliminated, with large welfare effects. The reduction of the taxation on labor earnings will imply a substantial fall in the demand for leisure as a proportion of the lifetime income. So, higher labor supply and larger capital accumulation jointly explain the growth in national income.

Long run macroeconomic and welfare effects of the reforms will depend on the type of tax structure as well as on the amount of the stock of government debt in the new (fully funded) steady state. Debt accumulation substantially worsens the long run results. When the debt stock increases during the first seven years of the transition, growing from 36% to 74% of the GNP, the tax rates must be higher to finance the debt services in the new steady state. Labor tax falls from 30% to 23%, but capital and consumption tax rates slightly increase. The result is a much smaller increase in national income (3.6%) and individual welfare (6.7%).

Oppositely, when the debt stock is reduced during the transition, the long run equilibrium under full privatization will have lower average tax rates, and hence larger national income. This is the case in Experiment G, when the reform happens only in  $T=20$ , and the tax rates are kept constant until then. General equilibrium effects lead to income growth and larger tax revenue, with subsequent debt reduction. In the long run, the debt stock falls from 36% to 26% of the GNP, national income grows by 22.1%, and individual welfare increases by 32%.

Under the assumed parametric assumptions, the magnitude of the welfare effects are substantial even when the replacement rate is not entirely phased out, being reduced from 100% to 30%. Experiment H is meant to replicate more realistic setups for the privatization, when a residual PAYG is kept to finance the retirement of the poor. Under such scheme, the PAYG system is not fully eliminated, and a remaining labor tax finances the reduced retirement benefits. The switch to this mixed scheme still induces higher capital accumulation, and substantial welfare effects. The national income will be 14% larger and the individuals will be 20.7% better off under such a scheme.

A substantial part of the welfare gains from the elimination of the PAYG system comes from the distortions in labor supply caused by the high labor tax. Even when the PAYG is kept unchanged, and a consumption tax is chosen to finance retirement benefits (Experiment I), there are substantial welfare gains in the long run (13%). It is well known that there is an equivalence between labor and consumption taxation, since these are different ways to tax lifetime consumption. So, why does national income grow by 8.3%, just by switching from labor to consumption taxation? This happens because of the double taxation over the initial elderly, which induces accumulation of physical capital and larger real wages for the unborn generations.

Replacing the labor tax by a capital tax has entirely different long run consequences. The life cycle consumption profile becomes flatter than under the initial steady state, as a result of substitution effect. The consequent crowding out of capital is compensated by a higher labor supply, and the national income hardly changes, increasing by 1.3%. In

contrast, individual well being will improve by 7.8% in the long run<sup>14</sup>. The after-tax labor earnings are larger both because the effect of capital accumulation on wages, and because of the reduction of labor taxation.

Long run results are sensitive to parametric assumptions, although the effects of the reforms are still sizeable for parametric assumptions around the benchmark values. For example, changing the intertemporal substitution from 0.35 to 1 decreases the resultant income growth of social security privatization from 20.5% to 16%. The argument behind the fall is that the leisure profile becomes very steep, lowering the average retirement benefits. Social security tax rate becomes smaller in the initial steady state and its elimination does not cause as much as benefit as under the benchmark parametric assumptions<sup>15</sup>. In general, long run changes are not too sensitive to parameter assumptions, as shown in Table 5.

## **6 – Discussing Transitional Issues about the Privatization**

In the long run, the magnitude of the macroeconomic and welfare effects of reforming social security will depend on the degree of retirement benefits cuts. In this section, I discuss those transitions that assume the elimination of the PAYG in the long run. If there is no variation in the debt stock, the remaining benefits will determine the size of the tax burden in the new steady state, and the transitional path of the tax rates will not matter for the long run results of the reform. Full elimination of benefits leads to about 30% of

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<sup>14</sup> If the social security labor tax is replaced by an income tax instead, the welfare gains are slightly lower (5.6%), and the national income grows by 1.8%.

<sup>15</sup> Sensitivity analysis is always done here without recalibration of the initial steady state. In other words, I change the value of the tested parameter, keeping everything else unchanged.

welfare improvement. Keeping the replacement rate at 100% leads to welfare effects between 5.6% and 13%, depending on the type of tax switch.

Why do we care for transitional paths? The reason is that the initial generations and their respective offspring will not benefit from macroeconomic environment in a distant future, when they will be already dead. However, those are the individuals who will build political coalitions to carry out the reform, choosing whether or not to reform. Hence, knowing how the current generations and those who will be alive in a near future are affected by the alternative reforms will give some insights about which type of reform will end up being chosen.

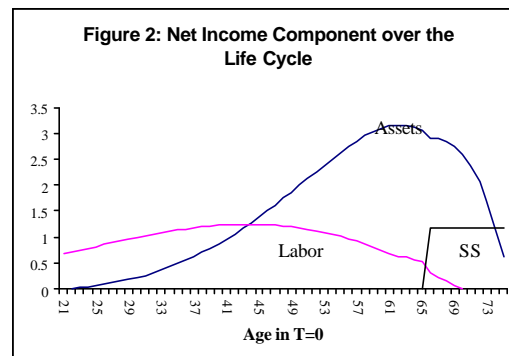
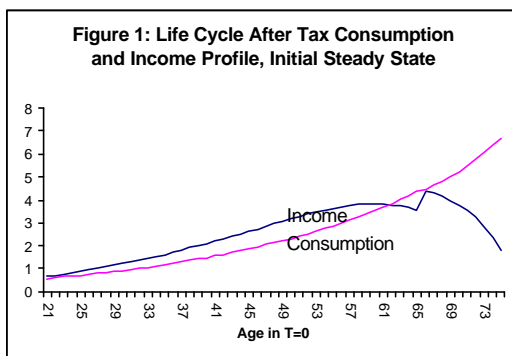
In this model, the only source of heterogeneity is given by the stage of the life cycle the individual will be at the moment of the reform, which will determine the lifetime budget constraints she faces. Depending on the transitional tax path, some generations will lose and others will gain. One could think that the generations alive in  $T=1$  will vote to choose which transitional scheme will be followed. The outcome of the intergenerational conflict would determine how radical the reform would be as well. In what follows, I look at how each type is affected by the reforms, and how this may influence their decision to vote<sup>16</sup>.

The Figures below give a hint on how the initial generations will be affected by different tax schemes, based only on their life cycle position when the reform starts. Individuals

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<sup>16</sup> I do not look for a voting equilibrium because such outcome must be dynamically consistent. For example, alive individuals in  $T=0$  might decide to carry out a transition through consumption tax, but one must look if the future generations would repeat such choice. If not, agents in year  $T=0$  must take this into account when deciding for voting for a consumption-based transition. Such interactions would involve more computationally-demanding simulation methods, and it is not what I intend here. See for example papers like Boldrin & Rustichini (1998) and Cooley & Soares (1999), which model political equilibrium specifically related to the issue of social security reform.

older than 62 are essentially asset owners, and consume over their wealth<sup>17</sup> (Figure 1). This elderly group is strongly hurt by an increase in the consumption tax rate. As Figure 2 shows, the individuals younger than 44 earn most of their income from labor supply. This group should be especially a target of a labor tax, and should gain in case of reduction in the social security labor tax. Individuals older than 45 already have accumulated enough assets to have most of their income coming from this source. A tax on capital will evenly distribute the tax burden across these middle aged and elderly individuals. Obviously, a tax on retirement benefits will hurt almost exclusively the retirees alive in year  $T=1$ .



### 6.1 – Full Privatization Financed by the Generations alive in $T=1$ :

Balanced budget transitions will have completely different “short run” macroeconomic and welfare impacts depending on which sort of tax replaces the social security tax. If an immediate cut in retirement benefits is implemented in  $T=1$ , the saving rate increases sharply and convergence is speeded up (Experiment A). The increase in savings is due to both an increase in labor supply and a decrease in consumption of the middle aged and old individuals. In  $T=19$ , national income is 12% larger as a result of faster capital

<sup>17</sup> The resultant high marginal propensity to consume of older individuals is a consequence of ruling out the bequest motive from the individual utility function.

accumulation. Table 6 shows the welfare impact on the generations alive in  $T=1$ . Youths benefit substantially from the parallel cut in retirement benefits and labor taxes. The individual born in  $T=1$  will be 15% better off, while the individual dying in  $T=1$  is 15% worse off. The welfare loss is concentrated among individuals older than 60. Such a “fascist” policy is similar to “confiscating the assets from the elderly”.

When the phased out benefits are financed by a consumption tax, the tax burden is more evenly spread, but it will affect mostly those who consume a higher share of their income – the old individuals. Taxing consumption works as a lump sum tax for the elderly, which lose about 4% on wealth equivalent, compared to the status quo. Capital accumulation is speeded up and the national income will be 6% higher in  $T=19$ . The fast growth will make youths substantially better off (8%), through higher real wages.

Replacing the labor tax with a tax on capital income shifts the tax burden from the elderly to middle aged individuals (Experiment C). A 50-year-old agent will be 2.2% worse off, compared to 0.9% worse off under the consumption tax scheme. A 70-year-old agent will lose 1.9% of her remaining lifetime utility under the capital tax scheme. The very young would rather have the transition under the capital tax because they will only pay capital income tax when they are older, but by that time, the tax rate will be already lower. Their lifetime income will be 8.9% larger under capital tax scheme and 7.9% under consumption tax. Because taxing capital leads to a reduction in capital stock, the national income suffers an initial sluggishness, converging slowly to the new steady state.

Experiment D phases out the social security tax. None of the cohorts alive in  $T=1$  will enjoy significant welfare gain. The tax burden is evenly distributed across those generations, and national income increases in a slow pace.

## 6.2 – Transferring the Tax Burden to Future Generations:

In Experiment F, the social security tax and retirement benefits are eliminated altogether in  $T=20$ , which under perfect foresight works like a 20-year-in-advance policy announcement. The future reduction in benefits forces a higher capital accumulation, resulting in national income growth prior to  $T=20$ . National income will be 1% larger in  $T=19$ .

The only difference between this experiment and the “Cold Turkey” is the timing in which the reform occurs, but this makes a lot of difference under an environment where generations are not attached through bequest motive. Under announcement, the initial elderly will not pay a dime, since she will be dead when the retirement benefit is zeroed. Those that in some way will be affected by benefit cuts will smooth consumption in order to prepare for such income loss, which will substantially decrease the impact of the transition. In a nutshell, “announcement” transfers the tax burden from the elderly to all those alive in  $T=20$ , which substantially postpone the welfare benefits of full privatization.

Another insightful way to transfer the burden of privatization to future generations is by carrying debt during the first years of transition, and then effectuating the tax adjustment some years later. Such scheme is very appealing to the generations alive in  $T=1$ , since they enjoy the tax relief, and the macroeconomic effects of it. Because the phase out respects the acquired rights of those already earning benefits (since they paid in full for such right), the debt scheme makes the initial elderly better off. The 70-year-old agent will have a 0.7% increase in benefits. Individuals younger than 40 in  $T=1$  enjoy substantial welfare gain compared to labor tax transitional scheme or to announcement

schemes. A 21-year-old individual is 3.5% better off under such scheme than under the old PAYG, notwithstanding being alive during the tax overshoot in  $T=7$ .

The other side of the coin is a deep welfare loss for future generations. Individuals born between years 6 and 36 will be worse off than under the old PAYG. In particular, individuals born in  $T=10$  will suffer a 2.2% decrease in her lifetime utility. Debt accumulation will lead to a crowding out in the capital stock, which is reinforced by the tax adjustment in  $T=8$ . National income falls after  $T=8$ , being still at 98% of its initial value by year  $T=25$ . In the long run, full privatization will lead only to an increase of 3.6% in national income.

One can say that debt accumulation is definitely more appealing to the initial alive than the announcement/postponing policy, except for those between ages 55 and 65. Moreover, it is more attractive than phasing out the social security labor tax, except for those between 50 and 55. Compared to the transitions financed either by capital tax or by consumption tax, the debt-financing scheme does not lead to such drastic redistribution of lifetime income among generations alive in  $T=1$ , and leave the initial elderly much better off.

### 6.3 – The Political Economy of the Social Security Reforms

One can imagine that the choice of the tax base may be the result of bargain among the agents alive in  $T=1$ , or may be decided by a majority voting mechanism. The difficulty of modeling and simulating reforms as a result of political interactions comes from the dynamic properties of this model. In this case, any commitment to reform in a given direction would not be credible. A political equilibrium with dynamic consistency requires that agents think about all future possible outcomes when new agents (electors)

are born. Although such ambition is beyond the scope of this paper, one can think about the political appeal of the reforms studied here when agents are myopic with respect to macroeconomic impacts of future changes in the social security institutions. In other words, how would be the choice if agents think that their decision will not be reconsidered in the future?

As the welfare analysis shows, there is an intrinsic intergenerational conflict among the generations alive in  $T=1$ : the elderly likes announcement or debt-finance, the youths like capital and consumption tax financing, and the middle aged prefer staying at the PAYG as it was originally conceived. Naturally, the outcome of the conflict will depend on demographic characteristics of the country.

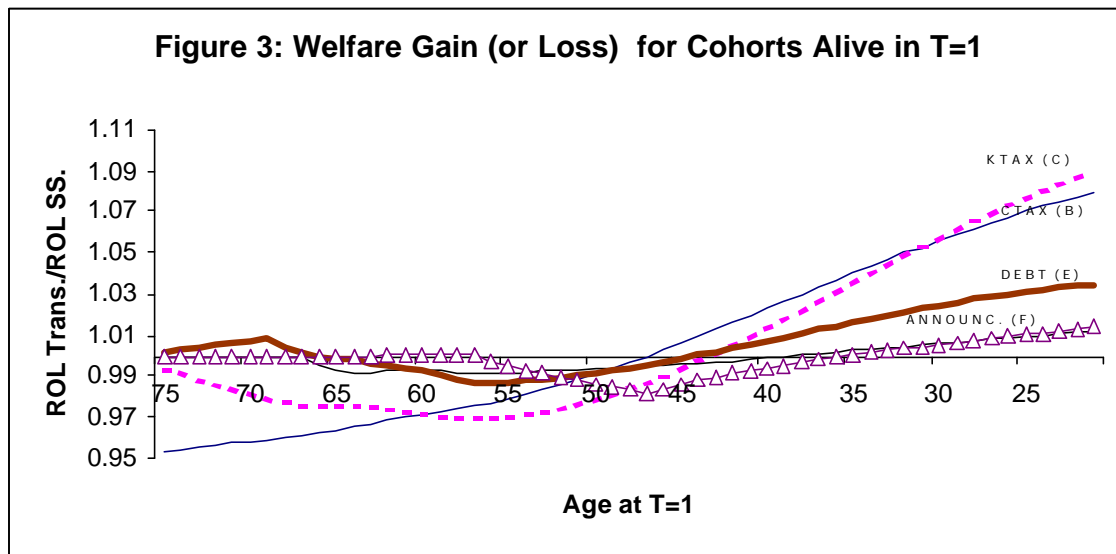


Figure 3 shows how agents would chose among the different forms of financing the complete phase out of retirement benefits. As one can see, there is no tax scheme that is strictly preferable for every generation alive in  $T=1$ . Moreover, every tax scheme but the transition financed by labor taxation is the most preferred to at least one generation. Debt scheme (E) is the most preferred by those older than 67. The previous announcement is

preferred by those between 57 and 64 years old (F). The PAYG is preferred by those between 48 and 56 years old. The consumption tax is preferred by those between 31 and 47 years of age (B), and capital tax is preferred by those below 31 years old (C). The labor tax reform is not preferred by any of the initial generations, because there is almost no redistribution involved.

The political outcome would depend on the demographic distribution of the population. I simulate voting using the true Brazilian demographic distribution, assuming that only agents alive in  $T=1$  vote for the tax scheme financing privatization. The menu of options exclude the Experiments A and those that do not consider the total elimination of the PAYG system. Because the median age in Brazil is 38 years old (among the assumed voters), the chosen tax policy will tend to privilege redistribution from the old to the youth. However, there is no tax scheme that is strictly preferred by more than 50% of the “voters”.

The consumption tax scheme is preferred by 40% of the “voters” (Table 7.A), while the status quo PAYG is the least preferred by 41% of the “voters” (Table 7.B). However, if I omit debt accumulation and announcement from the menu options (Table 7.C), 32% of the “voters” will be better off under the status quo, compared to 40% under consumption tax and 28% under capital tax. This happens because the elderly and middle aged are the ones in favor either of debt accumulation or postponement, and once I rule out such options, their votes will pool together. This may help to explain why there is a political resistance to privatize the PAYG in Brazil<sup>18</sup>.

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<sup>18</sup> The model does not incorporate neither uncertainty nor intragenerational heterogeneity, which implies the omission of important sources of conflict over the available policy instruments. See Deaton et al. (2000)

## 7 – Conclusion

In the absence of lifetime uncertainty, social security has no role, and the elimination of the labor tax, allowing individuals freely allocate their savings, has strongly positive long run welfare effects. Since there is no labor productivity growth, the implicit rate of return of social security “savings” is very small, and even a slight reduction in labor tax rate is able to produce substantial macroeconomic effects. Partial reforms that either reduce the replacement rate or switch the tax base that finances those benefits are able to produce significantly positive long run effects. Since there is no free lunch, in transitional issues reside all the conflicts about social security reform. I show that under a variety of possible transitional schemes, there is no tax path that is strictly preferred by every agent. Such lack of political consensus, generated by intergenerational conflict, may be a reason why Brazil has “chosen” not to reform its PAYG system.

A valuable extension of this research would be adding within-generation heterogeneity. The Brazilian old age pension system works as a minimum income program, and the present value of retirement benefits, net of contributions, varies widely across individuals. Another possible route is exploring the political economy features of the model, finding out which possible outcomes would rise if one imposes endogenous voting, in the sense that generations would be allowed to vote each period.

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for a welfare analysis comparing steady states with different social security systems, in the presence of uncertainty.

## References:

Altig, D., Auerbach, A., Kotlikoff, L. J., Smetters, K., Walliser, J., 2001. Simulating Fundamental Tax Reform in the United States. *American Economic Review* 91 (3), 574-595.

Altonji, J., Hayashi, F., Kotlikoff, L., 1997. Parental Altruism and Inter Vivos Transfers: Theory and Evidence. *Journal-of-Political-Economy* 105(6), 1121-1166.

Auerbach, A., Kotlikoff, L., 1987. *Dynamic Fiscal Policy*. Cambridge University Press, Cambridge.

Barreto, F., Oliveira, L., 2000 – Transição para Regimes Previdenciários de Capitalização e seus Efeitos Macroeconômicos de Longo Prazo no Brasil. *Estudos Economicos* 31(1), 57-87.

Boldrin, M., Rustichini A., 1998. Political Equilibria with Social Security. *Review of Economic Dynamics* 3, 41-78.

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

Deaton, A., Gourinchas, P., Paxson, C., 2000. Social Security and Inequality over the Life Cycle. National Bureau of Economic Research Working Paper: 7570.

De Nardi, M., Imrohoroglu, S., Sargent, T., 1998. Projected US Demographics and Social Security, *Review of Economic Dynamics* 2(3), 575--615.

Diamond, P., 1977. A Framework for Social Security Analysis. *Journal of Public Economics* 8, 275-298.

Edwards, S., 1998. The Chilean Pension Reform: a pioneering program. In: Feldstein, M. (Ed.), *Privatizing Social Security*. NBER Project Report. Chicago and London: University of Chicago Press, 33-57.

Feldstein, M., 1974. Social Security, Induced Retirement and Aggregate Capital Accumulation. *Journal of Political Economy* 82 (5), 905-926.

Ferreira, S., 2001. Three essays in social security and education in Brazil – Ph.D. Dissertation – University of Wisconsin – Madison.

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

Kotlikoff, L., 1979. Social Security and Equilibrium Capital Intensity. *Quarterly Journal of Economics* 93(2), 233-253.

Kotlikoff, L., 1996. Simulating The Privatization of Social Security in General Equilibrium. National Bureau of Economic Research Working Paper: 5776.

Kotlikoff, L., Smetters, K., Walliser, J., 1998. Opting Out of Social Security and Adverse Selection. National Bureau of Economic Research Working Paper: 6430.

Kotlikoff, L., Smetters, K., Walliser, J., 1998. Social Security: Privatization and Progressivity. *American-Economic-Review* 88(2), 137-141.

Malvar, R., 1999. The Economic Impact of Privatizing Social Insurance- a simulation study comparing two systems of social insurance- Boston University, Boston.

Valdivia, V., 1997. The Insurance Role of Social Security: Theory and Lessons for Policy Reform. International Monetary Fund Working Paper: WP/97/113.

**Tables:**

| TABLE 1:                              | simulated | actual |
|---------------------------------------|-----------|--------|
| Interest Rate (1)                     | 17.2%     | 18.0%  |
| Social Security Labor Tax             | 10.38%    | 10.32% |
| Consumption Tax (1)                   | 15.00%    | 14.64% |
| Capital Tax (1)                       | 13.00%    | 13.39% |
| Labor Tax (1) (Exclusive ss tax)      | 20.00%    | 20.74% |
| SS. Benef. (% GNP)                    | 4.56%     | 5.43%  |
| Capital-GNP                           | 2.55      | 3-4    |
| Govt. Debt (%GNP)                     | 35.72%    | 34.74% |
| Revenue (% GNP)                       | 24.88%    | 26.15% |
| Total Revenue * (%GNP)                | 29.45%    | 31.26% |
| Interest Service (% GNP)              | 6.16%     | 7.67%  |
| Govt. Consumption (%GNP)              | 18.72%    | 20.43% |
| National Saving Rate (% GNP)          | 4.85%     | 4.56%  |
| * It includes social security revenue |           |        |
| (1) Exogenous                         |           |        |

| TABLE 2: THEORETICAL ALTERNATIVES FOR FINANCING THE TRANSITION |  |   |
|--|--|---|
| FULL "PRIVATIZATION"   |  |   |
| EXPERIMENT   | REPLACEMENT RATE   | TAX PATH:   |
| A  | REPL. RATE = 0 IN T=1  | Social Security Tax = 0 from T=1 to T=150<br>Proportional Changes in all other Tax Rates                      |
| B  | REPL. RATE PHASED OUT TO ZERO IN T=55                          | Social Security Tax = 0 from T=1 to T=150<br>Consumption tax endogenous                                       |
| C  | REPL. RATE PHASED OUT TO ZERO IN T=55                          | Social Security Tax = 0 from T=1 to T=150<br>Capital tax endogenous   |
| D  | REPL. RATE PHASED OUT TO ZERO IN T=55                          | Social Security Tax = 0 from T=1 to T=150<br>Labor tax endogenous   |
| E  | REPL. RATE PHASED OUT TO ZERO IN T=55                          | Social Security Tax = 0 from T=1 to T=150<br>Tax rates constant until T = 7<br>Proportional Tax Change in T=8 |
| FULL "PRIVATIZATION" WITH ANNOUNCEMENT                         |  |   |
| F  | REPL. RATE = 100% FROM T=1 TO T=19<br>REPL. RATE = 0 IN T = 20 | Social Security Labor Tax Endogenous<br>Proportional Tax Change in every tax rate                             |
| G  | REPL. RATE = 100% FROM T=1 TO T=19<br>REPL. RATE = 0 IN T = 20 | Social Security Labor Tax Endogenous<br>Constant tax rates until T=20<br>Proportional tax change in T=21      |
| PARTIAL REFORMS OF THE PAYG                                    |  |   |
| EXPERIMENT   | REPLACEMENT RATE   | TAX PATH:   |
| H  | REPL. RATE PHASED OUT TO 30% FROM T=1 TO T=60                  | Social Security Labor Tax Endogenous<br>Proportional Tax Change in every tax rate                             |
| I  | REPL. RATE = 100% FOR EVERY T                                  | Social Security Labor Tax replaced by<br>Consumption Tax  |
| J  | REPL. RATE = 100% FOR EVERY T                                  | Social Security Labor Tax replaced by<br>"Income Tax"   |
| K  | REPL. RATE = 100% FOR EVERY T                                  | Social Security Labor Tax replaced by<br>Capital tax  |

| YEAR |                | 1     | 5     | 10    | 19    | 25    | 50    | 75    | 100   | 150   |
|------|----------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| A    | COLD TURKEY    | 102.8 | 105.4 | 108.4 | 112.0 | 113.5 | 117.3 | 119.1 | 119.9 | 120.5 |
| B    | CONSUMPTION    | 101.5 | 102.5 | 103.9 | 106.3 | 107.7 | 112.9 | 116.9 | 119.0 | 120.5 |
| C    | CAPITAL        | 102.1 | 101.9 | 101.9 | 103.0 | 104.2 | 111.3 | 116.3 | 118.7 | 120.5 |
| D    | LABOR          | 99.8  | 100.0 | 100.3 | 101.5 | 102.5 | 109.2 | 115.4 | 118.3 | 120.5 |
| E    | DEBT - 7       | 102.2 | 102.0 | 98.6  | 98.1  | 98.0  | 98.4  | 100.5 | 101.8 | 103.6 |
| F    | ANT./BAL.BUDG  | 100.0 | 100.2 | 100.4 | 101.0 | 105.0 | 112.1 | 117.1 | 119.0 | 120.5 |
| G    | ANT./SURPL.    | 100.0 | 100.2 | 100.4 | 101.1 | 105.3 | 113.1 | 118.5 | 120.5 | 122.1 |
| H    | R=30%          | 100.0 | 100.3 | 100.7 | 101.6 | 102.3 | 106.1 | 110.2 | 112.5 | 114.3 |
| I    | R=100%, C.TAX  | 101.4 | 102.4 | 103.5 | 105.2 | 106.0 | 107.5 | 108.1 | 108.3 | 108.3 |
| J    | R=100%, I. TAX | 101.2 | 101.0 | 100.9 | 101.0 | 101.1 | 101.4 | 101.6 | 101.6 | 101.8 |
| K    | R=100%, K. TAX | 102.1 | 101.7 | 101.4 | 101.2 | 101.3 | 101.4 | 101.3 | 101.3 | 101.3 |

OBS: Year T=0 = 100

| "BIRTH" YEAR |                | 1     | 5     | 10    | 25    | 50    | 75    | 100   | 150   |
|--------------|----------------|-------|-------|-------|-------|-------|-------|-------|-------|
| A            | COLD TURKEY    | 14.6% | 17.0% | 19.3% | 23.4% | 27.0% | 28.5% | 29.2% | 29.7% |
| B            | CONSUMPTION    | 7.9%  | 9.1%  | 10.7% | 15.6% | 22.8% | 26.7% | 28.4% | 29.7% |
| C            | CAPITAL        | 8.9%  | 9.2%  | 9.8%  | 13.1% | 21.4% | 26.0% | 28.2% | 29.7% |
| D            | LABOR          | 1.2%  | 2.1%  | 3.6%  | 9.5%  | 19.6% | 25.3% | 27.8% | 29.7% |
| E            | DEBT - 7       | 3.5%  | 0.5%  | -2.2% | -1.1% | 1.4%  | 3.8%  | 5.1%  | 6.8%  |
| F            | ANT./BAL.BUDG  | 1.4%  | 2.5%  | 4.7%  | 15.5% | 22.8% | 26.9% | 28.6% | 29.9% |
| G            | ANT./SURPL.    | 1.4%  | 2.6%  | 5.0%  | 16.9% | 24.7% | 29.0% | 30.8% | 32.0% |
| H            | R=30%          | 1.3%  | 2.1%  | 3.1%  | 6.5%  | 13.1% | 17.2% | 19.2% | 20.7% |
| I            | R=100%, C.TAX  | 7.4%  | 8.2%  | 9.1%  | 11.0% | 12.3% | 12.7% | 12.9% | 12.9% |
| J            | R=100%, I. TAX | 4.8%  | 4.8%  | 4.8%  | 5.0%  | 5.2%  | 5.4%  | 5.4%  | 5.6%  |
| K            | R=100%, K. TAX | 8.1%  | 7.9%  | 7.8%  | 7.8%  | 7.8%  | 7.8%  | 7.8%  | 7.8%  |

| Balanced Budget Transition <sup>(2) (3)</sup>   |            |              |            |              |  |      |      |      |      |      |                     |
|---|------------|--------------|------------|--------------|--|------|------|------|------|------|---------------------|
| Parametric Assumptions                          |            |              |            |              | Long Run Effects of Full Elimination of the PAYG |      |      |      |      |      |                     |
| Gamma   | Rho        | Delta        | Alpha      | Pop. Gth.    | dK/K   | dL/L | dC/C | dY/Y | dW/W | dR/R | dS/S <sup>(1)</sup> |
| 0.35  | 1.3        | 0.015        | 0.29       | 1.9%         | 36%  | 6%   | 26%  | 21%  | 13%  | -12% | 13%                 |
| <b>0.3</b>                                      | 1.3        | 0.015        | 0.29       | 1.9%         | 37%  | 7%   | 26%  | 21%  | 14%  | -12% | 13%                 |
| <b>0.7</b>                                      | 1.3        | 0.015        | 0.29       | 1.9%         | 32%  | 5%   | 22%  | 18%  | 12%  | -11% | 12%                 |
| <b>1</b>  | 1.3        | 0.015        | 0.29       | 1.9%         | 29%  | 5%   | 20%  | 16%  | 11%  | -10% | 11%                 |
| 0.35  | <b>0.9</b> | 0.015        | 0.29       | 1.9%         | 30%  | 3%   | 19%  | 55%  | 12%  | -11% | 12%                 |
| 0.35  | <b>1.5</b> | 0.015        | 0.29       | 1.9%         | 39%  | 7%   | 28%  | 22%  | 14%  | -12% | 14%                 |
| 0.35  | 1.3        | <b>0.025</b> | 0.29       | 1.9%         | 34%  | 6%   | 24%  | 20%  | 12%  | -11% | 12%                 |
| 0.35  | 1.3        | <b>0.005</b> | 0.29       | 1.9%         | 39%  | 7%   | 27%  | 22%  | 15%  | -12% | 14%                 |
| 0.35  | 1.3        | 0.015        | <b>0.2</b> | 1.9%         | 39%  | 6%   | 26%  | 21%  | 14%  | -13% | 15%                 |
| 0.35  | 1.3        | 0.015        | <b>0.5</b> | 1.9%         | 29%  | 7%   | 22%  | 18%  | 10%  | -9%  | 10%                 |
| 0.35  | 1.3        | 0.015        | 0.29       | <b>1.79%</b> | 38%  | 7%   | 27%  | 21%  | 14%  | -12% | 14%                 |
| 0.35  | 1.3        | 0.015        | 0.29       | <b>2.02%</b> | 35%  | 6%   | 25%  | 20%  | 13%  | -11% | 13%                 |
| LINKS - 0.2 FOR AGE 1 TO 49, 0 FOR AGE 50 TO 62 |            |              |            |              |  |      |      |      |      |      |                     |
| 0.35  | 1.3        | 0.015        | 0.29       | 1.90%        | 36%  | 6%   | 25%  | 20%  | 13%  | -12% | 13%                 |
| WAGE PROFILE - COHORT CONTROL                   |            |              |            |              |  |      |      |      |      |      |                     |
| 0.35  | 1.3        | 0.015        | 0.29       | 1.90%        | 23%  | 3%   | 16%  | 13%  | 9%   | -8%  | 9%                  |

(1) dS/S is the growth rate of the aggregate saving rate.  
(2) The first line corresponds to the long run effects of privatization under the benchmarking assumptions. For each line, the parameter value being changed is in Bold.  
(3) Sensitivity analysis is always done here without recalibration of the initial steady state. In other words, I change the value of the tested parameter, keeping everything else unchanged.

| COHORT (T=1)      | 21    | 30    | 40    | 50    | 55    | 60    | 65     | 70     | 75     |
|-------------------|-------|-------|-------|-------|-------|-------|--------|--------|--------|
| A COLD TURKEY     | 14.6% | 11.6% | 7.2%  | 2.2%  | -1.0% | -5.6% | -14.3% | -15.6% | -14.7% |
| B CONSUMPTION     | 7.9%  | 5.6%  | 2.3%  | -0.9% | -2.1% | -2.9% | -3.6%  | -4.2%  | -4.7%  |
| C CAPITAL         | 8.9%  | 5.6%  | 1.3%  | -2.2% | -3.0% | -2.9% | -2.4%  | -1.9%  | -0.7%  |
| D LABOR           | 1.2%  | 0.6%  | -0.1% | -0.7% | -0.8% | -0.8% | -0.7%  | -0.1%  | -0.1%  |
| E DEBT - 7        | 3.5%  | 2.5%  | 0.7%  | -0.8% | -1.3% | -0.7% | -0.2%  | 0.7%   | 0.2%   |
| F ANT./ BAL.BUDG. | 1.4%  | 0.6%  | -0.6% | -1.4% | -0.5% | 0.0%  | 0.0%   | 0.0%   | -0.1%  |
| G ANT./SURPL.     | 1.4%  | 0.5%  | -0.6% | -1.4% | -0.5% | 0.0%  | 0.0%   | 0.0%   | 0.0%   |
| H R=30%           | 1.3%  | 0.8%  | 0.3%  | -0.3% | -0.6% | -0.8% | -0.7%  | -0.4%  | -0.1%  |
| I R=100%, C.TAX   | 7.4%  | 5.3%  | 2.3%  | -0.5% | -1.7% | -2.7% | -3.6%  | -4.2%  | -4.7%  |
| J R=100%, I. TAX  | 4.8%  | 3.1%  | 0.9%  | -0.9% | -1.4% | -1.6% | -1.6%  | -1.1%  | -0.4%  |
| K R=100%, K. TAX  | 8.1%  | 5.1%  | 1.2%  | -1.7% | -2.5% | -2.6% | -2.3%  | -1.9%  | -0.7%  |

|  |         |       |      |              |      |
|--|---------|-------|------|--------------|------|
| 7.a - The most preferred (all included)  |         |       |      |              |      |
| consumption  | capital | labor | debt | announcement | payg |
| 40%  | 28%     | 0%    | 9%   | 8%           | 15%  |
| 7.b - The least preferred (all included)   |         |       |      |              |      |
| consumption  | capital | labor | debt | announcement | payg |
| 14%  | 16%     | 0%    | 0%   | 28%          | 41%  |
| 7.c - Ruling out debt and announcement options:  |         |       |      |              |      |
| consumption  | capital | labor | debt | announcement | payg |
| 40%  | 28%     | 0%    | 0%   | 0%           | 32%  |
| OBS: (1) It assumes that the policy is decided at T=1 once for all,<br>with no future turn back. |         |       |      |              |      |
| (2) It assumes the age distribution of the Populational Counting<br>IBGE/1996                    |         |       |      |              |      |