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Tax Incentives for Retirement Savings: Simulation Results in the Presence of Liquidity Constraints and Heterogeneous Consumers in an OLG-GE Model

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The overlapping generations general equilibrium (OLG-GE) framework constitutes an important tool for policy evaluation. One of its strengths is that it considers that at any given time the population is composed of workers of different ages and, therefore, whith different time horizons. This has two advantages. First, the assumption of a realistic distribution of time horizons and budget constraints among the population allows the analyst to realistically model the evolution of the equilibrium path of the economy given a certain policy. Second, modeling the different generations in detail supports making meaningful welfare comparisons across generations. These advantages make the framework attractive for policy evaluation, since it can help determine cohort-based compensatory policies that may be crucial for making a certain policy feasible.

This paper uses an OLG-GE model to assess the impact of the recently approved tax incentive mechanisms for retirement savings in Chile. The purpose is to determine the extent to which different groups of workers may take advantage of the incentives, the potential aggregate impact in the steady state, the transition path of the economy to the new steady state, and the welfare implications of the reform.

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The OLG-GE framework is particularly attractive for studying this reform because the reform triggers more than one transition. One is a transition in individual savings decisions. The fact that workers are at different stages in their life cycle implies that the final aggregate impact on capital accumulation will arise only when all living generations have faced the same conditions during their working lives. The second is an important fiscal transition. Taxes are deferred, which means that the public sector will have to make some kind of transitory adjustment until income tax collection returns to a stationary level.

The model used in this paper incorporates two important improvements with regard to previous versions, which are crucial for the problem at hand. First, it models an income tax structure with increasing marginal rates. Solving the consumption and savings problem in this context provides new insights into the impact of income taxes on savings. Moreover, it is crucial for the model to provide a realistic prediction of the impact of tax incentives on savings behavior. Second, the population is modeled with heterogeneity in income levels. This provides the necessary environment for welfare evaluation, since the benefits of the policy under study vary with income level.

The paper is organized as follows. The first section introduces the tax incentive mechanism recently approved in Chile for voluntary savings for retirement. Section 2 describes the model and section 3 its parameterization. Section 4 presents partial equilibrium results, showing optimal policies for voluntary savings for different agents. Steady-state comparisons are presented in section 5, while section 6 shows the results for the transitions. A final section summarizes the main findings and presents paths for future work.

1. Tax Incentive Mechanisms for Voluntary Savings for Retirement (VSR)

The incentive mechanism consists of allowing a deduction from the income tax base equal to the savings for retirement made during a year up to a maximum. These savings can only be accessed at retirement, at which time the withdrawals are subject to income tax. Withdrawals take the form of either annuities or monthly pension payments. In the latter case, the amount of the payments is determined via the phased withdrawal rules that apply to normal pensions, which try to secure a constant pension throughout retirement. In addition, a certain amount can be withdrawn tax-free in lump-sum payments, provided that the monthly pension is above a certain level.

An incentive scheme like this has been in place in Chile since the current pension system was implemented in 1981. A reform implemented in March 2002 introduced the following changes to the scheme:

— Maximum monthly voluntary contributions were raised from 48 UF to 50 UF a month;[1]
— Tax-free withdrawals after retirement were limited to 2,100 UF [2] (there was no limit before the reform);
— Withdrawals before retirement were allowed, subject to a penalty of 3 percent of the withdrawal plus one-tenth of the marginal income tax rate that corresponds to the income level of the worker (the penalty thus varies between a minimum of 3 percent and a maximum of 7.3 percent);
— The type of institution allowed to provide the service was expanded to include banks and insurance companies; and
— Providers were allowed to charge a fee.

Taken at face value, the effect of the legal changes on the amount of voluntary savings is ambiguous. The limit on tax-free withdrawals and the provider fee have a direct adverse pecuniary effect that makes VSR less attractive, whereas the higher monthly contributions and the possibility of early withdrawal make the mechanism more attractive (although the change in contributions is small and early withdrawal does not generate a direct pecuniary effect).

The crucial point of the legal modification, however, is that competition for VSR is now open to new players. These new entities can be expected to undertake a large marketing effort to encourage workers to participate in the system. Recent findings show that long-term savings are highly sensitive to framing and arrangements that reduce transaction costs (Choi and others, 2001). Marketing efforts should help to place retirement savings on the “path of least resistance”, expanding the use of existing programs.

1. The *Unidad de Fomento* (UF) is a CPI-indexed unit of account widely used in the financial sector in Chile. It varies daily.

2. Limit is defined as 1,200 *Unidades Tributarias Mensuales* (UTM), another CPI-indexed unit of account, which varies monthly. 1 UTM = 1.75 UF approximately.

2. The Model

The base model is the OLG-GE model with credit constraints developed by Cifuentes and Valdés-Prieto (1997) which, in turn, is an expanded version of Auerbach and Kotlikoff (1987). The main difference with the latter is that Cifuentes and Valdés-Prieto model the case of liquidity constraints. This is extremely important for the present case. In the absence of liquidity constraints, savers would take advantage of the full tax incentive, without considering preferences for consumption. Consumption would be maximized independently with total wealth as the only input. Liquidity constraints prevent this: the extent to which the tax advantage is used depends on both the income profile and time preferences.

The model has three sectors: households, firms, and the government. Households are endowed with an age-related path of units of labor. In this paper, I further consider three different types of household, according to the level of education attained by the head. Different levels of educational attainment imply different levels of productivity, so this is modeled as different amounts of labor units.

Households accumulate savings that are offered to the productive sector (firms) as capital and to the government as demand for bonds. This means that households own all the factors in the economy, and capital is owned homogeneously among households of similar characteristics. Firms demand factors with a profit-maximizing objective. Government, in turn, must finance expenditures through taxes and public debt issuances. There is no uncertainty of any sort in the model, and agents are assumed to have perfect foresight.

2.1 Households

Households are assumed to have an economically active life of sixty years, which represents a worker who offers labor in the market between ages twenty-one and sixty-five and is retired from age sixty-six through death at age eighty. The supply of labor typically increases with age or presents a hump shape, as a result of the effects of experience on productivity for different types of worker. The section on calibration shows the particular profiles for labor productivity used in this paper.

Factor prices and labor endowment are given. Each type of household maximizes a constant intertemporal elasticity of substitution (CIES)—or constant relative risk aversion (CRRA)—utility function to find the optimal path of consumption and savings:

$$\max U = \frac{1}{1-1/\gamma} \sum_{a=a_1}^{80} \left(1+\delta\right)^{-(a-a_1)} c_a^{e\,1-1/\gamma}, \tag{1}$$

subject to

$$F_{at}^{e} = \left[w_t l_a^e \left(1-\tau_t^{ss}\right) + r_t F_{a-1,t-1}^{e} + p_{at}^{e} \right]\left(1-\tau_t^{y}\right) + F_{a-1,t-1}^{e} - c_a^e \left(1+\tau_t^c\right) \tag{2}$$

for $a = a_1, \ldots , 80$,

$$F_{at} \geq 0 \text{ for all } a \in \{21, \ldots , 80\} \text{ and} \tag{3}$$

$$F_{20,t}^{e} = 0 \text{ for all } e \text{ and } t, \tag{4}$$

where

$$p_{at}^{e} = p_{t-a}^{e} = \begin{cases} 0 & \text{for } a = 21,\ldots,65 \\ \dfrac{\sum_{i=21}^{65} w_{t-a+1} l_{i,t-a+1}^{e} \tau_{t-a+1}^{ss} \prod_{j=i+1}^{65} \left(1+r_j\right)}{\sum_{i=1}^{15} \left(1+r_{t+i-1}\right)^{-i}} & \text{for } a = 66,\ldots,80 \end{cases} \tag{5}$$

and where δ is the discount rate or time preference parameter, γ is the elasticity of intertemporal substitution (or the inverse of the coefficient of risk aversion), a indicates age, t represents chronological time, e is education level, and a_1 is the age at which the consumer is maximizing.

Equation (2) is the budget constraint in flow terms. F_{at}^{e} indicates the stock of financial assets at the end of period t, l_{at}^{e} is the labor supply, w_t is the wage rate at year t, c_a^e is net consumption, τ^y and τ^c are income tax and value-added tax (VAT) rates, respectively, τ^{ss} is the social security contribution rate, and p_{at}^{e} is the pension benefit. As indicated in equation (5), pension is assumed to be a constant during retirement; therefore, $p_{at}^{e} = p_{t-a}^{e}$, which means that the pension does not depend on age, but on the cohort to which the worker belongs.

Equation (3) imposes credit constraints by requiring that financial assets can not be negative. Equation (4) indicates that workers do not own assets at the beginning of their working life.

Choices regarding consumption and saving plans are time consistent throughout the worker's life. This means that if maximization were to be revised later in life, the consumer would chose to stick to the original plan. Each worker thus optimizes only once, with $a_1 = 21$. However, optimization may change in the face of unanticipated changes in the evolution of the workers' environment. In this case, all agents have to re-optimize at the moment of the reform, and the optimization can be based on starting assets greater than zero.

The maximization problem so defined implies that households have perfect knowledge of factor prices and tax rates from the age at which they maximize until the end of life. The outcome of the maximization is a path of household consumption, asset holdings, and taxes paid.

Finally, I define the evolution of mandatory retirement assets, A, as

$$A_{at}^{e} = w_t l_{at}^{e} \tau_t^{ss} + \left(1 + r_t\right) A_{a-1,t-1}^{e} - p_{at}^{e} \text{ for } a = 21, \ldots, 80, \text{ and}$$

$$A_{20,t}^{e} = 0 \text{ for all } e \text{ and } t.$$

2.2 Aggregation

To move from individual data to aggregate macroeconomic variables, I sum across all individuals alive at a given time, t. This implies summing across age and educational levels. I assume that population grows at an annual rate of n percent. Aggregate supply of capital in year t is

$$K_t^S = \sum_{e=1}^{3} \left[\sum_{a=21}^{80} F_{at}^{e} \cdot \left(1 + n\right)^{-a} + \sum_{a=21}^{80} A_{at}^{e} \cdot \left(1 + n\right)^{-a} \right]. \tag{6}$$

In equilibrium, capital supply should equal capital demand by the productive sector plus total public debt, which is the demand for capital by the public sector.

Total labor supply is the sum of labor endowments of workers of different ages and educational levels alive in a given year:

$$L_t = L_t^S = \sum_{e=1}^{3} \left[\sum_{a=21}^{80} l_{at}^{e} \cdot \left(1 + n\right)^{-a} \right]. \tag{7}$$

In contrast with capital, labor supply is fixed. Factor prices adjust until full employment of labor is reached. The implicit assumption with regard to productivity growth is that each generation is born with a profile of labor endowments that is *x* percent higher than the previous generation for every age. This introduces productivity growth, in that it benefits only new generations that join the labor market. In terms of the notation introduced,

$$\frac{l_{a,t+1}^{e}}{l_{at}^{e}} = (1+x) \text{ for all } a, e, \text{ and } t.$$

2.3 Firms

Firms use a constant elasticity of substitution (CES) technology to produce. They maximize profits taking factor prices as given, as described in the following expression:

$$\max \Pi = \left[\alpha L^{(\sigma-1)/\sigma} + (1-\alpha) K^{(\sigma-1)/\sigma}\right]^{\sigma/(\sigma-1)} - \phi K - rK - wL \ , \tag{8}$$

where the subscript *t* has been dropped from the expression for simplicity, since all variables refer to the same time, *t*; σ represents the elasticity of substitution in production; and ϕ is the depreciation rate. First-order conditions of maximization imply that factors are hired until price equals marginal productivity:

$$\frac{\partial Y}{\partial K} = r + \phi; \quad \frac{\partial Y}{\partial L} = w \ .$$

Factor demands can be obtained from the first-order conditions:

$$L^{D} = w^{-\sigma} \alpha^{\sigma} Y^{\sigma/(\sigma-1)} \text{ and} \tag{9}$$

$$K^{D} = (r+\phi)^{-\sigma} (1-\alpha)^{\sigma} Y^{\sigma/(\sigma-1)} . \tag{10}$$

2.4 Government

Government must finance exogenously given expenditures. This can be done by issuing debt or imposing taxes. By definition, the balanced budget implies

$$G_t + r_t B_t = T_t + B_{t+1} - B_t \ ,$$

where G_t is total government expenditures, B_t is the outstanding public debt, and T_t is the tax collection, which equals

$$T_t = \left(w_t L_t + r_t F_t + p_t \right) \tau_t^y + c_t \tau_t^c \ ,$$

where F_t is total voluntary assets held at time t, p_t represents total pension payments at time t, and c_t is aggregate net consumption at time t. All three aggregates are determined according to the following relation:

$$z_t = \sum_{e=1}^{3} \left[\sum_{a=21}^{80} z_{at}^e \cdot \left(1+n\right)^{-a} \right].$$

The no-Ponzi-game condition implies that the present value of taxes should equal the present value of expenditure plus the initial stock of debt. This condition implies that the growth rate of debt cannot exceed the interest rate.

In practice, for a given path of public expenditures, fiscal budget can be balanced by an infinite number of combinations of paths for public debt and each of the taxes. In this paper I assume that public debt and income tax rates are fixed ex ante by rules and that the VAT rate is adjusted to attain equilibrium in fiscal budget. In particular, I assume that public debt is fixed as percentage of GDP. This guarantees that the no-Ponzi-game condition is always satisfied. The income tax schedule follows a rule that is described in the next section.

2.5 Equilibrium

Equilibrium is found using a Gauss-Siedel algorithm. The first step is to conjecture an initial path for the level of the aggregate stock of capital (K_t^D). Given that the path for labor (L_t) is known and fixed, paths for factor prices (r and w) consistent with the conjecture can be derived using equations (9) and (10). A path for the parameter that balances the fiscal budget is also conjectured. Given these paths, households decide consumption and savings. Individual variables are aggregated to determine capital supply and the level of the variable that adjusts the public sector finances. The equilibrium delivers new values for the conjectured variables. If these new values are the same as the initial conjecture, then an equilibrium has been found. This typically is not the case in the first rounds. When magnitudes differ, a new conjecture is used to simulate the model, typically a path between the previous conjecture and the previous outcome of the model. A solution is found after a few iterations. In formal terms, the equilibrium condition I am looking for is

$$K_t^D + B_t = K_t^S \text{ for all } t,$$

which says that capital demanded in the economy, from the production side (K_t^D) and from the government (B_t), should equal capital supply (K_t^S).

In the case of a transition, the algorithm is the same except that convergence is assumed to reach a maximum 180 years after the introduction of the reform that triggered the transition. This involves assuming that all relevant prices in the economy are fixed from that year on at the value they reach that year. This assumption is usually not binding, since the economy typically converges in shorter time spans.

3. Parameters

This section presents the parametrization of the model, with special attention to the tax scheme and the income profiles. It also discusses the strategy followed to determine the optimal savings policy in the presence of tax incentives for retirement savings.

3.1 Tax Scheme

Previous versions of the model consider single-rate income tax schemes. The incentive mechanisms under study here, however, have their greatest impact with income tax schemes in which the marginal tax rate increases with income, as is the case of Chile. This paper models the Chilean income tax structure (see table 1).

Table 1. Income Tax Rates in Chile, 2002

Income range (UFs per month)[a]	*Marginal tax rate (percent)*
0–23.6	0
23.6–52.5	5
52.5–87.5	10
87.5–122.5	15
122.5–157.5	25
157.5–210.0	33
210.0–262.5	39
262.5 and over	43

Source: Internal Revenue Service.
a. Tax brackets are defined in UTMs in the tax code. Here they are presented in UFs to facilitate presentation.

Incorporating this tax scheme has two implications for the model. First, the government budget is adjusted via the consumption or value-added tax. Adjusting marginal income tax rates introduces noise with regard to the object of study, which is precisely the fact that the effective marginal income tax rate can be changed through retirement savings. If I allowed the tax scheme to change over time in order to adjust the government budget, I would not be able to measure the additional savings generated by the tax incentive.

The second implication is more troublesome. In a context of productivity growth, keeping the income tax scheme of table 1 constant over time implies that the economy will only reach a stationary equilibrium when the entire population is in the highest income bracket. Consequently, a model economy will be in a very long transition path until this happens. Such a simulation is feasible, but it is highly intensive in computational capacity—and the main question is whether it is a meaningful exercise. In such a transition, distortions increase over time as the median marginal income tax rate increases (and the VAT or other tax rates decreases if the size of the government is to be kept constant). Income tax becomes the main source of revenue for the government.

That context clearly is not a reasonable scenario for policy evaluation. Agents in the economy will not allow the level of distortions to follow whatever path the dynamics of growth might determine. A more sensitive scenario is to assume that a decision has been made about the level of distortions that agents in the economy find optimal and then to keep that level of distortions constant, except for the consequences of the specific tax reform under study.

The practical way to keep the level of distortions constant is to adjust the threshold of each income tax bracket increase in line with productivity in the economy. Each generation will face the same scheme in relative terms, and a stationary equilibrium can be attained. While such adjustments do not occur on a yearly basis in reality, the strategy adopted here seems to provide a reasonable assumption regarding medium- and long-run tax policy dynamics.

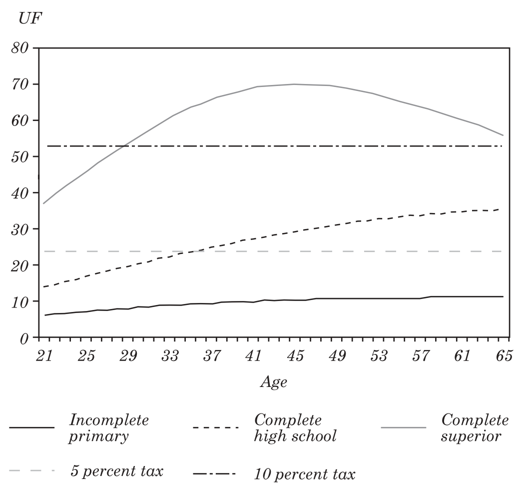
3.2 Income Profiles

Recent studies on the effects of age on income include Larrañaga and Paredes (1999) and Butelmann and Gallego (2001). The former paper estimates an average age-income profile using synthetic cohorts from a long series of panels (1957 to 1996) from the employment survey in Greater Santiago. Having data for various years allows them to isolate cycle effects properly. This profile is longitudinal, that is, it represents the income profile faced by individuals or cohorts throughout their lifetime. Butelmann and Gallego (2001), in turn, report cross-sectional age-income profiles. In principle, longitudinal profiles can be derived from cross-sectional ones based on assumptions about the evolution of productivity growth between generations. However, longitudinal profiles cannot be derived from the Butelmann-Gallego data using reasonable assumptions of productivity growth. This may be due to the fact that year effects affect their estimates.

Butelmann and Gallego (2001) report profiles for different levels of educational attainment, while Larrañaga and Paredes (1999) derive only one profile representing the population average. Assuming that year effects do not substantially affect the relative differences in income across workers with different educational attainment, I can use Butelmann and Gallego (2001) profiles to derive income profiles by educational attainment from Larrañaga and Paredes (1999). I determine this by imposing the condition that at every age, income levels for the three income categories have to keep the relative distances found in Butelmann and Gallego (2001), while averaging the level of Larrañaga and Paredes (1999). Weights are reported in Butelmann and Gallego (2001).

Figure 1 shows the income profile thus derived. The income profile of the worker with the lowest level of education never reaches the first income bracket with positive income tax. This implies that tax incentives for VSR will never be relevant for this group. In fact, they can only reduce welfare for this group, since these workers do not obtain any benefit from the tax incentives and the lower liquid income at working ages may heighten financial constraints. Population shares of different groups by educational attainment are as follows: incomplete primary school: 53.2 percent; complete high school: 25.2 percent; and complete superior education: 21.6 percent.

Figure 1. Income Profiles by Level of Educational Attainment[a]



Source: Author's calculations based on Butelman and Gallego (2001) and Larrañaga and Paredes (1999).
a. Based on monthly income in 2001.

3.3 Other Parameters

Table 2 shows the value used in the simulations of the other variables of the model. Data on public debt and public expenditure are Chile averages for the period 1993–2000. Public debt considers Central Bank long-term debt plus recognition bonds. It is not relevant for the model whether the issuer is the Treasury or the Central Bank, as in Chile. What is captured by the model is the crowding-out effect of public debt on investment, and this effect occurs independently of the issuer.

Table 2. Simulation Parameters

Variable	*Value*
Public debt over GPD	19.6 percent
Public expenditure over GPD	17.6 percent
Contribution rate to mandatory pension fund	5 percent
Production function (CES)	
Sigma	0.8 and 1.2
Alfa	0.53 and 0.75
Time preference	1, 3, and 10 percent
Intertemporal elasticity of substitution	0.9
Population growth rate	1 percent

Source: Central Bank of Chile and author's estimates.

With regard to public expenditure, what is relevant for the model is the part that is financed with taxes. This provides the measure of the government's impact on the budget constraints of private economic agents. Thus, public expenditures financed by means other than taxes (such as return on assets, asset sales, and income from public companies) is treated as part of the private economy in this model.

The mandatory contribution to pension funds is assumed to be 5 percent. The mandatory level in Chile is actually 10 percent, but because the model assumes a worker starts working at the age of twenty-one and contributes continuously until he/she is sixty-five, the amount accumulated in the personal account is usually very large. The model does not consider more realistic features of contribution histories, such as periods of unemployment, independent employment, or absence from the labor force, as it is not the purpose of the model to incorporate such features. Instead, their relevant impact on lifetime budget constraints is fully captured via a lower contribution rate.[3]

The parameters of the production function are chosen to generate a reasonable macroeconomic environment. Sigma captures the elasticity of substitution in production in the CES function; this is chosen in the vicinity of 1, the Cobb-Douglas case. Alpha, in turn, is set to generate a share of labor in GDP between 66 and 68 percent, which is an appropriate value for the Chilean economy. Finally, among the combinations of sigma and alpha that match this requirement, I choose those that generate a real interest rate around 5 percent, a reasonable benchmark for returns on long-term savings.

3. The accumulation of large balances in individual accounts can be avoided through early retirement. This can easily be included in the model.

3.4 Simulation Strategy

Tax incentives affect the consumer's maximization problem because wealth increases if income is transferred from periods with high marginal tax to periods with low marginal tax. The practical implication of this is that the income profile and the path of taxes cease to be exogenous and become a consequence of workers' savings decisions. This would not be a problem in the absence of borrowing constraints: workers would take full advantage of the tax benefit, and the resulting shape of the income profile would not have any material consequence, since workers would be able to follow any consumption stream they wanted. In other words, tax incentives would only have a wealth effect. In the presence of credit constraints, however, reallocations of income along the lifecycle can have important welfare effects if they change the extent to which credit constraints are binding. The combination of credit constraints and an endogenous income profile sets up a problem that is difficult to solve in a general way in the context of the Auerbach and Kotlikoff framework. A general solution can be found by modeling a dynamic programming problem as in Cifuentes (2000). Within the Auerbach and Kotlikoff framework, a good approximation to the solution can be found simplifying the space of possibilities available to the worker and selecting the optimal consumption and savings paths by numerical search. The simplifying assumptions are the following:

— Active life (twenty-one to sixty-five years of age) is divided into five periods of nine years each. I assume that the savings rate in voluntary retirement savings mechanisms is constant within each of these periods.
— Saving rates in voluntary retirement savings mechanisms are restricted to values that are multiples of 2.5 percentage points.
— Withdrawals take the form of annuities. This is reasonable considering that the optimal strategy should be similar to this. Withdrawing funds all at once triggers higher marginal tax rates.
— Strategies that consider withdrawal of funds from voluntary retirement savings accounts before retirement are discarded a priori. In a context of perfect certainty about income levels, withdrawing voluntary retirement savings before retirement would make sense only if income in some future period is sufficiently lower than current income such that taxes plus penalty in the future are lower than current marginal taxes. That situation never happens in this exercise given the shape of the income profiles used.

4. Partial Equilibrium Results

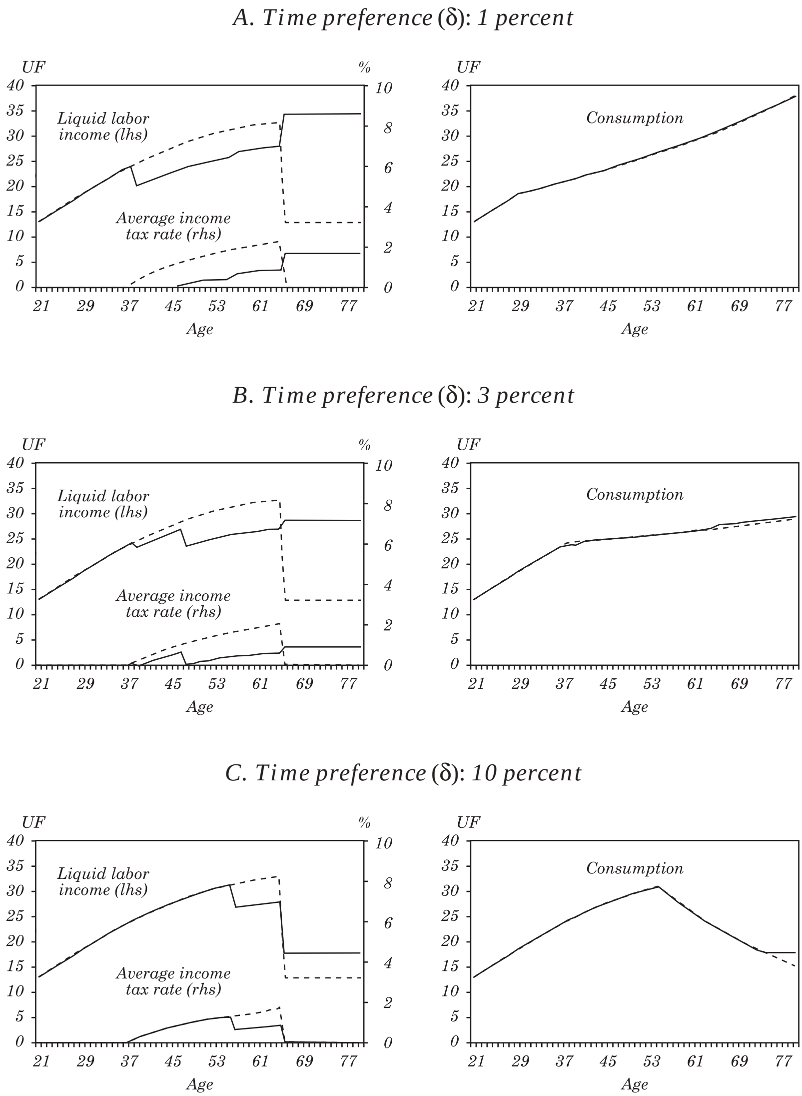
This section explores the optimal use of tax incentives for retirement for different types of agents. Given a tax structure for income taxes, the optimal use of voluntary retirement savings mechanisms is affected by four main factors:

- The shape of the income profile. A steep income profile implies that liquidity constraints are strongly binding in early periods, and the voluntary retirement savings mechanisms are less likely to be used in those periods.
- The presence of a mandatory retirement savings program. This is straightforward: if a portion of income is already being set aside for retirement, with no possibility of early withdrawal of the funds, then workers' desire to reserve more income for the future is reduced, despite the benefits provided through the incentives.
- Time preferences. As mentioned earlier, the presence of liquidity constraints means that the use of the tax advantage is not independent of preferences. A high discount rate lowers the degree to which workers take advantage of voluntary retirement savings mechanisms.
- Income level. Workers' income determines their relative position with regard to income tax brackets. This, in turn, determines the extent to which there is a tax-arbitrage opportunity.

Figure 2 shows the optimal policy with regard to voluntary retirement savings for the case of a worker with a complete high school education and intertemporal preferences (δ) of 1, 3, and 10 percent, respectively. All cases consider a 4 percent real interest rate (net of fees). Dotted lines show the situations without the voluntary retirement savings mechanisms.

In the case of δ = 1 percent (figure 2.A), optimal policy consists of a voluntary savings rate of 17.5 percent between ages of thirty-nine to fifty-six and 15 percent between fifty-seven and sixty-five. The new path for liquid income closely tracks the optimal consumption path. The new consumption path is above the previous in all years starting around the age of forty. The slope of consumption paths is not the same throughout the life cycle because the marginal income tax rate varies along the life cycle, changing the first-order condition for consumption. This is clear in the consumption path without voluntary retirement savings at the retirement age, when the marginal tax rate goes to zero. The consumption path steepens, which is why both

Figure 2. Liquid Labor Income, Consumption, and Average Income Tax Rate Profiles[a]



Source: Author's calculations.

a. The graphs show the case of a worker with complete high school education; the continuous line represents the case whith voluntary retirement savings, and the dotted line, the case without it.

consumption paths intersect at the end of life. The figure also shows the average tax rate, which illustrates how taxes are reduced and a portion of them deferred toward retirement age.

The case of δ = 3 percent shows a lower use of voluntary retirement savings mechanisms vis-à-vis the previous exercise (see figure 2.B). Here optimal rates are 5 percent for ages thirty-nine to forty-seven and 17.5 percent from forty-eight to sixty-five. The consumption path is lower in the new situation between ages thirty-eight and forty, but this sacrifice is compensated with larger consumption at retirement.

Finally, figure 2.C shows the case of a worker with a high intertemporal preference. Optimal policy is to save voluntarily for retirement at a rate of 15 percent between ages fifty-seven and sixty-five. Consumption is reduced between ages of fifty-five and fifty-nine relative to the previous situation, but it then becomes higher between the ages of seventy-five and eighty.

From the cases described above, I infer that the optimal policy consists of taking advantage of tax incentives subject to keeping the original consumption path attainable. This explains, for example, the apparent paradox that the optimal savings rate for ages fifty-seven to sixty-five is higher for the consumer with a higher discount rate when comparing the cases of δ = 1 percent and δ = 3 percent. A higher savings rate at those ages causes the original consumption path to become unfeasible for the agent with δ = 1 percent. This result is not absolute, however, since very small reductions in the consumption path can be tolerated.

Table 3 summarizes the optimal savings policy for the different agents and time preferences. Workers with complete superior education have their highest savings rates earlier in life than workers with complete high school. This is a consequence of the shape of their respective income profiles, which have a hump earlier in life for the former worker than for the latter.

5. General Equilibrium Results: The Steady State

Table 4 presents the impact of voluntary retirement savings mechanisms on the steady state given four different parameterizations. In all cases, the capital stock increases, with a subsequent increase in output and fall in the interest rate. The increase in the capital stock is higher in the cases with lower elasticity of substitution in

Table 3. Optimal Savings Rate in Retirement Accounts with Tax Incentives

Educational attainment and time preference	*Age* 21 to 29	30 to 38	39 to 47	48 to 56	57 to 65
Incomplete primary					
1 percent	0	0	0	0	0
3 percent	0	0	0	0	0
10 percent	0	0	0	0	0
Complete high school					
1 percent	0	0	17.5	17.5	15.0
3 percent	0	0	5.0	17.5	17.5
10 percent	0	0	0	0	15.0
Complete superior					
1 percent	0	15.0	20.0	0	0
3 percent	0	5.0	15.0	5.0	5.0
10 percent	0	0	0	0	5.0

Source: Author's calculations.

production ($\sigma = 0.8$). In this case, capital increases on the order of 4.8 percent, while output increases 1.6 percent. In the higher elasticity case, these figures are 2.7 percent and 0.8 percent, respectively.

In the new steady state, the VAT rate and the level of collection of VAT and income taxes change only slightly. In the case of the income tax, payments have been deferred from active life to retirement. This move will make sense for a worker only if the present value of taxes paid falls, so tax collection in the steady state should be lower. However, labor income rises as a result of the increase in salaries in response to higher capital accumulation. This implies that all income profiles shift upward and are subject to higher marginal tax rates. This is analogous to saying that the average tax rate increases. On the capital income side, the fall in returns is compensated with an increase in the capital stock, leaving the total effect close to null. This is verified by the small change in the relative share of factor income in GDP.

Summing the change in collection rates on the two taxes yields a small reduction. This reflects the fact that the fall in the interest rate implies lower payment for public debt, such that fewer funds need to be collected.

Pension funds (both voluntary and mandatory) grow considerably. Their share of total assets in the steady-state economy jumps from 50 percent to 80 percent. The increase in total capital is on the order of

Table 4. Impact of Tax Incentive Mechanisms for Voluntary Retirement Savings

	$\sigma = 0.8, \alpha = 0.53$			$\sigma = 1.2, \alpha = 0.75$		
Variable	*Without incentives*	*With incentives*	*Change*[a]	*Without incentives*	*With incentives*	*Change*[a]
Productivity growth = 0 percent						
Real interest rate	5.01%	4.69%	–0.32	4.57%	4.45%	–0.12
Gross investment rate	17.7%	18.2%	0.56	17.5%	17.8%	0.32
Capital-output ratio	3.9	4.0	3.1%	3.9	4.0	1.8%
Capital-labor ratio	9.8	10.2	4.8%	6.6	6.8	2.7%
Output-labor ratio	2.5	2.5	1.6%	1.7	1.7	0.8%
Share of labor in GDP	66.6%	66.9%	0.26	68.7%	68.6%	–0.09
VAT rate	22.6%	22.6%	0.01	24.5%	24.7%	0.21
VAT collection / GDP	14.6%	14.5%	–0.12	15.9%	16.0%	0.06
Income tax collection /GDP	3.8%	3.8%	0.06	2.4%	2.3%	–0.08
Pension fund / Total assets	50.3%	81.1%	30.8	47.6%	81.2%	33.6
Pension fund / GDP	207.1%	343.8%	136.7	194.4%	337.3%	142.9
Productivity growth = 1 percent						
Real interest rate	5.51%	5.16%	–0.35	4.97%	4.83%	–0.14
Gross investment rate	20.7%	21.3%	0.66	20.2%	20.6%	0.42
Capital-output ratio	3.7	3.9	3.2%	3.7	3.7	2.1%
Capital-labor ratio	9.1	9.6	4.9%	6.1	6.2	3.0%
Output-labor ratio	2.4	2.5	1.6%	1.7	1.7	0.9%
Share of labor in GDP	66.2%	66.5%	0.27	69.0%	68.9%	–0.10
VAT rate	23.6%	23.6%	0.07	25.4%	25.7%	0.32
VAT collection / GDP	14.6%	14.4%	–0.11	15.8%	15.9%	0.10
Income tax collection /GDP	3.7%	3.8%	0.05	2.4%	2.3%	–0.12
Pension fund / Total assets	49.2%	77.0%	27.8	46.9%	77.7%	30.8
Pension fund / GDP	194.0%	312.9%	119.0	180.9%	305.6%	124.7

Source: Author's calculations.
a. Percentage points or percent change, as indicated.

2–3 percent, so this large increase in pension funds mainly represents a transfer from other types of savings to these with tax advantages.

The impact on the total amount of funds is thus considerable despite the fact that the tax incentive mechanism is only relevant for workers with relatively high incomes. Two caveats must be kept in mind, however, when drawing conclusions from these numbers. First, all the demand for assets in this economy is based on lifecycle motives, whereas in reality, agents hold wealth with other purposes. The effects of changes in lifecycle savings thus tend to be amplified. Second, uncertainty may reduce incentives to voluntarily lock savings until retirement.

6. General Equilibrium Results: The Transition Path

Transition paths reveal key features with regard to the evolution of variables over time that are not possible to determine from steady-state comparisons. This is particularly true when the shocks that generate the transition take the form of changes in the tax regime or other dimensions of fiscal policy. In the particular case studied here, transition analysis is key to verifying that the evolution between steady states is not monotonic.

In addition, OLG models help determine the specific welfare change of the different generations affected by a reform. This is crucial, since policy reforms may look very positive based on a comparison of the steady states, but only the study of the transition will indicate whether there are costs and if so, how they are distributed among different groups.

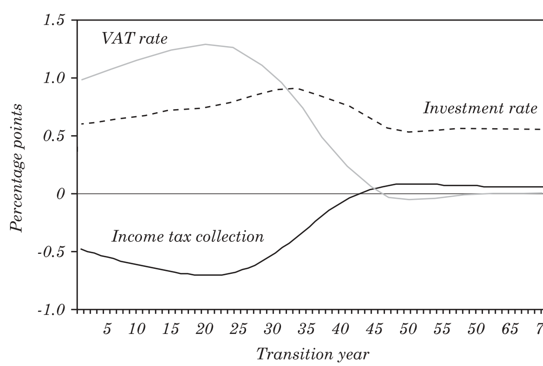
The previous section showed that output is higher in the new steady state and that income tax revenue is similar in the initial and final steady states. Given the nature of the reform, however, income tax should fall during the transition, such that other taxes should rise. Transition analysis provides an indication of the magnitude of the changes, the time it will take the economy to reach the new steady state, and the costs that different generations must bear while this is happening.

The results are summarized in figures 3 and 4. Figures 3 shows the evolution of the macroeconomic equilibrium for each case of elasticity of substitution in production and $x = 0$ percent. This can be summarized by the evolution of income tax collection, which drives the fiscal adjustments, and the evolution of the gross investment rate, which summarizes the accumulation process and thus gives an indication of the evolution of factor prices. The VAT rate is also shown for completeness.

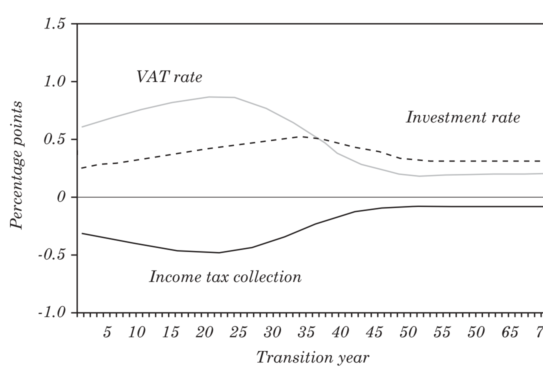
The two graphs have the same scale on the vertical axis to facilitate comparison. Variables are shown as changes from their initial steady-state values. Demand for capital in the case of low elasticity of substitution in production (figure 3.A) is such that the

Figure 3. Change with Respect to Steady-state Values

A. Elasticity of substitution in production (σ): *0.8*



B. Elasticity of substitution in production (σ): *1.2*



Source: Author's calculations.

increase in investment rates is larger than in the high elasticity case (figure 3.B) for all the periods after the shock. This implies that this economy moves to an equilibrium with higher capital and therefore greater output. Income tax collection falls initially (to a greater extent under low elasticity of substitution), but in both cases it recovers to slightly above the initial percentage of GDP in the final steady state. The necessary increase in the VAT rate is larger in the case of low elasticity of substitution, rising above 1 percentage point for 30 years.

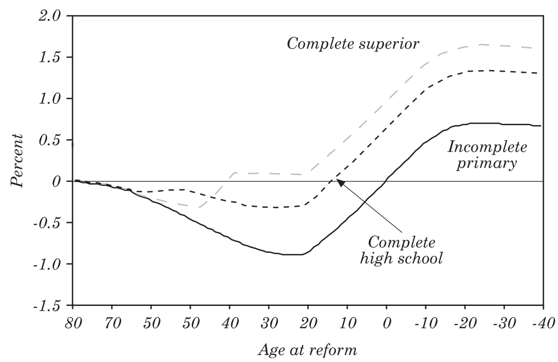
The path of aggregate macroeconomic variables is monotonic, as suggested by the evolution of the investment rate. These are increasing for thirty-two to thirty-four years, and then they decline until they converge to a level above the previous steady state by 0.55 and 0.31 percentage points in the first and second case, respectively. Capital stock, wages, and pension funds grow monotonically between steady states, a transition that takes fifty years.

Figure 4 shows the welfare impact of the reform for each of the transitions studied. Each transition features three types of agent, one for each of the educational levels considered. All three have the same time preference of 3 percent. The welfare impact is driven by two factors. The first is a set of macroeconomic factors, such as the prevailing level of wages, interest rates, and taxes for a given generation. The higher VAT of the initial years of the transition imply lower welfare for the generations that are alive in this period, while the higher wages that result from the increased accumulation of capital raise the welfare of the generations born after the reform. The second factor is the extent to which workers participate in the tax incentive scheme. Workers who are alive in the years of higher VAT may be able to counter this negative effect by exploiting the tax incentive mechanism and increasing their wealth.

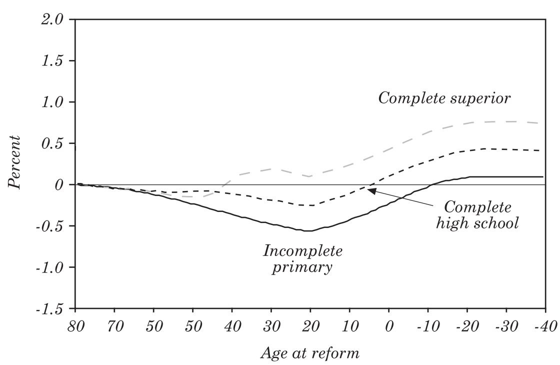
These two factors help explain the welfare impact shown in figure 4. Welfare is measured in terms of equivalent variations, which is the percentage change in lifetime consumption that is equivalent in welfare terms to the impact of the reform. Workers with the higher educational levels always benefit the most from the reform, since they take advantage of the tax incentive mechanism. The welfare differential is constant for generations that were not in the labor force at the time of the reform. For generations that were in the labor force at the time of the reform, the welfare effect depends on the extent to which they use the tax incentive mechanism.

Figure 4. Welfare: Equivalent Variations

A. Elasticity of substitution in production (σ): *0.8*



B. Elasticity of substitution in production (σ): *1.2*



Source: Author's calculations.

Agents with the lowest level of education do not benefit from the tax incentive mechanism, so they do not have any direct means of offsetting the increased VAT. Welfare for this type of agent starts improving when VAT rates start decreasing and capital accumulation drives wages up. In the case depicted in figure 4.A, the welfare of this group starts to improve with the generation that is born exactly in the year of the reform. This generation starts its active life in the twentieth year of the transition. Figure 3.A indicates that VAT rates are at their highest twenty years after the reform and that they remain above the steady-state level for twenty-five more years. However, at the same time wages are higher and increasing for the next twenty-five years, and this evolution compensates that of taxes in welfare terms.

For workers who are over forty-five years of age at the reform, those with complete high school are better off than those with complete superior education. The reason for this can be seen in table 3, which shows that the former type of worker has a higher voluntary retirement savings rate in this age group than the latter. For younger workers (that is, those below forty-seven at the time of the reform), the savings rate is higher for the group with complete superior education than for the group with complete high school, and the welfare ranking is also higher. In fact, university-educated workers younger than forty years of age at the moment of the reform do not suffer any loss of welfare.

7. Conclusions

This paper has shown that tax incentive mechanisms to promote voluntary retirement savings have the potential to increase both savings and output in the long-run equilibrium of the economy. This change stems from a shift in the payment of income taxes from active life to retirement. Thanks to this shift, workers can reduce the total amount of taxes paid by reallocating income from periods in which marginal tax rates are high to periods in which they are low. This raises the capital accumulation in the economy. The increase in capital prevails in the new equilibrium, while tax collection returns to its original composition.

The increase in capital, however, has not come without a cost. The delay in tax payments implies that other taxes will have to be raised during a transition period. The paper shows how this burden is distributed among groups with different income levels. The impact is regressive, in that the lower income groups are the most affected because they have to suffer the tax increase without being able to exploit the new benefits of the system. In the long run, future generations of all income levels benefit, but the groups with the highest income levels benefit the most.

The impact on capital accumulation described in the paper is high. This is a consequence of assumptions and features of the model that need to be addressed. An important assumption, for example, is that all workers participate in the system. An alternative exploration of the issue should incorporate independent and informal workers into the model, which was beyond the scope of this paper.

Another important element that should be explored is the impact of uncertainty. In the model, agents can perfectly anticipate the tax payments generated by different paths of savings and withdrawals, and they optimize accordingly. Uncertainty makes this less clear. If the realization of an adverse shock makes it necessary for workers to access the funds in their voluntary retirement savings accounts before retirement, they will have to pay a penalty. The tax saved on making deposits will have to be higher than the expected penalty for early withdrawal if voluntary retirement savings are to continue to be attractive. This implies that voluntary retirement savings will be lower than in the certainty case. Exploring this issue will be highly informative for assessing the optimal conditions of access to funds before retirement.

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