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TAX INCENTIVES FOR RETIREMENT SAVINGS: MACRO AND WELFARE EFFECTS IN AN OLG-GE MODEL WITH LIQUIDITY CONSTRAINTS AND HETEROGENEOUS CONSUMERS

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Resumen

Mediante un modelo de equilibrio general y generaciones traslapadas se estudia el impacto de la introducción de incentivos tributarios al ahorro voluntario para el retiro en Chile. Este artículo analiza el impacto macroeconómico de esta reforma, el que depende de sus efectos sobre el ahorro y la acumulación de capital, y su impacto sobre bienestar. Se considera un escenario con consumidores heterogéneos, donde los agentes difieren en su nivel de ingresos y, por tanto, en la importancia que tienen para ellos los incentivos tributarios. Se analizan tanto los efectos en el estado estacionario final como en la transición hacia él. La heterogeneidad del modelo permite develar importantes efectos redistributivos de la reforma, en particular durante la transición hacia el nuevo estado estacionario.

Abstract

This paper uses an Overlapping Generations-General Equilibrium model to study the impact of the introduction of tax incentives to voluntary savings for retirement in Chile. The paper analyzes the macro impact of the reform, driven mainly by its effect on savings and capital accumulation, and its effect on welfare. A setting with heterogeneous consumers is considered where agents differ in their income levels, and therefore on the relevance that tax-incentives have for them. Both the transition and the final steady state are analyzed. The heterogeneity modeled allows unveiling important distributive effects of the reform, in particular during the transition to the new steady state.

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Introduction

The Overlapping Generations-General Equilibrium (OLG-GE) framework constitutes an important tool for policy evaluation. One of its strengths is that it considers that in any given moment the population is composed of workers of different age and, therefore, different time horizons. This has two advantages. The first is that, by assuming a realistic distribution of time-horizons and budget constraints among the population, the evolution of the equilibrium path of the economy given a certain policy can be modeled in a realistic way. The second is that by having modeled the different generations with detail, meaningful welfare comparisons across generations can be made. This makes them attractive for policy evaluation given that it is possible to determine compensatory policies that can be crucial in order to make a certain policy feasible.

This paper uses an OLG-GE model to assess the impact of the recently approved tax-incentive mechanisms for savings for retirement in Chile. The purpose is to determine the incentives that different workers have to make use of such incentives, the aggregate impact in steady state, the transition path of the economy to the new steady state, and the welfare implications of the reform.

The OLG-GE framework is particularly attractive to study this reform because there are several "transitions" that are triggered by it. One is the transition in individual savings decisions. The fact that workers are at different stages in their life-cycle imply that the final aggregate impact on capital accumulation will arise only when all generations alive have faced the similar conditions during their working lives. More interestingly, there is an important fiscal transition. Taxes are deferred, which means that part of those taxes that the government is failing to receive today will be received at a later date. This implies that for a while, the public sector will have to make an adjustment of some form. Therefore, there is a second shock that generates a transition, which is the transitory fiscal policy that the public sector pursues until income tax collection returns to a stationary level.

The model used in this paper incorporates two important improvements with regards to previous versions, which are crucial for the problem at hand. The first is that it models an income tax structure with increasing marginal rates. Solving the consumption and savings problem in this context provide new insights with regards to the impact of income taxes on savings that make it an improvement worth on its own. Moreover, it is crucial for the model to provide a realistic prediction of the impact of tax incentives on savings behavior. The second is the modeling of a population with heterogeneity in income levels. This provides the necessary environment for welfare evaluation, since the ability to benefit from the policy under study varies with the income level.

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

I. The tax-incentive mechanisms for voluntary savings for retirement (VSR)

The tax-incentive mechanism for VSR basically allows deducing from the income tax base voluntary savings made into special accounts. These accounts can be accessed at retirement, when the withdrawals are subject to the income tax. Withdrawals should take the form of monthly pension payments. Pension payments are determined via the phased withdrawal rules that apply to normal pensions, which try to secure a pension which is as close to constant during retirement life as possible; or they come from annuities. In addition, a certain amount can be withdrawn free of taxes in lump-sum payments, provided that the monthly pension is above a certain level.

An incentive scheme like this has been in place since the start of the current pension system in Chile in 1981. The recent reform introduced in March 2002 introduced the following changes to the scheme:

1. Maximum monthly voluntary contributions were raised from 48 UF to 50 UF a month (or 27.4 UTM to 28.5 UTM).
2. Tax-free withdrawals after retirement were limited to 1,200 UTM. Before March 2002 they had no limit.
3. Withdrawals before retirement are allowed subject to a penalty.
4. The type of institutions allowed to provide the service is expanded to include banks and insurance companies.
5. Providers are allowed to charge a fee.

The penalty for accessing funds before retirement is a rate of 3% plus the 1/10 of the marginal income tax rate that corresponds to the income level of the worker. Therefore, the penalty varies between a minimum of 3% and a maximum of 7.3%.

Taken at face value, it may be thought that the effect of the legal changes over the amount of voluntary savings is ambiguous. Changes 2 and 5 have a direct adverse pecuniary effect and tend to make VSR less attractive. On the other hand, 1 and 3 make the instrument more attractive, but 1 is a small change and 3 does not generate a direct pecuniary effect.

However, the crucial point of the legal change is number 4, the fact that competition for VSR is open to new players. This implies that there will be a large marketing effort to make workers participate in the system. Recent findings argue that long-term savings are highly sensitive to framing and arrangements that reduce transaction costs (Choi *et al*, 2001). Marketing efforts should help to place saving for retirement in the "path of least resistance", making existing programs more widely used.

II. The Model

The base model is the OLG-GE model with credit constraints of Cifuentes and Valdés-Prieto (1997). This, 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 of extreme importance for the case under study in this paper. If liquidity constraints were not present all the tax incentive would be taken advantage of, without considering preferences for consumption. Consumption would be maximized independently taking only total wealth as the input. Liquidity constraints prevent this, and the extent to which the tax advantage is used depends on the income profile as well as on time preference.

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

Households accumulate savings that are offered to the production sector (firms) as capital and to the government as demand for bonds. This means that households own all the factors in the economy, and, in particular, that capital is owned homogeneously among households of similar characteristics. Firms demand factors with a profit-maximizing objective. Government, in turn, has expenditure to finance via taxes and public debt issuances. There is no uncertainty of any sort in the model, and agents are assumed to have perfect foresight. In what follows we present the model formally and with more detail.

1. Households

Households are assumed to have an economically active life of 60 years, which represents a worker that starts working at age 21 and dies with certainty at age 80. Workers offers labor in the market between ages 21 and 65, and are retired from ages 66 to 80. The supply of labor by each age is typically increasing or presents a hump-shape, due to the effects that experience has on productivity for different types of workers. The section on calibration shows the particular profiles for labor productivity used in this paper.

Taking factor prices and labor endowment as given, each type of household maximizes a CIES (CRRA) utility function in order to find the optimal path of consumption and savings. Formally:

$$MaxU = \frac{1}{1-1/g} \sum_{a=a_1}^{80} (1+d)^{-(a-a_1)} c_a^{e\,1-1/g} \tag{2.1}$$

subject to:

$$F^e_{a,t} = (w_t l^e_a (1-t^{ss}_t) + r_t F^e_{a-1,t-1} + p^e_{a,t})(1-t^{y}_t) + F^e_{a-1,t-1} - c^e_a (1+t^{c}_t) \qquad for\ a = a_1, K\ ,80 \tag{2.2}$$

$$F_{a,t} \geq 0 \qquad \forall a \in \{21, K\ ,80\} \tag{2.3}$$

$$F^e_{20,t} = 0 \qquad \forall e, t \tag{2.4}$$

where

$$p^e_{a,t} = p^e_{t-a} = \begin{cases} 0 & for\ a = 21,\ldots,65 \\ \dfrac{\sum_{i=21}^{65} w_{t-a+1} l^e_{i,t-a+1} t^{ss}_{t-a+1} \prod_{j=i+1}^{65}(1+r_j)}{\sum_{i=1}^{15}(1+r_{t+i-1})^{-i}} & for\ a = 66,\ldots,80 \end{cases} , \qquad (2.5)$$

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

Equation (2.2) is the budget constraint in flow terms. $F^e_{a,t}$ indicates the stock of financial assets at the end of period t, $l^e_{a,t}$ is the labor supply, w_t is the wage rate at year t, c^e_a is net consumption, t^y and t^c are income and VAT tax rates respectively, t^{ss} is the contribution rate to social security, and $p^e_{a,t}$ is the pension benefit. As indicated in (2.5), pension is assumed to be a constant during retirement therefore $p^e_{a,t}=p^e_{t-a}$, which means that it does not depend on age, but on the cohort that the worker belongs to.

Equation (2.3) imposes credit constraints by requiring that financial assets can not be negative. Equation (2.4) indicates that workers do not own assets at the beginning of their working life.

Choices of consumption and saving plans for the whole life are time consistent. This means that if maximization were to be revised later in life, the consumer would chose to stick to the original plan. This implies that optimization has to be done only once per worker, with a_1=21. However, when there are unanticipated changes in the evolution of the environment that the worker faces, optimization may deliver a different plan. In this case all agents have to re-optimize at the moment of the reform. In this case, optimization can consider assets different than zero to start with.

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

It is useful also to define the evolution of mandatory retirement assets A, as:

$$A^e_{a,t} = w_t l^e_{a,t} t^{ss}_t + (1+r_t) A^e_{a-1,t-1} - p^e_{a,t} \qquad for\ a = 21,\ldots,80 \qquad (2.6)$$

$$A^e_{20,t} = 0 \qquad \forall e,t \qquad (2.7)$$

2. Aggregation

In order to move from individual data to aggregate macro variables we have to sum across all individuals alive at a given time t. This implies to sum across individuals of different ages and different educational levels. We assume that population grows at an annual rate of n%. Aggregate supply of capital in year t will be:

$$K_t^S = \sum_{e=1}^{3}\left[\sum_{a=21}^{80} F_{a,t}^{e}\cdot(1+n)^{-a} + \sum_{a=21}^{80} A_{a,t}^{e}\cdot(1+n)^{-a}\right] \qquad (2.8)$$

In equilibrium, capital supply should equal capital demand by the production 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 at a given year:

$$L_t = L_t^S = \sum_{e=1}^{3}\left[\sum_{a=21}^{80} l_{a,t}^{e}\cdot(1+n)^{-a}\right] \qquad (2.9)$$

In contrast with capital, labor supply is fixed so factor prices will adjust in order that all of it is demanded. The assumption implicit about productivity growth is that each generation is born with a profile of labor endowments which is x% higher than the previous generation for every age. This is a specific way to introduce productivity growth, in that it benefits only new generations that join the labor market. In terms of the notation introduced:

$$\frac{l_{a,t+1}^{e}}{l_{a,t}^{e}} = (1+x) \qquad \forall a,e,t \qquad (2.10)$$

3. Firms

Firms use a CES technology to produce. They maximize profits taking factor prices as given as described in the following expression:

$$Max\Pi = \left[aL^{(s-1)/s} + (1-a)K^{(s-1)/s}\right]^{s/(s-1)} - fK - rK - wL \qquad (2.11)$$

where subscripts t have been dropped from the expression for simplicity since all variables are referred to the same time t, s represents the elasticity of substitution in production and f is the rate of depreciation. First order conditions of maximization imply that factors are hired until price equals marginal productivity:

$$\frac{\partial Y}{\partial K} = r + f; \quad \frac{\partial Y}{\partial L} = w \qquad (2.12)$$

From the first-order conditions, factor demands can be obtained:

$$L^D = w^{-s} a^s Y^{s/s-1} \tag{2.13}$$

$$K^D = (r+f)^{-s} (1-a)^s Y^{s/s-1} \tag{2.14}$$

4. Government

Government has an exogenously given expenditure that needs to be financed. This can be done by issuing debt or imposing taxes. By definition, the balanced budget implies:

$$G_t + r_t B_t = T_t + B_{t+1} - B_t \tag{2.15}$$

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

$$T_t = (w_t L_t + r_t F_t + p_t) t_t^y + c_t t_t^c \tag{2.16}$$

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

$$z_t = \sum_{e=1}^{3} \left[\sum_{a=21}^{80} z_{a,t}^{e} \cdot (1+n)^{-a} \right] \tag{2.17}$$

Non-ponzi game condition implies that present value of taxes should equal present value of expenditure plus the initial stock of debt. This condition implies that rate of growth of debt can not 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 exante by rules and that VAT tax 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 Non-ponzi game condition is always satisfied. Income tax schedule follows a rule that will be described in the next section.

5. Equilibrium

Equilibrium is found using a Gauss-Siedel algorithm. This starts by guessing an initial path for the level of the aggregate stock of capital ($K^D{}_t$). Given that the path for labor (L_t) is known and fixed, paths for factor prices (r and w) consistent with the guess can be derived using equations (2.13) and (2.14). A path for the parameter that balances the fiscal budget is also guessed. Given these paths, households decide consumption and savings. Individual variables are aggregated in order to determine capital supply and the level of the variable that adjusts the public sector finances. The equilibrium delivers new values for the guessed variables. If these new values are the same as the initial guess, then an equilibrium has been found. Typically this will not be the case in the first rounds. When magnitudes differ, a new guess is used to simulate the model, typically a path between the previous guess and the previous outcome of the model. A solution is found after a few iterations. In formal terms, the equilibrium condition we are looking for is:

$$K_t^D + B_t = K_t^S \qquad \forall t \tag{2.18}$$

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

In the case of a transition the algorithm is the same with the only difference that it is assumed that convergence is reached at a maximum after 180 years after the reform that originated the transition is introduced. This is done by assuming that all relevant prices in the economy are fixed from that year on at the value they reach that year. Usually this assumption is not binding, since the economy typically converges in shorter spans of time.

III. Parameters

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

1. Tax scheme

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

Table 1: Income Tax Rates in Chile, 2002

Income Range	Marginal Tax Rate
In UTMs per month	%
0 - 13.5	0
13.5 - 30	5
30 - 50	10
50 - 70	15
70 - 90	25
90 - 120	33
120 - 150	39
150 - +	43

Incorporating this tax-scheme has two implications with regards to the model. The first is that the government budget is adjusted via the consumption or value-added tax (VAT). Adjusting marginal income tax rates will introduce noise with regards to our object of study. In effect, our object of study is precisely the fact that marginal income tax rates can be changed through saving for retirement. If we allow the tax scheme to change over time in order to adjust the government budget we will not be able to measure the additional savings generated by the tax incentive.

A second implication is more troublesome. In a context were there is productivity growth, keeping the income tax scheme of table 1 constant over time implies that the economy will only reach a stationary equilibrium when all the population is in the higher income bracket. This implies that a model economy will be in a very long transition until this happens.

Such a simulation is feasible, although highly intensive in computational capacity. But the main question is whether it is a meaningful exercise. In such a transition path, distortions increase over time as the median marginal income tax rate increase (and the VAT-or other taxes-rate decreases if we want to keep the size of the government constant). Income tax becomes the main source of revenue for the government.

That context clearly does not provide us with a reasonable scenario for policy evaluation. It is not reasonable to assume that the agents in the economy will allow the level of distortions to follow whatever path the dynamics of growth would determine. A more reasonable scenario is to assume that a decision has been made about the level of distortions that agents in the economy find optimal, and that that level of distortions is going to be kept constant, except for the consequences of a specific tax reform that is going to be studied.

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

2. Income profiles

Recent studies on the effects of age on income include Larrañaga and Paredes (LP) (1999) and Butelmann and Gallego (BG) (2001). The first 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*, i.e. represents the income profile faced by an individual or cohort throughout their lifetime. BG, in turn, report *cross-section* age-income profiles. In principle, *longitudinal* profiles can be derived from *cross-section* ones by making assumptions about the evolution of productivity growth between generations. However, it is not possible to derive reasonable longitudinal profiles from BG data using reasonable assumptions of productivity growth. This may be due to the fact that year effects are affecting their estimates.

However, BG report profiles for different levels of educational attainment, while LP derive only one representing the population average. Assuming that year effects do not affect substantially the relative differences in income across workers with different educational attainment, I can use BG profiles to derive income profiles by educational attainment from LP. I determine this by imposing that at every age income levels for the three income categories have to keep the relative distances of BG, while averaging the level of LP. Weights are reported in BG.

Figure 1 shows the income profile so derived. A first fact that is important to highlight is that 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 they do not obtain any benefit from it and they can be bothered by the lower liquid income at working ages.

Population shares of different groups by educational attainment are: primary incomplete 53,2%, complete high school 25,2%, and complete superior 21,6%.

3. Other parameters

Table 2 show the value used in the simulations of the other variables of the model.

Table 2: Simulation Parameters

Variable	Value
Public Debt over GPD	19.6 %
Public Expenditure over GPD	17.6 %
Contribution rate to mandatory PF	5 %
Production Function (CES)	
Sigma	0.8 and 1.2
Alfa	0.53 and 0.75
Preferences	
Time Preference	1%, 3% and 10%
Intertemporal Elast. of Substitution	0.9
Rate of Growth of Population	1 %

Data on public debt and public expenditure are averages for Chile 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 the model captures is the crowding-out effect on investment that public debt has, and this effect occurs independently of who is the issuer.

With regards to public expenditure, what is relevant from the point of view of the model is the part of it financed with taxes. This gives us the measure of the impact of the government on the budget constraints of private economic agents. In this way, public expenditures financed by means other than taxes (return from assets, assets sales, public companies income) should be treated as part of the private economy in this model.

The mandatory contribution to pension funds is assumed at a level of 5%. Despite the fact that the mandatory level in Chile is 10%, it should be noted that this model assumes a worker that starts working at the age of 21 and contributes continuously until he/she is 65. Under those circumstances the amount accumulated in the personal account is usually very large. This is due to the fact the model does not consider more realistic features of histories of contributions such as periods of unemployment, independent work, or out of the labor force for different reasons. Is not the purpose of the model to incorporate all these features, while their relevant impact on life-time budget constraints can be fully captured via a lower contribution rate.[1]

Parameters of the production function are chosen within a reasonable range in order to generate a reasonable macroeconomic environment. Parameter 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 chosen so as to generate a share of labor on GDP between 66% and 68%, a reasonable value for the Chilean economy. Finally, among the combinations of sigma and alpha that match this requirement, we pick those that generate a real interest rate around 5%, a reasonable benchmark for returns to long-term savings.

4. Simulation Strategy

Tax incentives affect the maximization problem of the consumer in several ways. First there is a potential wealth increase 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 are not exogenous anymore but become a consequence of the savings decisions of workers. In the absence of borrowing constraints this would not be a problem. Workers would take full advantage of the tax benefit and the resulting shape of the income profile would not have any material consequence, since they would be able to follow any consumption stream they want. In other words, tax incentives would only have a wealth effect.

But in the presence of credit constraints, reallocations of income along the lifecycle can have important welfare effects if they change the extent at which credit constraints are binding. The combination of credit constraints and an endogenous income profile conform 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).

[1] Moreover, workers via early retirement can avoid the accumulation of large balances in individual accounts. This can be easily included in the model.

However, we can find a good approximation to the solution within the Auerbach and Kotlikoff framework by 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:

1. Active life (21 to 65 years of age) is divided into 5 periods of 9 years each. I assume that the savings rate in VSR mechanisms has to be constant within each of these periods.
2. Saving rates in VSR mechanisms are restricted to take values multiples of 2.5 percentage points only.
3. Withdrawals take the form of annuities. This is reasonable if we consider 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 VSR accounts before retirement are discarded a priori. In a context of perfect certainty about income levels as here, saving in VSR to withdraw before retirement would make sense only if in some period ahead income is below the current by an amount such that taxes plus penalty in the future are lower than current marginal taxes. Given the income profiles used in this exercise that situation never happens.

IV. Partial equilibrium results

In this section I explore the optimal use of tax incentives for retirement for different types of agents. Given a tax structure for income taxes, we will see that the optimal use of VSR mechanisms, is affected by:

- The shape of the income profile. The steeper it is, the more binding liquidity constraints are in early periods, therefore the less likely VSR mechanisms are to be used in those periods.
- The presence of mandatory savings for retirement program. This is straightforward: the more income is already being left for retirement, and with no possibility of anticipating its consumption, the less the desire to leave more income for the future, despite the beneficial conditions in which this can be done.
- Time preferences. As mentioned earlier, the presence of liquidity constraints determine that the use of the tax advantage is not independent of preferences. Higher discount rate implies a less extensive use of VSR mechanisms.
- Income level. This determines the relative position with regards to income-tax brackets. This, in turn, determines the extent to which there is a tax-arbitrage opportunity.

Figures 2 to 4 show the optimal policy with regards to VSR for the case of a worker with complete high school and intertemporal preferences (d) of 1%, 3% and 10% respectively. All cases consider a 4% real interest rate (net of fees). Dotted lines show the situations without VSR mechanisms.

In the case of d =1%, optimal policy consists of a voluntary savings rate of 17,5% between ages 39 to 56, and 15% between 57 and 65. The new path for liquid income tracks closely the optimal consumption path. The new consumption path is above the previous in all years starting around the age of 40. It is interesting to note that the slope of consumption paths is not the same in the whole life cycle. This is due to the fact that 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 VSR at the retirement age, were marginal tax rate goes to zero. Consumption path turns steeper, and this is why both consumption paths intersect at the end of life. The figure also shows the average tax rate. We can see how taxes are reduced and part of it deferred towards retirement age.

The case of d =3% shows a lower level of use of VSR mechanisms. Here optimal rates are 5% for ages from 39 to 47, and 17.5% from 48 to 65. Consumption path is lower in the new situation between ages 38 to 40, but this sacrifice is compensated with larger consumption at retirement.

Finally, figure 4 shows the case of a worker with high rate of intertemporal preference. Optimal policy is to save voluntarily for retirement a rate of 15% between ages 57 and 65. Consumption is reduced between ages 55 to 59 with respect to the previous situation, but then is higher between ages 75 to 80.

From the cases described we can 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 57 to 65 is higher for the consumer with higher discount rate when comparing the cases d =1% versus d =3%. The explanation is that with a higher savings rate at those ages, the original consumption path becomes unfeasible for the agent with d =1%. However, this result is not absolute, as we saw that very small reductions in the consumption path can be tolerated.

Table 3 summarizes the optimal savings policy for the different type of agents and time preferences. It is interesting to note that in the case of the worker with complete superior education, higher saving rates occur earlier in life than in the case of the worker with complete high school. This is a consequence of the shape of the income profile of the former, which has a hump earlier in life than the latter.

Table 3: Optimal savings rate in retirement accounts with tax incentives

Educational Attainment	Time Preferences	Age				
		21 to 29	30 to 38	39 to 47	48 to 56	57 to 65
Primary Incomplete	1%	0	0	0	0	0
	3%	0	0	0	0	0
	10%	0	0	0	0	0
Complete High School	1%	0	0	17.5	17.5	15
	3%	0	0	5	17.5	17.5
	10%	0	0	0	0	15
Complete Superior	1%	0	15	20	0	0
	3%	0	5	15	5	5
	10%	0	0	0	0	5

V. General Equilibrium Results I: The Steady State

Table 4 presents the impact of VSR mechanisms when comparing steady states. The table presents four cases with different parameterizations. In all cases the stock of capital increases, with the subsequent increase in output and fall of the interest rate. The increase in the capital stock is higher in the cases with the lower elasticity of substitution in production (sigma = 0.8). In this case, capital increases in the order of 4.8%, while output increases in 1.6%. In the higher elasticity case these figures are 2.7% and 0.8% respectively.

It is interesting to note that in the new steady state, both the level of VAT and the collection from both taxes have changed 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 fall; therefore tax collection in steady state should be lower. However, labor income has increased due to the increase in salaries in response to higher capital accumulation. This implies that all income profiles are shifted upward, meaning that they are subject to higher marginal tax rates. This is analogous to say that the average tax rate has increased. On the capital income side, the fall in returns is compensated with an increase in capital stock, leaving the total effect close to null. This can be verified by the small change in the relative shares of factor income on GDP.

Adding collection from both taxes a small reduction can be verified. This comes from the fact that the fall in the interest rate implies lower payment for public debt and hence a less funds that need to be collected.

Funds managed by pension funds (both voluntary and mandatory) grow by a considerable magnitude. Their share of total assets of an economy in steady state jumps from 50% to 80%. The increase in total capital is in the order of 2%-3%, so this large increase in pension funds is mainly a transfer from other types of savings to these with tax advantages.

This shows that despite the fact that the tax-incentive mechanism is relevant for the workers with higher incomes only, the impact on the total amount of funds is considerable. Although illustrative, there are several caveats that have to be kept in mind when drawing conclusions from these numbers. First, all the demand for assets in this economy comes from lifecycle motives. In reality, agents hold wealth with other purposes. Therefore the effects of changes to lifecycle savings tend to be amplified. Second, and perhaps more important, uncertainty may reduce incentives to voluntarily lock savings until retirement.

Table 4: Impact of Tax-incentive mechanisms for voluntary savings for retirement

	Sigma = 0.8, Alpha = 0.53			*Sigma = 1.2, Alpha = 0.75*		
	Without VSR	With VSR	Change*	Without VSR	With VSR	Change*
Productivity Growth = 0%						
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
K/Y ratio	3,9	4,0	3,1%	3,9	4,0	1,8%
K/L ratio	9,8	10,2	4,8%	6,6	6,8	2,7%
Y/L ratio	2,5	2,5	1,6%	1,7	1,7	0,8%
Share of Labor of 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%						
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
K/Y ratio	3,7	3,9	3,2%	3,7	3,7	2,1%
K/L ratio	9,1	9,6	4,9%	6,1	6,2	3,0%
Y/L ratio	2,4	2,5	1,6%	1,7	1,7	0,9%
Share of Labor of 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

*: Percentage points or percentage change as indicated

VI. General Equilibrium Results II: The Transition Path

Transition paths reveal key features with regards 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 verify that the evolution between steady states is not monotonic.

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

The previous section showed that in the new steady state output is higher and that income tax revenue is similar in the initial and final steady states. But from the nature of the reform we know that income tax falls during the transition and therefore other taxes should rise. However, so far we have no sense of the magnitude or the extent of time during which these tax changes occur. Transition analysis will allow us to know how long does it take for the economy for reach the new steady state and the costs that different generations have to bear while this is happening.

Results are summarized in figures 5 to 8. Figures 5 and 6 show the evolution of the macro equilibrium for each case of elasticity of substitution in production and x=0%. 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 therefore give us a hint of the evolution of factor prices. The VAT rate is shown for completeness.

Both figures have the same scale in the vertical axis to facilitate comparison. Variables are shown as changes from their initial steady states values. Demand for capital in the case of low elasticity of substitution is such that investment rates increase by a larger amount than in the high elasticity case, for all the periods after the shock. This implies that this economy moves to an equilibrium with higher capital and therefore output. Income tax collection falls initially by a larger amount, but then it recovers in such a way that collection in the final steady state is slightly above the initial as percentage of GDP. The necessary increase in the VAT rate is larger in the case of low elasticity of substitution in production, above 1 percentage point for 30 years.

The path of aggregate macro variables is monotonic, as hinted by the evolution of the investment rate. These are increasing for 32-34 years. Then they start declining 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 50 years.

Figures 7 and 8 show the welfare impact of the reform for each of the transitions studied. In each transition, three types of agents exist, one for each of the educational levels considered. All of them have the same time preference, 3%. The welfare impact will be driven by two factors. One set of factors are the macro ones, i.e. the level of wages, interest rates and taxes that prevailed at the moment a certain generation was alive. The higher taxes of the initial years of the transition would certainly imply lower welfare of the generations that were alive in this period. Higher wages that result from the increased accumulation of capital increase welfare for the generations that are born after the reform.

The second factor is the extent to which workers participate in the tax incentive scheme. Workers that 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 us explain the welfare impact shown in figures 7 and 8. Welfare is measured in terms of equivalent variations, which is the percentage change in lifetime consumption that is equivalent in welfare terms to the reform. Workers with the higher educational levels are always the most benefited from the reform, since they take advantage from the tax incentive mechanism. For the generations that were not in the labor force at the time of the reform, the welfare differential is constant. For the generations that were in the labor force at the reform, the welfare effect will depend on the extent at which they used the tax incentive mechanism.

Agents with the lower level of education do not get any benefit from the tax incentive mechanism, so they are they do not have any direct means to compensate the increase in 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 7, the generation that marks the limit between those that lose from those that start improving welfare due to the reform is the one that is born exactly in the year of the reform. Notice that this generation will start its active life in year 20 of the transition. From figure 5 we see that VAT rates are at their highest and that they still have 25 more years to be above the original steady state level. However, at the same time wages are higher and increasing for the next 25 years, and this evolution compensates in welfare terms that of taxes.

For the generations that are older than 45 years of age at the reform, workers with complete high school are less worse off than those with complete superior education. The reason for this can be seen in table 3, which shows that the first type of workers make a more intense use of VSR than the latter. For the generations where this is reversed, i.e. those below 47 at reform, the welfare ranking is also reversed. In fact, workers younger than 40 years of age at reform do not suffer any loss of welfare.

VI. Conclusions

This paper has shown that tax-incentive mechanisms for voluntary savings for retirement have the potential of increasing savings and output in the long run equilibrium of the economy. This change comes from a shift on 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 where marginal tax rates are high to periods where they are low. When doing this arbitrage, capital accumulation in the economy increase. It is interesting to note that this increase in capital prevails in the new equilibrium while the composition of tax collection comes back to the original one.

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 is this burden distributed among groups with different income levels. The impact is regressive, in that the lower income groups are those who suffer the most, as long as they have suffer the tax increase without being able to exploit the benefits of the system. In the long run, future generations of all income levels will benefit, with the groups with the highest income levels benefiting 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 can be discussed. An important assumption is that it is assumed that all workers participate in the system. An alternative exploration of the issue may incorporate independent and informal workers into the model. That was beyond the scope of this paper.

Another important element that should be explored is the impact of uncertainty. In the model of this paper it does not exist, then agents can perfectly anticipate the tax payments that different paths for savings and withdrawals would imply, and optimize accordingly. In the case of uncertainty this is less clear. If the realization of a bad shock implies that funds in VSR accounts have to be accessed before retirement, a penalty will have to be paid. The tax saved when deposits where made will have to be higher than the expected penalty to be paid in a context of uncertainty for saving into VSR to be attractive. This implies that savings into VSR will be lower than in the certainty case. Exploring this case will be highly informative in order to assess the optimality of the conditions of access to funds before retirement.

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Figure 1

Income Profiles by level of Educational Attainment

Monthly Income, 2001

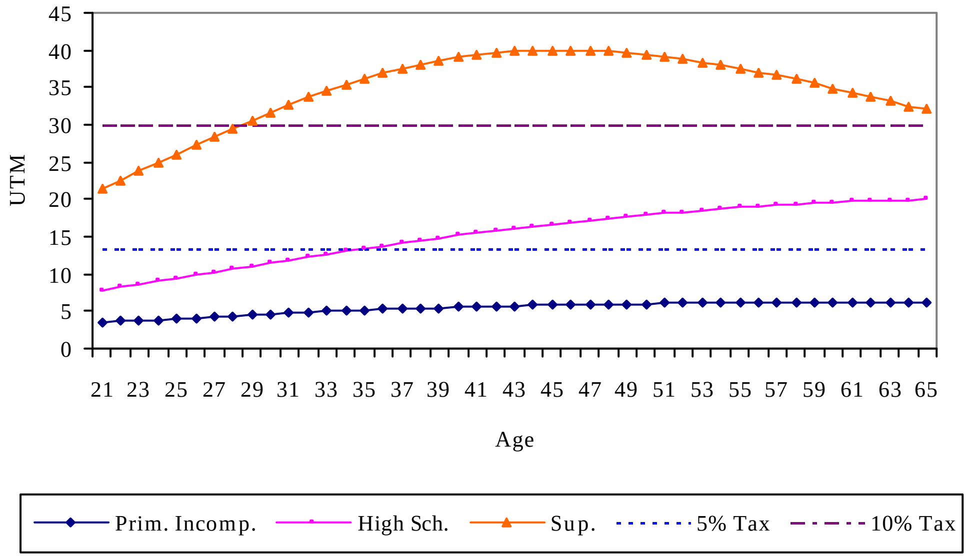


Figure 2

Liquid Labor Income, Consumption and Average Income Tax rate Profiles

Complete High School, 1% time preference (Continuous line: Case with VSR)

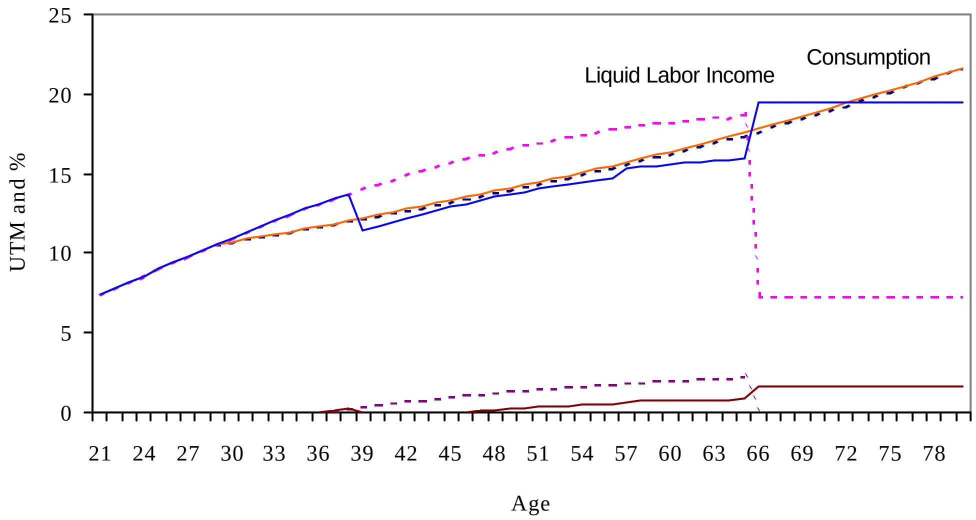


Figure 3

Liquid Labor Income, Consumption and Average Income Tax rate Profiles

Complete High School, 3% time preference (Continuous line: Case with VSR)

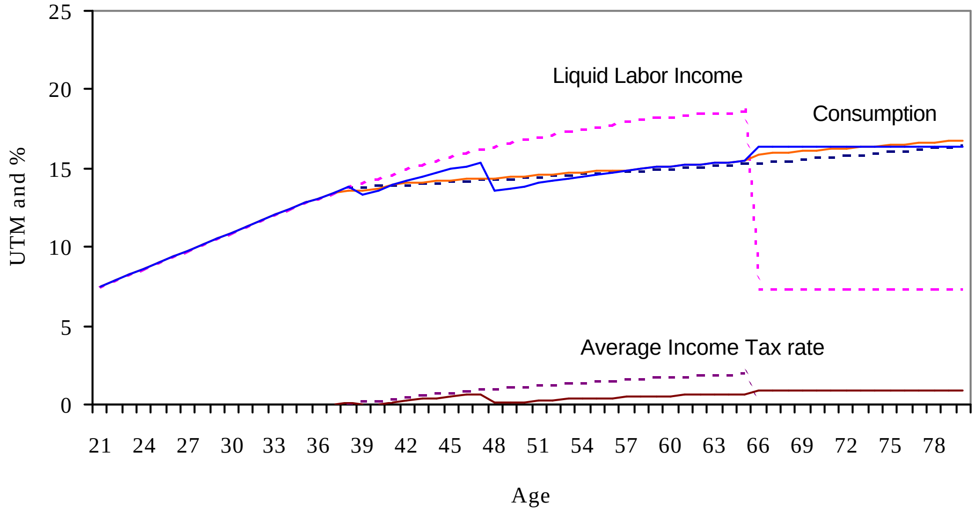


Figure 4

Liquid Labor Income, Consumption and Average Income Tax rate Profiles

Complete High School, 10% time preference (Continuous line: Case with VSR)

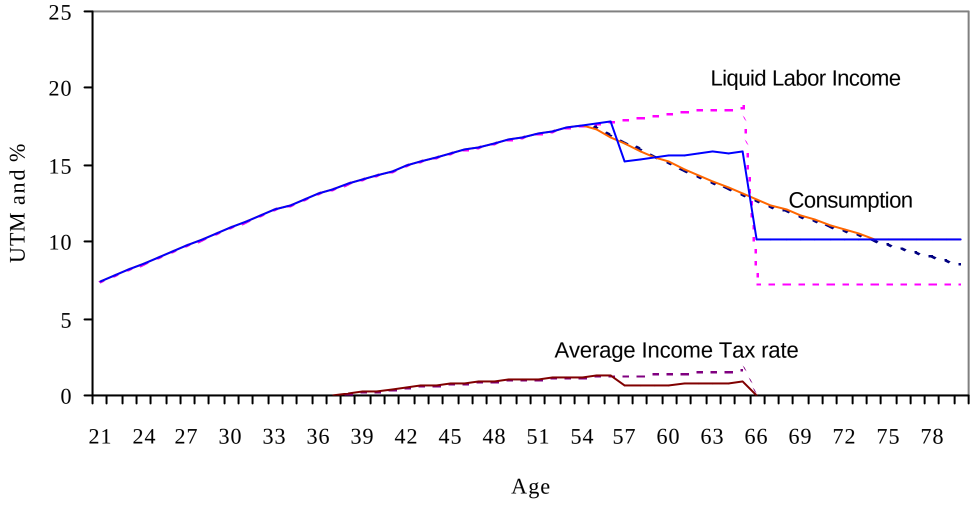


Figure 5

Change with respect to Steady State values

Case Elasticity of Substitution in production = 0.8

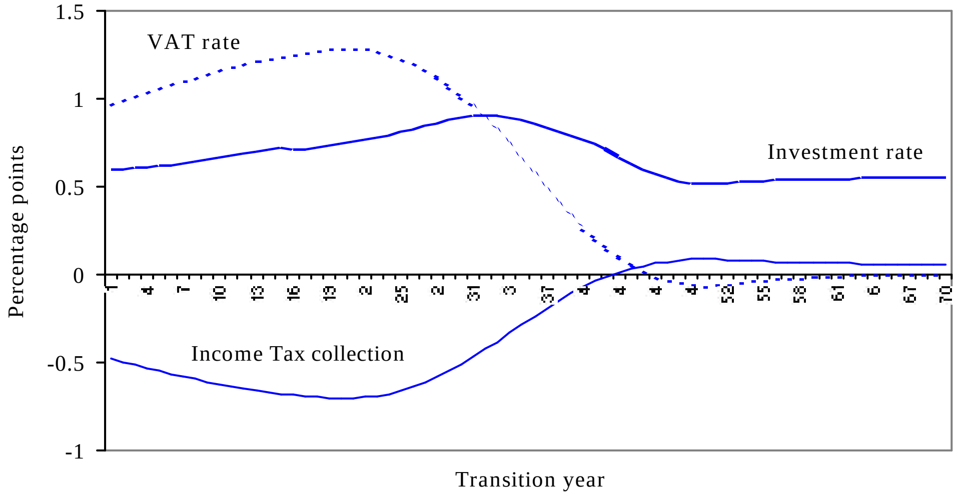


Figure 6

Change with respect to Steady State values

Case Elasticity of Substitution in production = 1.2

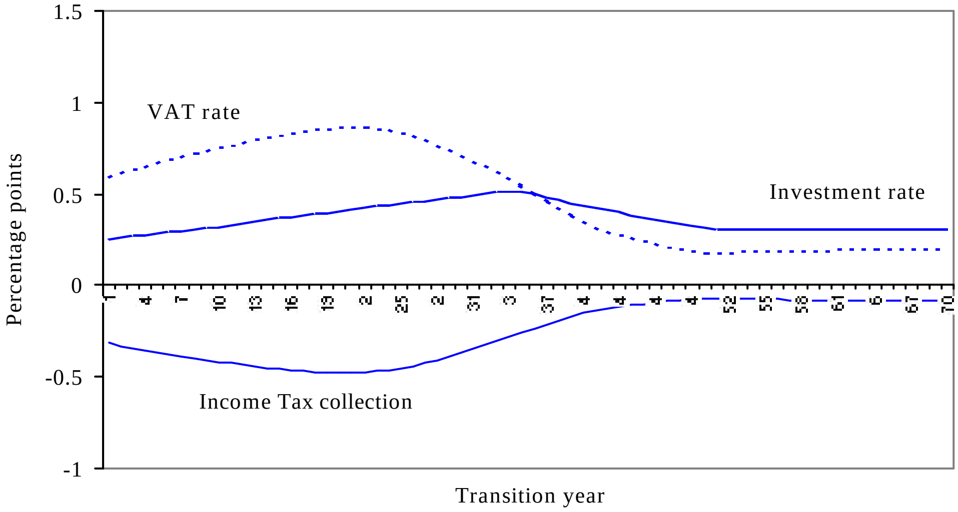


Figure 7

Welfare: Equivalent Variations

Case Elasticity of Substitution in production = 0.8

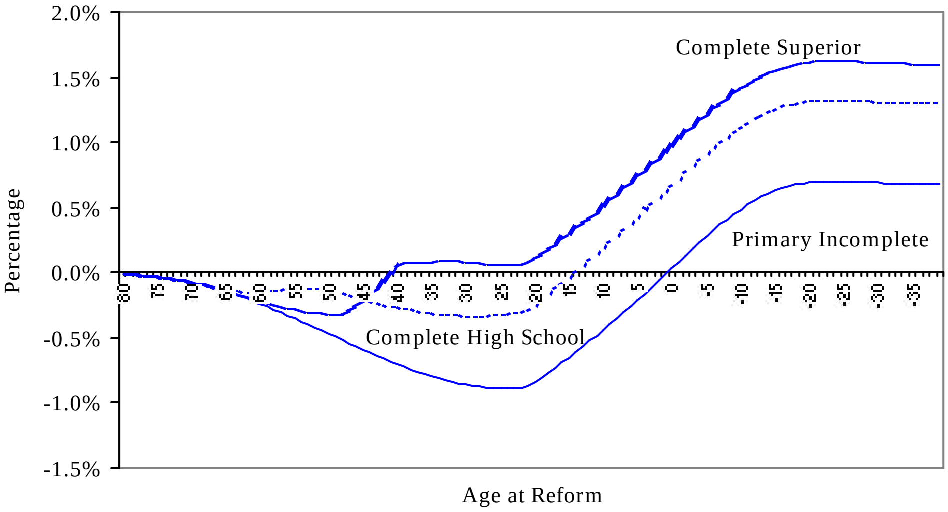
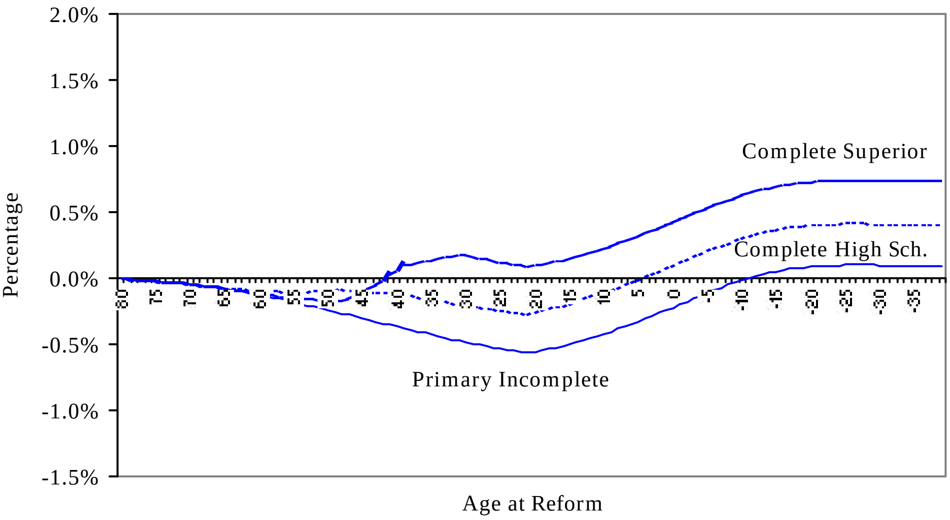


Figure 8

Welfare: Equivalent Variations

Case Elasticity of Substitution in production = 1.2



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