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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Preliminary and Incomplete
March 2002

General Equilibrium OLG models constitute 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 implies that they differ with regards to their budget constraints and effective preferences. A consequence is that they react in different ways to changes in fiscal policy (taxes and subsidies) and prices in the economy (interest rates and wages).

A crucial advantage of OLG models is that they allow making welfare comparisons across generations. 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, and the transition path of the economy to the new steady-state.

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 presents the model and the parametrization. Section III presents partial equilibrium results, showing optimal policies for voluntary savings for different agents. Steady-state comparisons are presented in section IV, while section V presents results for transitions. A final section summarizes the main findings.

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

<To be expanded>

The mechanism basically permits to deduce 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. Funds can be accessed earlier, but a penalty has to be paid. The penalty is not relevant in the context of this model, since there is no uncertainty. In this context, agents save only the amounts they know that they will keep until retirement. In other words, they can not rationally plan to pay a penalty in the future.

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. In the Chilean case, tax-incentives for retirement come to interplay with existing mandatory retirement savings plans. Liquidity constraints come to provide the right context in order to determine the constraints that workers face at every age in order to take advantage of the incentives.

Liquidity constraints are key here, if they 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 is explained in detail in the appendix. This section discusses the main changes in the model needed to study the issue of tax-incentives for VSR.

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 change allow the tax scheme to change in 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 never reach a stationary equilibrium. This is because productivity growth implies that new generations have larger income than previous ones. This, in turn, implies that the path of average and marginal income tax rates that they face in their life-time differ. If this is the case, then each new generation faces a path of prices, in particular tax rates, which is different from the previous. If this is the case, a steady state can not exist[1].

In order to address this problem, it is necessary that the limits of each income-tax bracket increase with productivity in the economy. Therefore each generation faces 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 may be a reasonable one when analyzing the medium and long run. In effect, if the tax schedule is kept constant over time, productivity growth implies that average and marginal tax rates are constantly increasing. This, in turn, implies either that the share of the government in the economy is increasing, or that other (possibly) less distortionary taxes, such as VAT, are being reduced. In either case that raise of marginal income tax rates increases distortions. This reduces savings and, therefore, capital formation in the economy.

Therefore, adjusting the limits of income tax brackets is a way to reach a stationary tax policy.

Income profiles

Recent studies for age effects on income include Larrañaga and Paredes (1999) and Butelmann and Gallego (2001). The first paper estimates an average age-income profile using synthetic cohort 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. The authors present one profile, representative of all the population. Butelmann and Gallego, in turn, report cross-section age-income profiles. Longitudinal income profiles--i.e. the income profile faced by an individual or cohort throughout their life--can be derived from cross-sections by making assumptions about the evolution of productivity growth between generations. However, it is not possible to derive reasonable longitudinal profiles from Butelmann and Gallego data using reasonable assumptions of

[1] Despite the fact that numerically an equilibrium can be found, it will not make sense economically.

productivity growth. This may be due to the fact that year effects are affecting the cross-section.

However, Butelmann and Gallego report profiles for different levels of educational attainment. 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 profiles to derive income profiles by educational attainment from Larrañaga and Paredes. I determine this by imposing that at every age income levels for the three income categories have to keep the relative distances of Butelmann and Gallego, while averaging the level of Larrañaga and Paredes. Weights are reported in Butelmann and Gallego.

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%.

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	1.2 and 1.5
Alfa	0.75
Preferences	
Time Preference	3 %
Intertemporal Elast. of Substitution	0.9
Rate of Growth of Population	1 %

Data on public debt and public expenditure are 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 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 works 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 stories 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 this features, while their relevant impact on life-time budget constraints can be fully captured via a lower contribution rate.[2]

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. This affects consumption in all periods. Second, the first order condition for consumption is not exogenous, but can vary according to the consumers decision since marginal tax rates can change. These two facts make the analytical solution difficult to find.

The strategy adopted is to use numerical methods to search for the optimal path of savings for retirement. I adopt some simplifying assumptions:

1. I divide active life (21 to 45 years of age) 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. I assume that saving rates in VSR mechanisms can only take multiples of 2.5 percentage points.
3. I assume that the retirements 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.

III. Partial equilibrium results

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

In this section I explore the optimal use of tax incentives for retirement for different type 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 a 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% interest rate. 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

IV. General Equilibrium Results I: The Steady State

Table 4 presents the impact of VSR mechanisms when comparing steady states. The table presents six cases with different parametrizations. Production function parameters were chosen in order to target a real interest rate in the neighborhood of 5%. This is sensitive assumption for a long run real return on retirement savings.

The six cases are combinations of different scenarios for productivity growth and parameters of the production function (sigma). In particular, sigma is the parameter in the CES function that determines the elasticity of substitution between factors. A value of sigma equal to 1 is the Cobb-Douglas case.

In all cases the stock of capital increases, on a range between 3% and 5%, leading to an increase in output per capita between 0.8% and 2.1%. Real interest rate falls between 12 and 19 basis points.

Funds managed by pension funds (both voluntary and mandatory) grow by a considerable magnitude, between 60% and 70% as a share of GDP. 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.

It is interesting to note that in equilibrium the impact on income tax collected is ambiguous. The higher wages associated with a larger capital stock generates more tax income revenue that in some cases can compensate the reduction in taxes paid when the population is using optimally the tax incentives mechanisms.

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

Case: Productivity Growth= 1.5%	*Sigma = 1.5*			*Sigma = 1.2*		
	Without VSR	With VSR	Change	Without VSR	With VSR	Change
Real Interest Rate	6.24%	6.06%	-0.18	5.17%	5.02%	-0.15
Gross Investment rate	24.72%	25.45%		21.44%	21.89%	
K/Y ratio	4.11	4.23		3.56	3.64	
K/L ratio	8.04	8.45	5.0%	5.83	6.00	3.0%
Y/L ratio	1.96	2.00	2.0%	1.63	1.65	0.9%
Share of Labor of GDP	60.0%	59.6%		69.1%	69.0%	
VAT rate	26.9%	26.9%		25.8%	26.2%	
VAT collected over GDP	15.5%	15.3%		15.8%	15.9%	
Income Tax collected over GDP	2.8%	3.0%		2.4%	2.2%	
Pension Fund / Total Assets	43.8%	68.3%	1.56	46.2%	75.7%	1.64
Pension Fund / PIB	188.6%	302.3%	1.60	173.9%	290.1%	1.67

Case: Productivity Growth = 1%	*Sigma = 1.5*			*Sigma = 1.2*		
	Without VSR	With VSR	Change	Without VSR	With VSR	Change
Real Interest Rate	6.08%	5.89%	-0.19	4.97%	4.83%	-0.14
Gross Investment rate	23.24%	23.94%		20.18%	20.60%	
K/Y ratio	4.22	4.34		3.66	3.74	
K/L ratio	8.40	8.83	5.1%	6.06	6.24	3.0%
Y/L ratio	1.99	2.03	2.0%	1.65	1.67	0.9%
Share of Labor of GDP	59.6%	59.2%		69.0%	68.9%	
VAT rate	26.3%	26.2%		25.4%	25.7%	
VAT collected over GDP	15.6%	15.3%		15.8%	15.9%	
Income Tax collected over GDP	2.9%	3.0%		2.4%	2.3%	
Pension Fund / Total Assets	44.7%	70.3%	1.57	46.9%	77.7%	1.66
Pension Fund / PIB	197.1%	318.9%	1.62	180.9%	305.6%	1.69

Case: Productivity Growth = 0%	*Sigma = 1.5*			*Sigma = 1.2*		
	Without VSR	With VSR	Change	Without VSR	With VSR	Change
Real Interest Rate	5.74%	5.55%	-0.19	4.57%	4.45%	-0.12
Gross Investment rate	20.03%	20.65%		17.49%	17.81%	
K/Y ratio	4.45	4.59		3.89	3.96	
K/L ratio	9.20	9.70	5.3%	6.60	6.78	2.7%
Y/L ratio	2.07	2.11	2.1%	1.70	1.71	0.8%
Share of Labor of GDP	58.9%	58.5%		68.7%	68.6%	
VAT rate	25.1%	24.9%		24.5%	24.7%	
VAT collected over GDP	15.7%	15.4%		15.9%	16.0%	
Income Tax collected over GDP	2.9%	3.1%		2.4%	2.3%	
Pension Fund / Total Assets	46.1%	73.8%	1.60	47.6%	81.2%	1.71
Pension Fund / PIB	214.1%	353.1%	1.65	194.4%	337.3%	1.73

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 comparing steady states. 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.

Results in this section consider an elasticity of substitution in production of 0.8.

Figure 5 shows the evolution of revenue from income tax over GDP. Once the tax-incentive mechanisms are adopted, for in 0.5 percentage points of GDP or, equivalently, 12,3% of previous income-tax revenue. The fall continues in subsequent years, reaching its maximum on the 20^{th} year after the introduction of the tax-incentive mechanism. However, collection starts to recover, and in the new steady state, income-tax revenue is higher--as a percentage of GDP--than in the initial steady state in 6 basis points.

The force behind this is that the increase in savings for retirement increases the stock of capital in the economy, leading to an increase in wages. The increase in the wage level implies that income-tax revenue increases. The increase in wages is not a result lead by exogenous productivity growth, but by changes in the relative availability of factors. Figure 6 shows a general wage index. Wages accumulate a 2% increase in year 45 of the reform.

The evolution of income-tax collection has implications on other taxes if public expenditure remains constant as a % of GDP. The VAT rate increases by 0.9 percentage points in the year of the reform. The peak increase occurs in year 20 of the reform, when VAT is 1.3-percentage points higher than its initial steady state level. Mirroring the evolution of the revenue from the income tax, VAT rates fall to the same level than the initial steady state.

The path of aggregate macro variables is monotonic, as reflected in the evolution of the wage index. In effect, Capital stock and real interest rates show a similar pattern (inverted in the case of the interest rate) of that of wages.

Assets managed by pensions funds (mandatory and voluntary) increase by 60%, reaching its new steady state level in around 35-40 years after the reform. Figure 8 shows this evolution.

VII. Conclusions

This paper has shown that in a context of liquidity constraints the recently approved tax-incentive mechanisms generate gains for the workers with higher levels of income. When workers take advantage of them, capital in the economy can be increased in a range of 3%-5%, which in turn generates output increases in the order of 1%-2%.

Despite the fact of an initial fall in revenue from income tax, growth of wages can revert this situation. This leads to a new equilibrium were the tax scheme of the economy is almost the same as before the reform.

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Figure 1

Income Profiles by level of Educational Attainment

Monthly Income, 2001

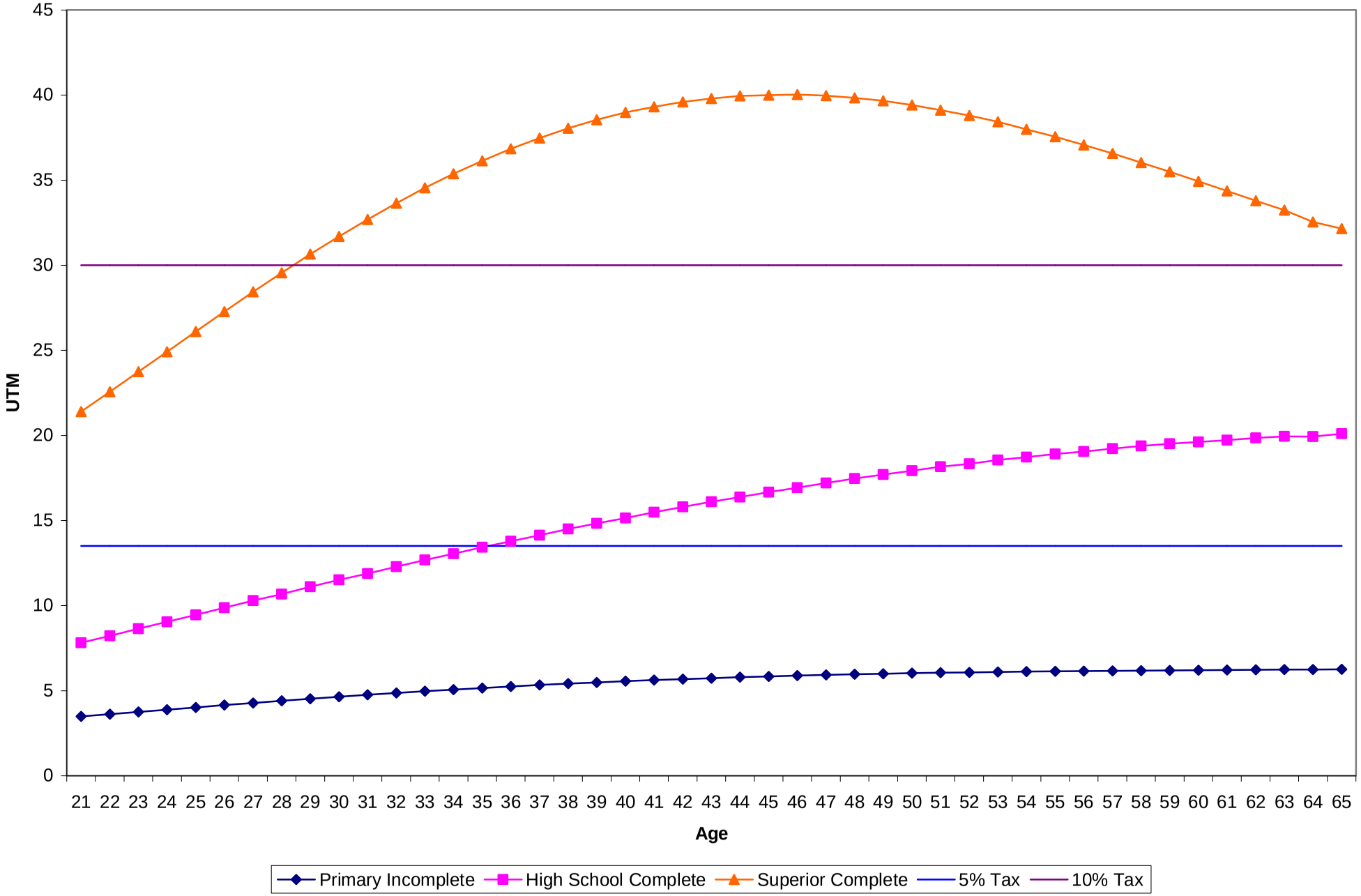

Figure 2

Liquid Labor Income, Consumption and Average Income Tax rate Profiles

Worker with Complete High School, 1% time preference

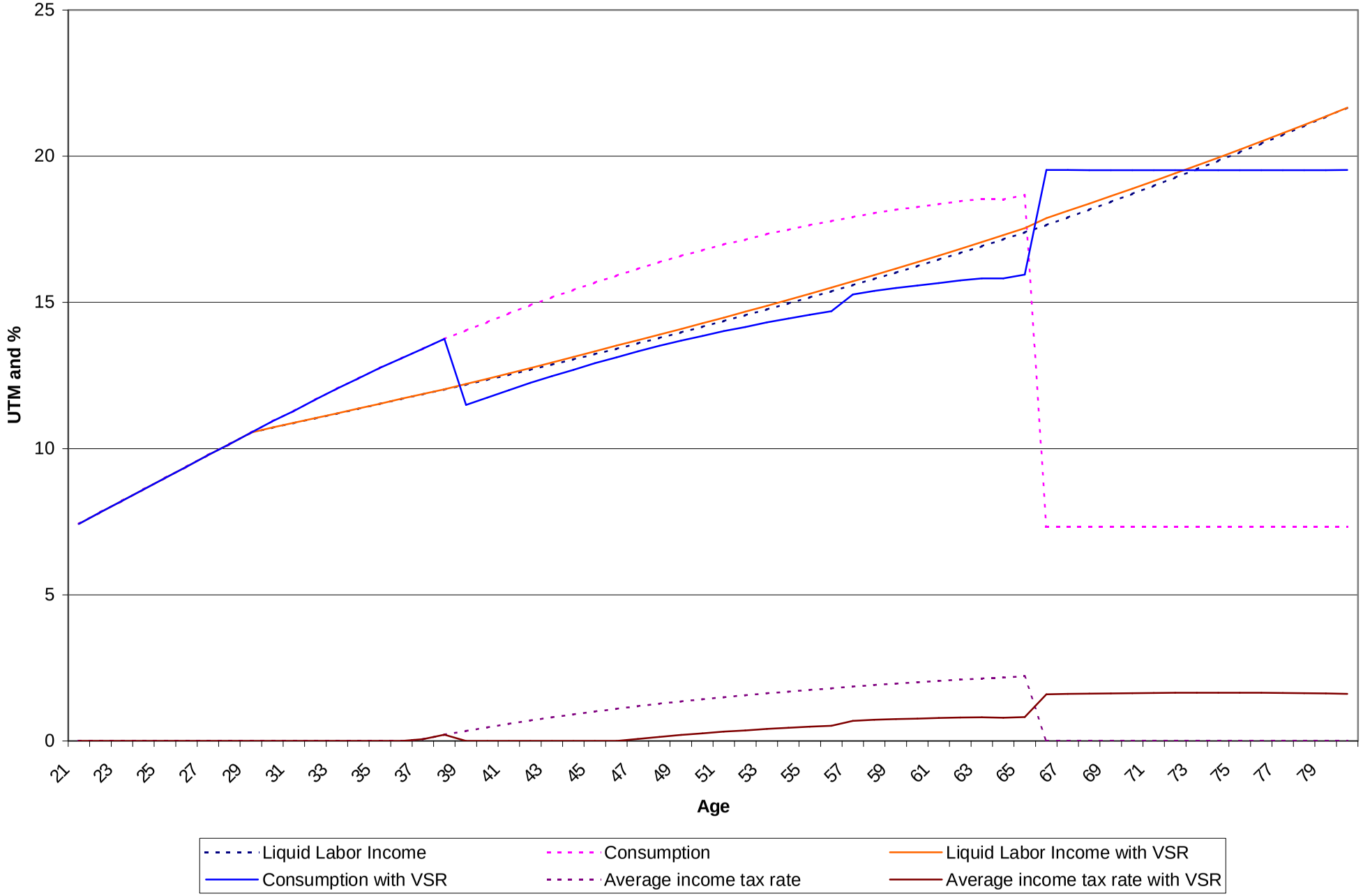

Figure 3

Liquid Labor Income, Consumption and Average Income Tax rate Profiles

Worker with Complete High School, 3% time preference

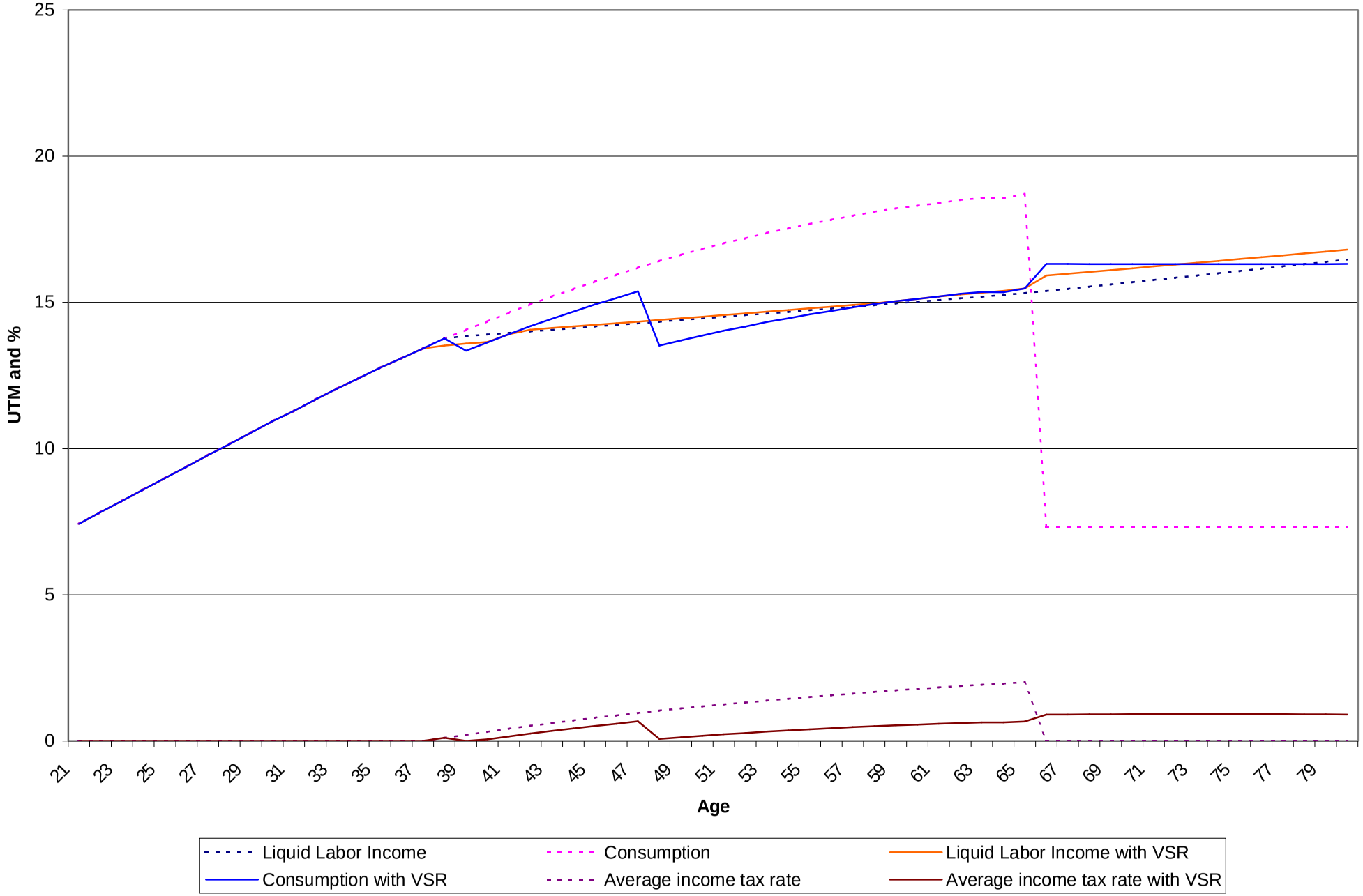

Figure 4

Liquid Labor Income, Consumption and Average Income Tax rate Profiles

Worker with Complete High School, 10% time preference

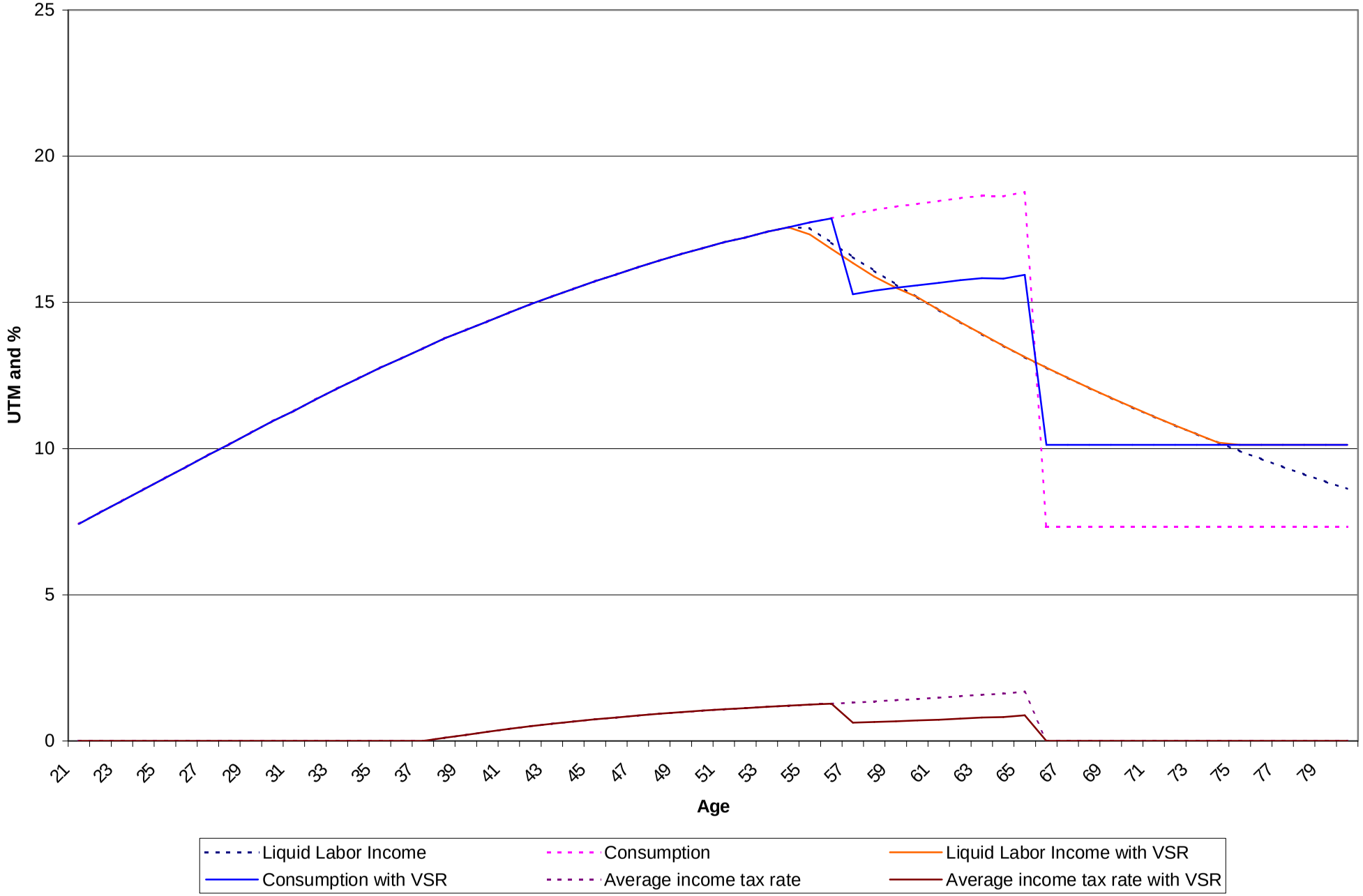

Figure 5

Income Tax Revenue over GDP

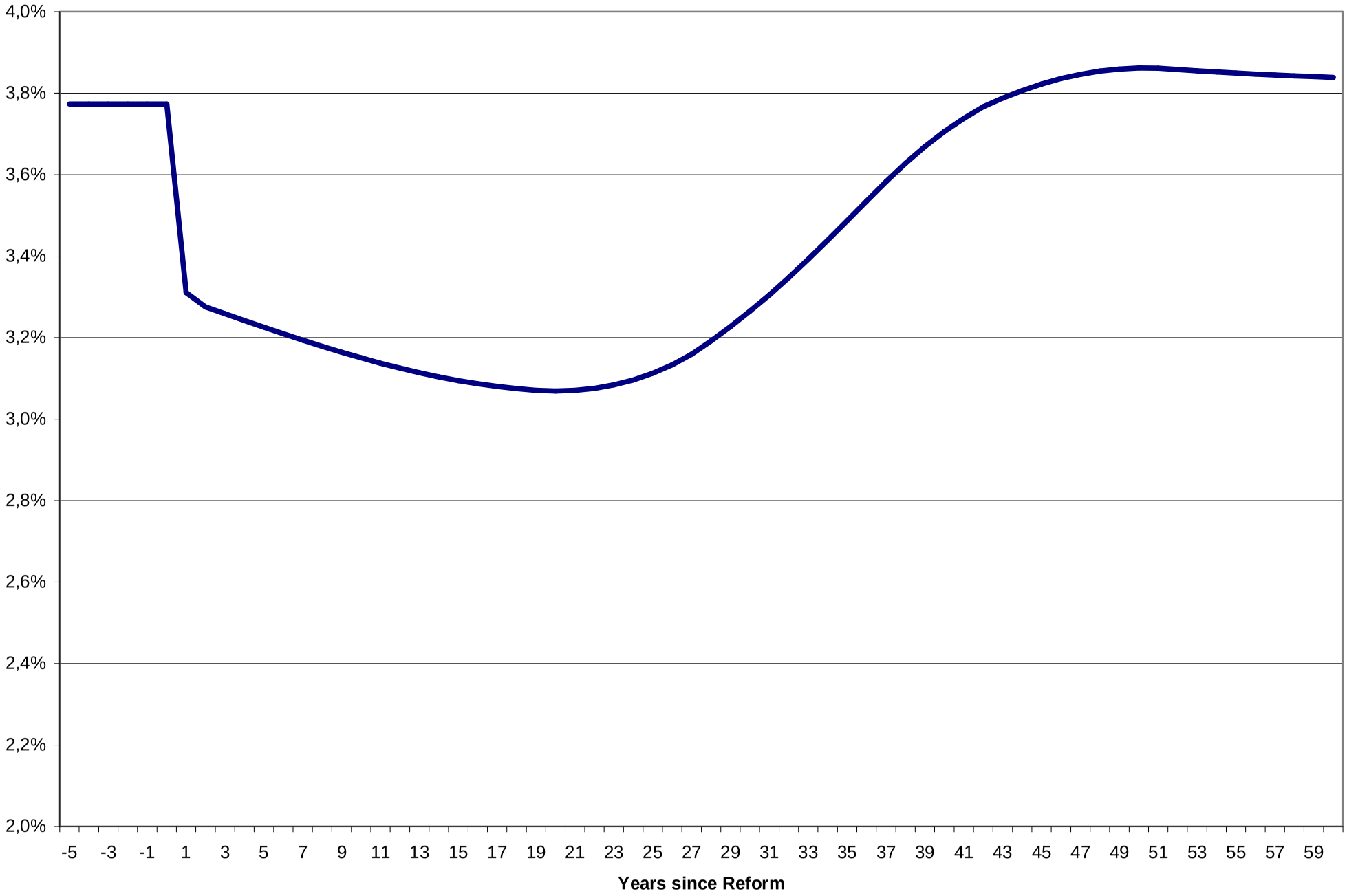

Figure 6
Wage Index
Before reform = 1

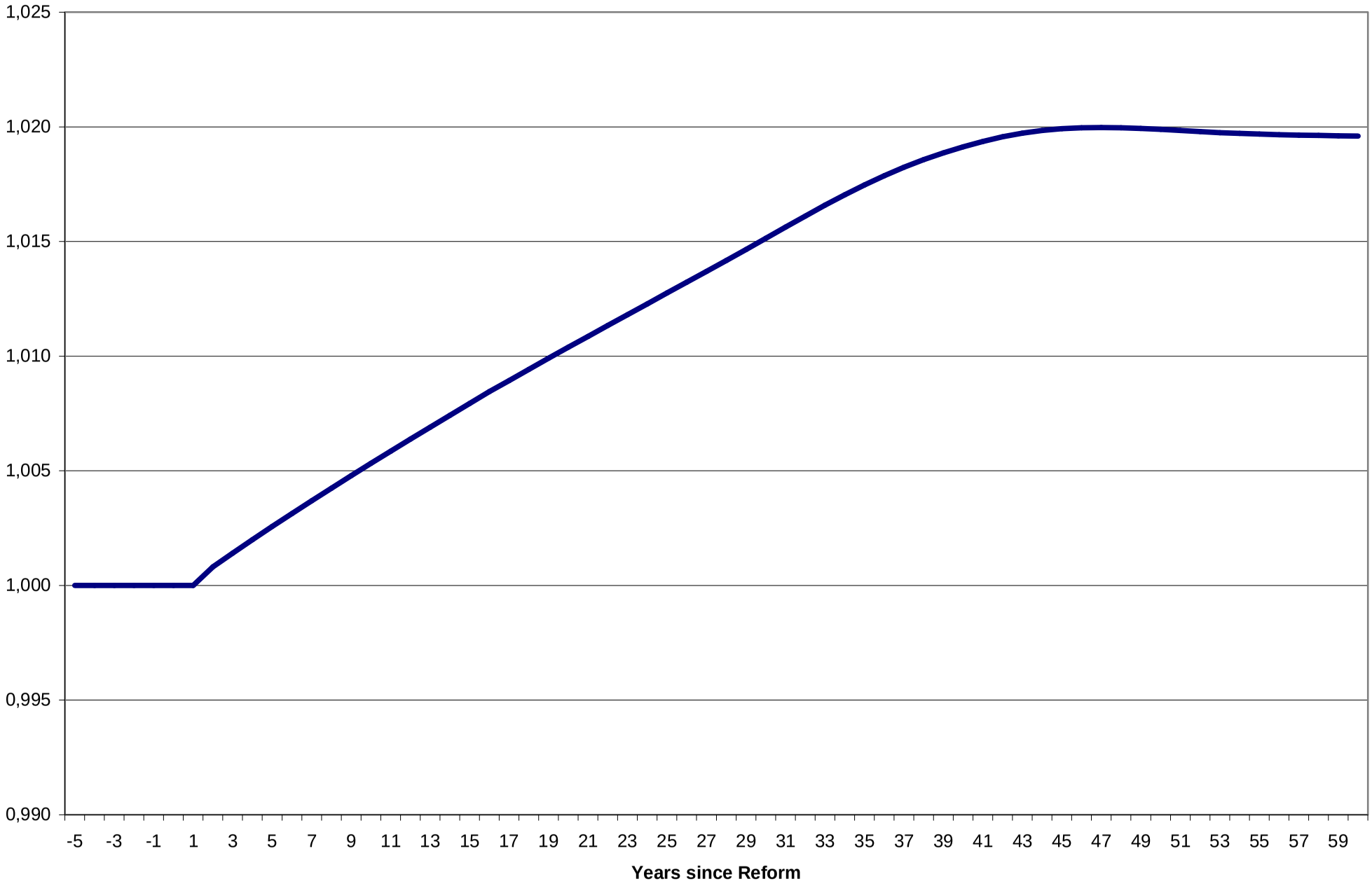

Figure 7

Value-Added Tax Rate

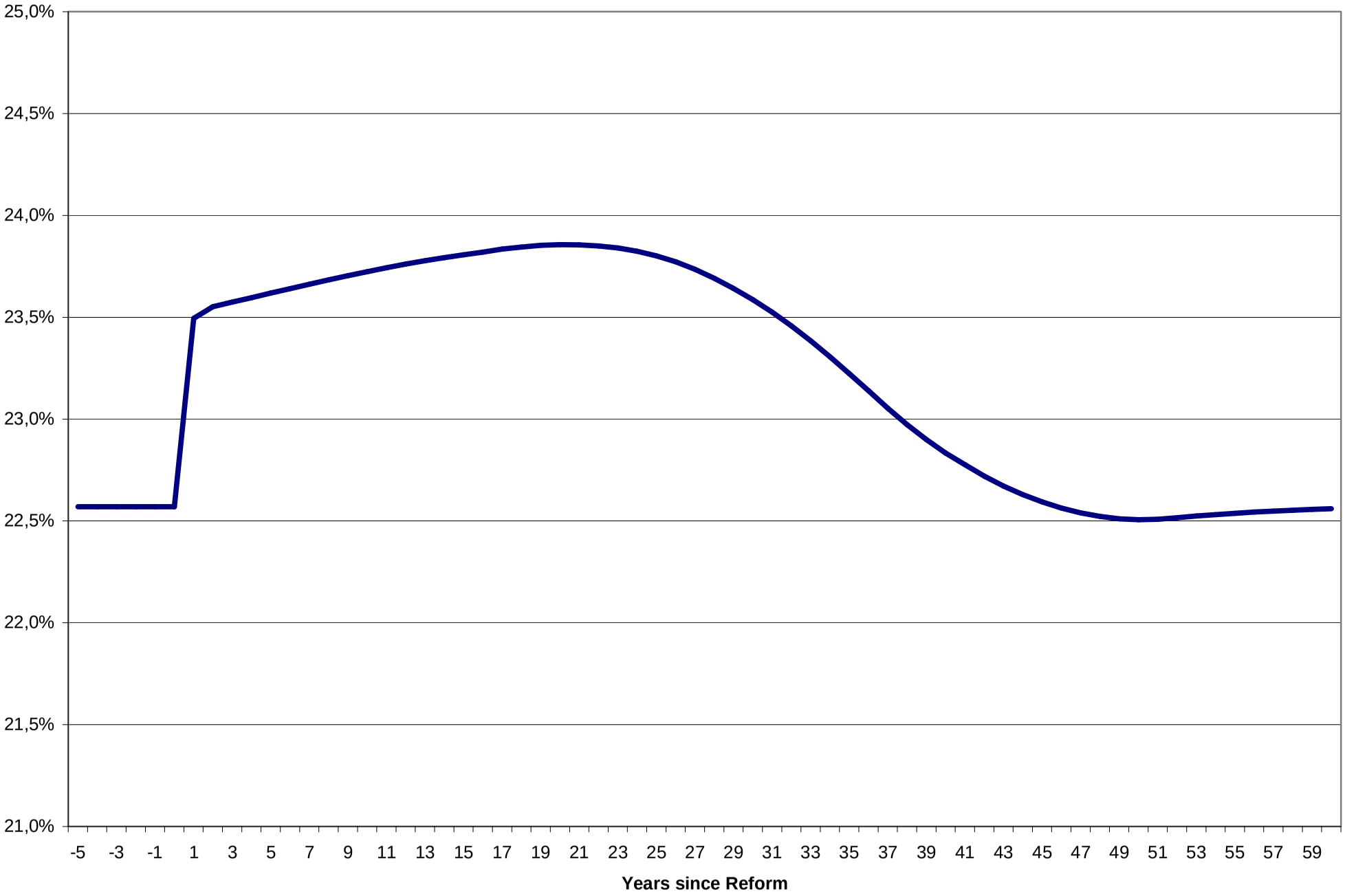

Figure 8

Pension Fund Assets over Total Assets