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No. 4863

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Discussion Paper No. 4863  
January 2005

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## ABSTRACT

### The Evolution of Retirement\*

We provide a long-term perspective on the individual retirement behaviour and on the future of early retirement. In a cross-country sample, we find that total pension spending depends positively on the degree of early retirement and on the share of elderly in the population, which increase the proportion of retirees, but has hardly any effect on the *per capita* pension benefits. We show that in a Markovian political economic theoretical framework, in which incentives to retire early are embedded, a political equilibrium is characterized by an increasing sequence of social security contribution rates converging to a steady state and early retirement. Comparative statistics suggest that aging and productivity slow-downs lead to higher taxes and more early retirement. However, when income effects are factored in, the model suggests that periods of stagnation – characterized by decreasing labour income – may lead middle-aged individuals to postpone retirement.

JEL Classification: D72, H53 and H55

Keywords: lifetime income effect, pensions, politico-economic Markovian equilibrium and tax burden

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\*This Paper is produced as part of the CEPR-managed Research Training Network 'Financing Retirement in Europe - Public Sector Reform and Financial Market Development', funded by the European Community's Human Potential Programme under EC contract HPRN-CT-2001-00225 (FINRET). We thank J F Jimeno for many useful comments and suggestions and participants at the Fourth CEPR/RTN workshop 'Financing Retirement in Europe' at CORE, Louvain-la-Neuve and to the 2004 Annual Meeting of the IIPF. All remaining errors are ours. Financial support from Fundacion Ramon Areces and Fundacion BBVA is gratefully acknowledged. The views expressed herein are those of the authors and not necessarily those of the Prime Minister's Economic Bureau.

Submitted 05 January 2005

# 1 Introduction

Retirement decisions represent one of the hottest issues of the current social security debate. Several studies - see Blondal and Scarpetta (1998) and Gruber and Wise (1999 and 2003) among the most recent work - have suggested that individual retirement decisions are strongly affected by the design of the social security system. In particular, individuals tend to retire either as soon as they are given the opportunity, i.e., at early retirement age, or at normal retirement age. Moreover, most social security systems have been proven to provide strong incentives - in terms of large implicit taxes on continuing to work - to anticipate retirement. In taking their retirement decisions, most individuals prefer to enjoy generous early retirement benefits - and the leisure associated with an early exit from the labor market - rather than to continue working, since, in the latter case, their additional contributions to the system would not sufficiently increase their future pension benefits.

Several studies have made an additional step by arguing that the massive use of early retirement provisions has come at a cost: the deterioration of the financial sustainability of the system, already under stress because of population aging. In fact, several international organizations - such as the European Union at the 2001 Lisbon Meetings - have advocated an increase in the effective retirement age, or - analogously - the increase in the activity rate among individuals aged above 55 years, as a key policy measure to control the rise in social security expenditure. In a nutshell, the postponement of the retirement age has become a milestone in all social security reform's proposals. However, whether these policy prescriptions will actually be adopted depends on the politics of early retirement (see Fenge and Pestieau, 2004, for a detailed discussion of early retirement issues, and Galasso and Profeta, 2002, for a more general survey of the political economy of social security).

In this paper, we aim at providing a long term perspective on the individual retirement behavior. We start from the role played at present by retirement decisions in social security and we analyze implications for the future of early retirement.

First, we address the relation between the use of the early retirement provisions and the pension expenditure in a cross-country sample to evaluate the impact of the effective retirement age on the level of pension expenditure. We find that the total size of pension expenditure depends positively on different measures of early retirement, on the share of elderly in the population and on per capita GDP. To better investigate these relations, we decompose the total pension expenditure over GDP in the number of pensioners over total population and the average pension over per capita GDP. We find that early retirement shows a positive relation with the number of elderly, but hardly any relation with the average pension.

Second, we provide a simple theoretical framework in which the incentives to retire early - as identified by Blondal and Scarpetta (1998) and Gruber and Wise (1999 and 2003) - are examined in conjunction with some long term determinants of the retirement decision. We use a Markovian politico-economic model to predict the equilibrium path of fiscal policies over social security. We find a political equilibrium characterized by an increasing sequence of social security tax rates converging to a steady state and by a parallel increment in the use of early retirement provisions. Comparative statics suggest that aging will lead to higher taxes and more early retirement. However, when income effects are factored in, the model suggests that period of stagnation – characterized by decreasing labor income – may lead middle aged individuals to increase their labor supply and hence reduce early retirement.

There exists a vast literature on retirement decisions. Already two decades ago, Feldstein (1974) and Boskin (1977) analyzing the determinants of the de-

cline in the labor force participation of elderly workers pointed at two key parameters of social security systems: the income guarantee and the implicit tax on earnings. Endogenous retirement decisions have been analyzed by showing how pensions systems introduce distortions in the labor supply choice (see among others Diamond and Mirrless, 1978, Hu, 1979, Crawford and Lilien, 1981, and Michel and Pestieau, 1999). The empirical literature of the effects of social security design on retirement includes Boskin and Hurd (1978), Hurd (1983), Diamond and Housman (1984), and more recently Gruber and Wise (1999 and 2003) and Blondal and Scarpetta (1998). A new literature has lately emerged on the political economy of early retirement (see Fenge and Pestieau, 2004, Lacomba and Lagos, 2000, Casamatta et al., 2002, Conde-Ruiz and Galasso, 2003 and 2004). Markovian politico-economic models of social security have been recently studied by Azariadis and Galasso (2002), Hassler et al (2003), and Gonzalez-Eiras and Niepelt (2004).

The paper is structured as follows. In the next section, we address the relation between retirement decisions and social security expenditure in a cross-country sample. Section 3 presents a Markovian politico economic model, in which individual retirement decisions and evolution of social security and early retirement are analyzed. Section 4 concludes.

## **2 Some Evidence on Retirement and Pension Expenditures**

The relation between retirement and social security has been largely analyzed (see Latulippe, 1997, and Gruber and Wise, 1999 and 2003, among many others). The social security system may induce early exit from the labor market before collecting pension benefits or may provide large incentives to retire early. It is however worth noticing that the relation between retirement behavior and social security expenditure seems to depend crucially on the number of elderly

in the population (see Profeta 2002). In fact, in countries with a large share of elderly in the population, the effective labor force participation of the elderly tends to be low. These countries are also associated with a large total pension expenditure.

What are then the main determinants of social security expenditures? And in particular, what is the role of the retirement behavior? To answer these questions, we build a large data set collecting information on demographics, retirement and social security for many countries around the world and perform a simple cross-country analysis.

As demographic variable we use the proportion of elderly (individuals aged more than 65 years) in the total population (OLD), taken from the United Nations Demographics Yearbook (1999). From the Yearbook of Labor Statistics of the International Labour Office (1990-2000) we construct two variables that measure the effective retirement age: (i) the average activity rate in the period 1985-2000 for individuals between 55 and 64 years old (ACTOT for all and ACTOTM for man) and (ii) the difference between the average activity rate in the period 1986-2000 for individuals between 40 and 55 years old (AC1TOT for all and AC1M for man) and the average activity rates for individuals between 55 and 64 years old (DAC for all and DACM for man). This last variable (DAC) represents a measure of the extent of early retirement, by capturing the drop in the activity rate from age 40-55 to age 55-64. From the International Monetary Fund Government Finance Statistics Yearbook (several years in the period 1986-1998) we obtain the average level in the period 1986-1998 of pension expenditures as percentage of GDP (PENSEXP)<sup>1</sup>. Finally, from the ILO World Labour Report (2000) we obtain the percentage of pensioners over total population (NUMPENS). Combining this information and the level of pension

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<sup>1</sup>Notice that the IMF's definition of social security includes old age payments, and therefore it differs from an ideal measure of "governments transfers to the elderly", because it excludes medical and other subsidies for the elderly.



expenditures as percentage of GDP, we calculate the per capita average pension (AVPENS).

Table 1 provides some simple statistics of our variables.

We perform a simple cross-country regression. Table 2 summarizes the results for a sample of all countries for which the data are available and table 3 for a sub-sample of OECD countries. The level of pension expenditures as percentage of GDP depends significantly and positively on the number of elderly and on GDP, and significantly but negatively on the activity rate of individuals between 55 and 64 years old (column (a)). According to this result, countries with a larger share of elderly in their populations spend more for pensions, as intuitively expected. Richer countries also spend more in pension, as predicted by Wagner's law. Finally, countries where the effective retirement age is higher (i.e. individuals between 55 and 64 years old have higher activity rates) spend less in pensions. These determinants together explain most of the variability in pension expenditures ( $R^2=0.837$ ). To obtain a better measure of early retirement, we use the variable DAC, which represents the reduction of the activity rate of individuals between 55 and 64 years old with respect to the activity rate of people in age 40-55. This measure of early retirement is significantly and positively related to the level of pension expenditures (column (b)), suggesting that countries which use more early retirement spend more for pensions. A similar result is obtained if we restrict to the activity rates of man (column (c)).

To better understand the determinants of the level of pension expenditures and the role played by each of the identified variables, as pointed out by Jimeno (2002a, 2002b) we use the following identity:

$$PENSEXP = NUMPENS * AVPENS$$

which makes clear how the level of pension expenditures as percentage of GDP is the product of the number of pensioners as a proportion of total population and

of the average pension in terms of GDP per capita. According to this decomposition, the role played by the demographic variable (the proportion of elderly in the population) and the retirement variables (the measures of early retirement) in explaining the level of pension expenditures can be better understood using two additional sets of regressions. Due to limited information on the number of pensioners and the average pension, we perform these regressions only using the sample of all countries.

First, we try to estimate the determinants of the number of pensioners, as shown in table 4. Clearly, countries where there are more elderly in the population have more pensioners (OLD is positively and significantly related to NUMPENS). Countries where there is more early retirement have also more pensioners (ACTOT is negatively and significantly related to PENSEXP in column (a) and DAC negatively and significantly in column (b)). This regression makes clear that both the proportion of elderly in total population and early retirement increase the level of pension expenditures through the increase of the number of pensioners. Second, we estimate the impact of demographics and retirement on the level of average pension. Table 5 shows that both aging (OLD) and early retirement (DAC) are not significant in explaining the average pension.

To summarize, these simple results suggest that while more elderly and lower early retirement increase the overall pension expenditures, *via* a significant increase of the number of retirees, they do not affect the per capita average pension.

### 3 A politico-economic model

#### 3.1 The economic Environment

We consider a simple three -period overlapping generations model. Every period, three generations are alive, we call them respectively young, adult and old. Young face a labor-leisure trade off on the intensive margin. They choose how many hours of work to supply, receive a wage,  $w^y$ , pay a payroll tax,  $\tau$ , on labour income and save all their disposable income for old age consumption. There exists a storage technology that transforms a unit of today's consumption into  $1 + r$  units of tomorrow's consumption. All private intertemporal transfers of resources into the future are assumed to take place through this technology.

Adult individuals decide what fraction,  $z$ , of the second period to spend working; in other words, they decide when to retire. An adult individual who works a proportion  $z$  of the second period receives a net labor income equal to  $w^a(1 - \tau)$ , for the fraction  $z$  of the period. To simplify the analysis, we assume that no pension benefit is received for the remaining fraction  $(1 - z)$ , during which individuals however enjoy leisure. Finally, all old individuals are assumed to retire and to obtain a pension,  $p$ . Population grows at a rate  $n$ .

The life time budget constraint for an agent born at time  $t$  is then equal to:

$$c_{t+2}^o = (1 - \tau_t) l_t w_t^y (1 + r)^2 + (1 - \tau_{t+1}) z_{t+1} w_{t+1}^a (1 + r) + p_{t+2} \quad (1)$$

where  $c_{t+2}^o$  is old age consumption at time  $t+2$ ,  $l_t$  represents the amount of work supplied by a young individual at time  $t$  and subscripts indicate the calendar time. Moreover,  $\tau_t$  and  $\tau_{t+1}$  are the pay roll taxes respectively at periods  $t$  and  $t + 1$  and  $r$  is the interest rate.

To account for differences in the wages by age, i.e., between young and adult workers, and for economic growth, we characterize the relations between wages across time and generations as follows:  $w_{t+1}^a = (1 + g) w_t^a$ , where  $g$  is the real

growth rate of wages, and  $w_t^y = \varphi w_t^a$ , where  $\varphi$  defines the ratio between the wage of young and adult workers at time  $t$ .

To simplify the analysis, we assume that agents only value life-time income – or analogously old age consumption,  $c_{t+2}$  – and leisure when young and adult, according to the following utility function, which has been introduced by Casamatta, Cremer and Pestieau (2002) to study incentive effects on early retirement provisions:

$$U(l_t, z_{t+1}, c_{t+2}) = c_{t+2}^o - \frac{l_t^2}{2\alpha} w_t^y - \frac{z_{t+1}^2}{2\gamma} w_{t+1}^a \quad (2)$$

where the second and third terms represent the disutility from the effective labor supply, and  $\alpha$  and  $\gamma$  are parameters that quantify the relative importance of leisure when young and adult, and that we take to be equal respectively to  $\alpha = 1/(1+r)^2$  and  $\gamma = 1/(1+r)$ .

Hence, a young agent at time  $t$  and an adult at time  $t+1$  maximize eq. 2 with respect to  $l_t$  and  $z_{t+1}$  subject to the budget constraints at eq. 1. The solution of the two maximization problems yields the following optimal individual labor supply decisions:

$$\widehat{l}_t = 1 - \tau_t \quad (3)$$

$$\widehat{z}_{t+1} = 1 - \tau_{t+1} \quad (4)$$

We consider a balanced budget pay as you go (PAYG) social security system, where the sum of all pension transfers is equal the sum of all contributions. Since pensions are awarded to elderly individuals only, whereas young and adults workers contribute according to their labor income, the full pension transfer at time  $t$  which balances the budget constraint is equal to:

$$p_t = \tau_t \left( (1+n_t)(1+n_{t-1}) w_t \widehat{l}_t + (1+n_{t-1}) w_t^a \widehat{z}_t \right) \quad (5)$$

or equivalently

$$p_t = \tau_t (1 - \tau_t) (1 + n_{t-1}) \bar{w}_t \quad (6)$$

where  $\bar{w}_t = ((1 + n_t)w_t^y + w_t^a)$ .

Finally, by substituting the individual decisions at eq. 3 and 4 and the above social security budget constraint, we derive the following expression for the indirect utility function of an adult individual at time  $t$ :

$$V^a(\tau_{t-1}, \tau_t, \tau_{t+1}) = (1 - \tau_{t-1})\hat{l}_{t-1}w_{t-1}^y(1+r)^2 + (1 - \tau_t)\hat{z}_tw_t^a(1+r) + \tau_{t+1}(1 - \tau_{t+1})(1 + n_t)\bar{w}_{t+1} - \frac{\hat{l}_{t-1}^2}{2\alpha}w_{t-1}^y - \frac{\hat{z}_t^2}{2\gamma}w_t^a. \quad (7)$$

### 3.2 The Political Equilibrium

The purpose of this paper is to propose a theoretical framework in which to account for the link between early retirement provision and the size of the social security system examined in section 2. We have already showed at eq. 4 that early retirement behavior may be induced by specific features of the social security system, such as the contribution rate. Here, we analyze the determination of this social security contribution rate within the political arena. We follow a well established tradition in political economics by concentrating on the median voter decision. Yet, due to the intergenerational nature of the system, we allow for some interdependence between current and future political decisions. In particular, we analyze Markov perfect equilibrium outcomes<sup>2</sup> of a repeated voting game over the social security contribution rate. Since we want to examine the possible link between the use of early retirement provisions and the size of the social security system, we consider the state of the economy for the Markov equilibrium to be summarized by the share of early retirees in the population.

More specifically, at every period  $t$ , the median voter in each generation of voters – hence typically an adult individual – decides her most favorite social

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<sup>2</sup>For examples of Markov equilibria, see Krusell et al.(1996), Grossman and Helpman (1998), Bassetto (1999), Azariadis and Galasso (2002), Hassler et al. (2003) and Gonzalez-Eiras and Niepelt (2004).

security system (i.e., the tax rate  $\tau_t$ ). In taking her decision, she expects her current decision to have an impact of future policies. In particular, her expectations about the future social security tax rate – and hence about her pension benefits – depend on the current level of early retirement, according to a function  $\tau_{t+1} = q^e(z_t)$ . Hence, future contribution rates depend on the current level of labor force participation by the elderly, which is in turn affected by the current voter’s decision over the social security contribution rate. Therefore, the median voter’s optimal decision can be obtained maximizing her lifecycle utility with respect  $\tau_t$  and given expectations on the next period policy function  $\tau_{t+1} = q^e(z_t) = Q(z_t(\tau_t))$ :

$$\max_{\tau_t} V^a(\tau_{t-1}, \tau_t, \tau_{t+1}) = \max_{\tau_t} V^a(\tau_{t-1}, \tau_t, Q(z_t(\tau_t))) \quad (8)$$

We can now define the Markov political equilibrium as follows

**Definition 1** *A Markov political equilibrium is a pair of functions  $(Q, Z)$ , where  $Q : [0, 1] \rightarrow [0, 1]$  is a policy rule,  $\tau_t = Q(z_{t-1})$ , and  $Z : [0, 1] \rightarrow [0, 1]$  is a private decision rule,  $z_t = 1 - \tau_t = Z(\tau_t)$ , such that the following functional equations hold:*

- i)  $Q(z_{t-1}) = \arg \max_{\tau_t} V^a(\tau_{t-1}, \tau_t, \tau_{t+1})$  subject to  $\tau_{t+1} = Q(Z(\tau_t))$ .
- ii)  $Z(\tau_t) = 1 - \tau_t$

The first equilibrium condition requires that  $\tau_t$  maximizes the objective function of the median voter – an adult individual as long as  $n_t(1 + n_{t-1}) < 1$  – taking into account that the future social security system tax rate,  $\tau_{t+1}$  depends on the current social security tax rate,  $\tau_t$ , via the private labor supply decision of the adults. Furthermore, it requires  $Q(z_{t-1})$  to be a fixed point in the functional equation in part i) of the definition. In other words, if agents believe future benefits to be set according  $\tau_{t+j} = Q(z_{t+j-1})$ , then the same function  $Q(z_{t-1})$  has to define the optimal voting decision today. The second

equilibrium condition requires that all old individuals choose their labor supply optimally.

In order to compute the Markov political equilibrium, we have to consider the optimal social security tax rate chosen by the median voter at time  $t$ , who maximizes the indirect utility function at eq. 7 with respect to  $\tau_t$  and subject to  $\tau_{t+1} = Q(Z(\tau_t))$ .

The corresponding first order condition is:

$$-w_t^a z_t (1+r) + \frac{dp_{t+1}}{d\tau_{t+1}} Q'(z_t) Z'(\tau_t) = 0 \quad (9)$$

where  $Z'(\tau_t) = -1$ , which suggests that the current cost of contributing to the system has to be compensated by a corresponding benefit in the future. The solution of the maximization problem of the median voter yields the optimal fiscal policies, as summarized in the following proposition.

**Proposition 2** *The set of feasible fiscal policies  $\{\tau_t^*\}_{t=s}^\infty \in [0, 1]$  which can be supported by a Markovian politico-economic equilibrium satisfies:*

$$\tau_{t+1} = Q(Z(\tau_t)) = \frac{1}{2} - \frac{1}{2} \sqrt{1 - \frac{2A - 2(1+r)w_t^a Z(\tau_t)^2}{(1+n_t)\bar{w}_{t+1}}}$$

where  $A$ , the free parameter pinned down by the first median voter's expectation of future policies, is restricted to the support  $A \in [(1+r)w_t^a, (1+n_t)\bar{w}_{t+1}/2]$ .

**Proof. See Appendix.**

The result in proposition 2 points to the existence of a positive link between the current use of early retirement provisions and the future social security contribution rate. This link completes the economic channel running from the social security contribution rate to the current labor supply decision of the adults, as described at eq. 4. In particular, a current increase in the social security contribution rate leads to more current early retirement – by reducing the opportunity cost of retirement – which in turn creates expectations for more social security contributions – and hence more early retirement – in the future.

In fact, since  $z_t = 1 - \tau_t$ , the dynamics for the equilibrium policy function can be described as follows:

$$\tau_{t+1} = \frac{1}{2} - \frac{1}{2} \sqrt{1 - \frac{2A - 2(1+r)w_t^a(1-\tau_t)^2}{(1+n_t)\bar{w}_{t+1}}} \quad (10)$$

Furthermore, it is easy to show that  $d\tau_{t+1}/d\tau_t \in (0, 1)$ , and thus the equilibrium path converges to a stable steady state with a positive social security contribution rate – and early retirement. As shown in figure 3.1, if the initial social security contribution is below the steady state level, the dynamics feature an increasing sequence of tax rate (and an increasing use of early retirement), which converges to the steady state.

### 3.3 Aging, Social Security and Early Retirement

The equilibrium policy function obtained in the previous section allows us to analyze the effects of aging on the dynamics of the social security tax rate and on the use of early retirement. To see how aging may affect this evolution, consider the decision of the median voter at time  $t$ . When determining the current social security contribution rate, this adult voter follows the equilibrium function described at eq. 10 – lagged one period. By setting the policy according to this function, she validates the expectations of the previous median voter, since she is indifferent on what to vote, provided that she expects the next median voter to follow the same function in the future.

Consider now that at time  $t$  information becomes available that aging will occur at time  $t + 1$ . In other words, at time  $t$ , the median voter learns that population growth will permanently drop from the following period:  $n_{t+i} < n_t \forall i > 0$ . Since no change occurs in the policy function at time  $t$  – notice from eq. 10 that  $\tau_t = Q(Z(\tau_{t-1}))$  only depends on  $n_{t-1}$  and on  $n_t$  – the social security contribution rate will be set in accordance with the expectations of the median voter at time  $t - 1$ . Yet, the current median voter's expectations on the



future social security contribution rate do change because of the expected aging and so will the policy function in the next and in all future periods. The next proposition summarizes the results of this expected aging process on the social security contribution rate and on early retirement.

**Proposition 3** *Consider an economy at its stable steady state characterized by the social security contribution  $\bar{\tau}$ , a pension transfer  $\bar{p}$  and by  $\bar{z} = 1 - \bar{\tau}$ . A permanent decrease in the population growth rate taking place at time  $t + 1$ , but anticipated by the voters at time  $t$  – that is,  $n_{t+i} < n_t \forall i > 0$ , with  $E_t(n_{t+i}) = n_{t+i}$  – has the following effects:*

- *at time  $t + 1$ , it increases the contribution rate,  $\tau_{t+1} > \tau_t$ , and the early retirement,  $z_{t+1} < z_t$ , while leaving the per-capita pension unaffected,  $p_{t+1} = p_t$ ; and*
- *at steady state, it increases the social security contribution rate – i.e.,  $\bar{\tau}' > \bar{\tau}$  – the use of early retirement – i.e.,  $\bar{z}' < \bar{z}$ .*

**Proof. See Appendix.**

According to the proposition above, aging leads to higher social security tax rates and more early retirement, while leaving the per-capita pension transfer unaffected, at least in the short run. The intuition behind this result is the following. As the population growth rate drops, the implicit return from a PAYG social security system decreases as well. Hence, the median voter modifies the policy function by making it more responsive to the past early retirement (and hence to the past social security contribution rates) in order to compensate the lower returns with higher contributions. In particular, the median voter at time  $t + 1$  – that is, when the aging process effectively begins – increases the tax rate to counterbalance the effect of the aging on the pension transfer to the current elderly, which in fact remains constant. In future periods, until a new steady

state is reached, contribution rates will increase to finance higher social security spending and to compensate the successive median voters – the adults – for the higher contributions paid on their labor income. Eventually, at the new steady state, the contribution rate increases leading to more early retirement.

Another component of the returns from social security that has received large attention in the literature is the growth rate of wages,  $g$ . In fact, higher economic growth is often advocated as a painless solution to the financial sustainability problems affecting most PAYG social security systems. Yet, the political economy literature on social security has pointed out that changes in economic growth – by affecting the social security returns – modify the incentives faced by the voters in deciding the future pension policy.

To see how higher economic growth may affect these dynamics, consider the decision of the median voter, who determines the social security contribution rate, at time  $t$ , when a permanent increase in the economic growth rate takes place,  $g_{t+i} > g_{t-1} \forall i \geq 0$ . In our Markov perfect equilibrium, the median voter does not change her voting behavior, in order to validate the expectations of the previous median voter. Yet, she expects future median voters to obey to the new policy function – see eq. 10 – where the new values of the growth rates are taken into account. The next proposition summarizes the results of this increase in economic growth on the social security contribution rate and on early retirement.

**Proposition 4** *Consider an economy at its stable steady state characterized by the social security contribution  $\bar{\tau}$  and by  $\bar{z} = 1 - \bar{\tau}$ . A permanent increase in the economic growth rate at time  $t$  – that is,  $g_{t+i} > g_{t-1} \forall i \geq 0$  – decreases the steady state social security contribution rate – i.e.,  $\bar{\tau}' < \bar{\tau}$  – and reduces the use of early retirement – i.e.,  $\bar{z}' > \bar{z}$ .*

**Proof.** See Appendix.

Our Markov political equilibrium hence confirms the conventional (economic) wisdom that more growth reduces the size of the social security system. The intuition is similar, yet specular, to the case of aging. Higher growth now rises the implicit returns from a PAYG system. Hence, the pension benefits to the retirees may be obtained with lower contribution rates, and the policy function becomes less responsive to the past early retirement (and hence to the past social security contribution rates). Eventually, at the new steady state, the contribution rate drops leading to a lower use of the early retirement provisions.

### 3.4 Social Security, Early Retirement and Income Effects

The results obtained in the previous section are hardly reassuring. According to our political economy analysis, aging and productivity slow-downs will lead to larger social security system and more early retirement. However, the analysis carried out in the previous sections did not incorporate the possible effect of changes in income or wealth on the individual early retirement decisions, and thus on the politically determined social security contribution rate. According to eq. 4, in fact, retirement decisions only depended on substitution effects – through the impact of the labor tax on continuing to work. Possible income effects – leading poorer individuals to work longer, i.e., to retire later – were abstracted from, although several authors (see for instance Costa, 1998) have suggested that the long lasting decreasing trend in the retirement age may at least partially be due to the major improvements in economic conditions that increased the demand for leisure, and hence for early retirement.

In this section, we introduce a simple income effect in our economic model. In particular, we modify the utility function at eq. 2 by adding a new term for the disutility of labor which depends on the adult's wage:

$$U(l_t, z_{t+1}, c_{t+2}) = c_{t+2}^o - \frac{l_t^2}{2\alpha} w_t^y - \frac{z_{t+1}^2}{2\gamma} w_{t+1}^a - \lambda z_{t+1} (w_{t+1}^a)^2 \quad (11)$$

This modification<sup>3</sup> of the previous specification amounts to assume that the adults' retirement decision depends negatively on their current income. In fact, their optimal individual labor supply decision becomes:

$$\widehat{z}_{t+1} = 1 - \tau_{t+1} - \delta w_{t+1}^a \quad (12)$$

where  $\delta = \lambda * \gamma$ , and the growth rate of wages,  $g$ , is assumed to be equal to zero. Thus, low-income adults decide to work for longer periods and richer adult to retire earlier.

Clearly, this change in the retirement behavior of adults affects the PAYG social security systems, since the full pension transfer at time  $t$  which balances the budget constraint becomes:

$$p_t = \tau_t (1 + n_{t-1}) \left[ \overline{w}_t (1 - \tau_t) - \delta (w_t^a)^2 \right]. \quad (13)$$

How does the introduction of this negative income effect in the retirement decision modify the result of the Markov political equilibrium described in section 3? In this new scenario, the sequence of median voters face a similar political decisions to the one described in section 3.2, which leads to the following dynamics for the equilibrium social security contribution rates:

$$\begin{aligned} \tau_{t+1} = & \frac{1}{2} \left( 1 - \frac{\delta (w_{t+1}^a)^2}{\overline{w}_{t+1}} \right) + \\ & - \frac{1}{2} \sqrt{\left( 1 - \frac{\delta (w_{t+1}^a)^2}{\overline{w}_{t+1}} \right)^2 - \frac{2[A - (1+r)w_t^a(1 - \tau_t - \delta w_t^a)^2]}{(1+n_t)\overline{w}_{t+1}}}. \end{aligned} \quad (14)$$

with  $A \in [(1+r)w_t^a(1 - \delta w_t^a), (1+n_t) \left( \overline{w}_{t+1} - \delta (w_t^a)^2 \right)^2 / 2\overline{w}_{t+1}]$ .

Hence, also in this scenario, the dynamics described at eq. 14 points to the existence of a positive link between the current use of early retirement provisions

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<sup>3</sup>An alternative, more satisfactory way of introducing an income effect in the retirement decision would be to simply eliminate the linearity from the utility function. Were the utility function to be concave in the level of consumption, the retirement decision would immediately depend (negatively) on the lifetime income of the agent. However, this alternative specification would not yield a close form solution for the Markov perfect political economic equilibrium.

and the future social security contribution rate. A higher current social security contribution rate induces more current early retirement – due to the reduction in the opportunity cost of retiring – and creates expectations for more social security contributions and early retirement in the future. Moreover, as in the previous case, it is easy to show that  $d\tau_{t+1}/d\tau_t \in (0, 1)$ , and thus the equilibrium path converges to a steady state with a positive social security contribution rate – and early retirement, with equilibrium paths that are qualitatively similar to the ones shown in figure 3.1.

The discussion above suggests that this scenario, which incorporates an income effect, features similar properties for the Markov equilibrium outcomes as in the previous case. However, this new specification allows an analysis of the impact of a reduction in the adult’s labor income – i.e., a negative income effect – on the adults’ retirement behavior, in which the effect on the sequence of equilibrium social security contribution rates is also taken into account.

To see how this negative income effect may modify these dynamics, we consider an unexpected and permanent reduction in the labor income of the adults (and of the young) that takes place at time  $t$ ,  $w_{t+i}^a < w_t^a$  and  $w_{t+i}^y < w_t^y \forall i > 0$ . Faced with a lower income, the adults at time  $t$  will postpone retirement, according to eq. 12. In our Markov perfect equilibrium, the median voter will not change her voting behavior, in order to validate the expectations of the previous median voter. Yet, she will expect future median voters to obey the new policy function – see eq. 14 – where the new values of the wages are taken into account. The next proposition summarizes the results of this drop in the adults wages on their retirement decision.

**Proposition 5** *Consider an economy at its stable steady state characterized by the social security contribution  $\bar{\tau}$ , a pension transfer  $\bar{p}$  and by  $\bar{z} = 1 - \bar{\tau}$ . An unanticipated, permanent drop in the adults’ (and young’) wages taking place at*

time  $t$  increases the labor supply of the adults at time  $t$  and  $t + 1$ , that is,  $z_t > \bar{z}$  and  $z_{t+1} > \bar{z}$ .

**Proof. See Appendix.**

This proposition provides an interesting insight on the future of the early retirement provisions, which complements the results obtained in the previous section. When the effects of changes in income or wealth on the retirement behavior are taken into account, a reduction in the adult labor income induces individuals to postpone retirement, although we are not able to evaluate the impact on the equilibrium social security contributions. We argue that – to the extent that this reduction in the adults’ labor income may proxy for a drop in the life-time labor income – this may prove a crucial result to understand the future evolution of the early retirement provision. Societies characterized by economic stagnation or raise in inequality that increase the share of low-income individuals may thus be associated with a less pervasive use of these early retirement provisions.

## 4 Conclusions

Since the recent studies by Blondal and Scarpetta (1998) and Gruber and Wise (1999 and 2003), among others, providing evidence that individual retirement decisions are strongly affected by the design of the social security system, measures to postpone the effective retirement age has become a milestone in all social security reform’s proposals.

We concentrate on the current and future role of retirement, by analyzing the individual retirement decisions under different perspectives. First, we analyse the relation between the use of the early retirement provisions and the social security expenditure. In a cross-country sample, we find that the level of pension expenditures depends positively and significantly on the proportion of elderly

in the population (demographic variable) and on measures of early retirement (retirement variables). This total effect can be decomposed in the effect on the number of pensioners as proportion of total population and the effect on the per capita average pension. An older population and/or more early retirement imply more pensioners, while the effect on the generosity of the system, i.e., on the per capita average pension, are less evident.

We then introduce a political economy theoretical model to analyse the long term determinants of early retirement and the evolution of the social security system and of the early retirement provisions. In our politico-economic Markovian environment, every period, an adult median voter determines the social security contribution by considering the evolution of the early retirement behavior.

We use two specifications of our economic environments. In the former model, we emphasize the relevance of the incentives to retire early – i.e., the substitution effect – in line with a large empirical literature which shows how (at the margin) non-actuarially fair pension systems may induce rational agents to retire early, by reducing the opportunity cost of leisure. In this scenario, we obtain a political equilibrium characterized by a raising sequence of social security tax rates converging to a steady state. Along this equilibrium path, the use of early retirement provisions is increasing. The results of the comparative statics on this specification are dismaying. In line with the conventional wisdom in the economic literature, but unlike most of the implications found in the political economy literature (see Galasso and Profeta, 2002), productivity slowdowns (and aging) are expected to lead to higher social security contributions and to more early retirement.

In the latter economic specification, we introduce a negative effect of income on the retirement decisions: a decrease in the labor income when adult leads to postponing retirement. In this scenario, which aims at including an additional

long term determinant of the retirement decision – namely the life-time income – the political economic equilibrium is still characterized by an increasing sequence of social security tax rates and early retirement converging to a steady state. Yet, comparative statics now suggest that a decrease in the adult labor income will reduce the use of early retirement provisions, even after the effects on the equilibrium social security contributions are considered. To the extent that this change in adult income may proxy for a change in the net life-time income, we believe that this may prove an important result for the evolution of the early retirement provisions. In fact, we notice that, by reducing the internal rate of return to social security, aging also decreases the life-time net income of the new generations – the more so, the more the system is used. In its initial specification – with no income effects – our politico-economic model suggests that aging leads to a large social security system and to more early retirement. Yet, to the extent that this also translates into a lower life-time income, an additional channel may arise that reduces the use of early retirement provisions and hence postpones retirement.



## References

- [1] Azariadis, C. and Galasso, V., 2002. "Fiscal Constitutions". *Journal of Economic Theory* 103, 255-281.
- [2] Boskin and Hurd, 1978. "The effect of social security on early retirement". *Journal of Public Economics*, 10, 361-377.
- [3] Blondal S. and S. Scarpetta, 1998. "Falling Participation Rates Among Older Workers in OECD Countries: the Role of Social Security Systems", OECD Economic Department Working Paper.
- [4] Casamatta, G., H. Cremer and P. Pestieau, 2000. "The Political Economy of Social Security", *Scandinavian Journal of Economics*, 102, 503-522.
- [5] Casamatta, G., H. Cremer and P. Pestieau, 2002. "Voting on Pensions with Endogenous Retirement Age", mimeo.
- [6] Costa, D.L., 1998, *The Evolution of Retirement: An American Economic History 1880-1990*, University of Chicago Press for NBER.
- [7] Conde-Ruiz J.I. and V. Galasso, 2003. "Early Retirement", *Review of Economic Dynamics*, 6, 12-36.
- [8] Conde-Ruiz J.I. and V. Galasso, 2004. "The Macroeconomics of Early Retirement", *Journal of Public Economics*
- [9] Crawford V.P. and D. Lilien, 1981. "Social Security and retirement decision", *Quarterly Journal of Economics*, 95, 505-529.
- [10] Cremer, H., J. Lozacheur and P. Pestieau, 2002, "Social Security, Retirement Age and Optimal Income Taxation". mimeo

- [11] Cremer, H., and P. Pestieau, 2000, “Reforming Our Pension System: Is it a Demographic, Financial or Political Problem?”, *European Economic Review*, 40, 974-983.
- [12] Diamond P. and J. Housman, 1984 “The retirement and Unemployment Behavior of older men” in Aaron, H. and Burtless, G (eds). *Retirement and economic behaviour* (Washington, D.C. Brookings Institution), 97-134.
- [13] Diamond, P. A. and J. A. Mirrless “A model of social Insurance and with variable retirement”, *Journal of Public Economics* 10, 294-336
- [14] Fenge R. and Pestieau, P., 2004. MIT Press forthcoming
- [15] Feldstein, M., 1974. Social Security, induced retirement, and Aggregate Capital Accumulation, *Journal of Political Economy*, 82(5), 905-926.
- [16] Galasso, V., and P. Profeta, 2002, “The Political Economy of Social Security: A Survey”, *European Journal of Political Economy*, 18, 1-29.
- [17] Gonzalez-Eiras, M. and D. Niepelt, 2004. “Sustaining Social Security”. WP 371, IIES Stockholm.
- [18] Gruber, J. and D. Wise (eds.), 1999. *Social Security and Retirement Around the World*, University of Chicago Press, Chicago.
- [19] Gruber, J. and D. Wise (eds.), 2003. *Social Security Programs and Retirement Around the World: Micro Estimation*, forthcoming.
- [20] Hassler, J. Rodriguez-Mora, J.V., Storesletten, K. and Zilibotti, F., 2003, “The Survival of the Welfare State”, *American Economic Review* 93(1), 87-112.
- [21] Hu, S., 1979. “Social security, the supply of labor and capital accumulation”, *American Economic Review* 69 (3), 274-283.

- [22] International Labour Office, 1999. Yearbook of Labour Statistics.
- [23] International Labour Office, 2000. World Labour Report 2000.
- [24] International Monetary Fund, Government Finance Statistics Yearbook (1985-1998)..
- [25] Latulippe, D., 1997. "Effective Retirement Age and Duration of Retirement in the Industrialised Countries Between 1950 and 1990". ILO Discussion Paper 2.
- [26] Jimeno, J. F., 2002a. "Demografía, empleo, salarios y pensiones", Documento de Trabajo 2002-04. FEDEA, Madrid.
- [27] Jimeno, J. F., 2002b, "Incentivos y desigualdad en el sistema español de pensiones contributivas de jubilación". Documento de Trabajo 2002-13. FEDEA, Madrid.
- [28] Lacomba, J.A: and F.M. Lagos, 2000, "Election on Retirement age", mimeo.
- [29] Lazear, E.P., 1979 "Why is there mandatory retirement" Journal of Political Economy, 87(6), 1261-1284.
- [30] Michel, P. and Pestieau, P., 1999. "Social security and early retirement in an overlapping-generations growth model", CORE Discussion Paper 9951.
- [31] Profeta, P., 2002. "Aging and Retirement: Evidence Across Countries", International Tax and Public Finance 9, 651-672.
- [32] United Nations, Demographic Yearbook (1990-2000).
- [33] U.S. Social Security Administration. Social Security Throughout the World, (1999-2003).

## 5 Appendix

### 5.1 Proof of proposition 2

The first order condition of the median voter is:

$$-z_t w_t^a (1+r) + \frac{\partial p_{t+1}}{\partial \tau_{t+1}} Q'(z_t) Z'(\tau_t) = 0$$

where

$$\frac{\partial p_{t+1}}{\partial \tau_{t+1}} = (1+n_t)(1-2\tau_{t+1})\bar{w}_{t+1} \text{ and } Z'(\tau_t) = -1$$

Thus, the first order condition becomes

$$-z_t w_t^a (1+r) - (1+n_t)\bar{w}_{t+1} Q'(z_t) + 2(1+n_t)\bar{w}_{t+1} Q'(z_t) Q(z_t) = 0$$

Integrating the above equation with respect to  $z_t$ , we obtain

$$A - z_t^2 w_t^a (1+r) - 2(1+n_t)\bar{w}_{t+1} Q + 2(1+n_t)\bar{w}_{t+1} Q^2 = 0$$

where  $A$  is a constant of integration. Solving the equation w.r.t.  $Q$ , we have

$$Q(\tau_t) = \frac{1}{2} \mp \frac{1}{2} \sqrt{1 - \frac{2A - 2(1+r)w_t^a(1-\tau_t)^2}{(1+n_t)\bar{w}_{t+1}}}$$

Since  $\tau_{t+1} = Q(\tau_t)$  represents a tax rate, it has to be that  $Q \in [0, 1]$ . Thus, we have that

$$\tau_{t+1} = Q(\tau_t) = \frac{1}{2} - \frac{1}{2} \sqrt{1 - \frac{2A - 2(1+r)w_t^a(1-\tau_t)^2}{(1+n_t)\bar{w}_{t+1}}}$$

and the following restrictions on the free parameter  $A$ :

$$(1+r)w_t^a(1-\tau_t)^2 \leq A \leq \frac{(1+n_t)\bar{w}_{t+1}}{2} + (1+r)w_t^a(1-\tau_t)^2$$

Notice that, since the lower constraint is maximized for  $\tau_{t+1} = 0$ , while the upper constraint is minimized for  $\tau_{t+1} = 1$ , a sufficient condition for  $Q \in [0, 1]$  is

$$A \in [(1+r)w_t^a, \frac{(1+n_t)\bar{w}_{t+1}}{2}]$$

Finally, to make sure that the upper bound is indeed larger than the lower bound, we need to assume that  $(1 + n_t) \bar{w}_{t+1} > 2(1 + r)w_t^a$ ; or, analogously, that  $[(1 + n_{t-1})\varphi + 1]/2 > (1 + r)/[(1 + n_t)(1 + g)]$ . **Q.E.D.**

## 5.2 Proof of proposition 3

Consider the economy at its steady state and recall that eq. 10 provides the law of motion of the social security contribution rate. At time  $t + 1$ , a decrease in the population growth rate,  $n_{t+1} < n_t$ , shifts the function at eq. 10 upwards, since

$$\frac{\partial \tau_{t+1}}{\partial n_{t+1}} = - \frac{w_{t+1}^y [A - (1 + r)w_t^a(1 - \tau_t)^2]}{2(1 + n_t)(\bar{w}_{t+1})^2 \sqrt{1 - \frac{2A - 2(1+r)w_t^a(1 - \tau_t)^2}{(1+n_t)\bar{w}_{t+1}}}} < 0. \quad (15)$$

For  $\tau_t = \bar{\tau}$ , the social security contribution rate hence increases,  $\tau_{t+1} > \tau_t$ , and – from eq. 4 – so does the early retirement, since  $z_{t+1} = 1 - \tau_{t+1} < z_t = 1 - \tau_t$ . To see the effects on the per capita pension, notice that – by eq. 6 – at time  $t+1$ , the transfer depends directly on the contemporaneous population growth rate but also indirectly through the changes in the contribution rate:

$$\frac{\partial p_{t+1}}{\partial n_{t+1}} = \tau_{t+1}(1 - \tau_{t+1})(1 + n_t)w_{t+1}^y + (1 - 2\tau_{t+1})(1 + n_t)\bar{w}_{t+1} \frac{\partial \tau_{t+1}}{\partial n_{t+1}}.$$

Using the expression at eq. 10 we have that

$$\begin{aligned} 1 - 2\tau_{t+1} &= \sqrt{1 - \frac{2A - 2(1+r)w_t^a(1 - \tau_t)^2}{(1 + n_t)\bar{w}_{t+1}}} \text{ and} \\ \tau_{t+1}(1 - \tau_{t+1}) &= \frac{A - (1 + r)w_t^a(1 - \tau_t)^2}{2(1 + n_t)\bar{w}_{t+1}} \end{aligned}$$

By substituting these two expressions and the expression for  $\partial \tau_{t+1}/\partial n_{t+1}$  at eq.15 in the equation above, we hence have that  $\partial p_{t+1}/\partial n_{t+1} = 0$ .

Let us now consider the effects on aging on the steady state variables. To find the steady state value of the social security contribution rate, we need to consider that there may be growth in this economy, since we postulated that

$w_{t+1}^a = (1+g)w_t^a$ . By setting  $\tau_{t+1} = \tau_t = \bar{\tau}$  in eq. 10 we obtain the following value for the steady state social security contribution rate:

$$\bar{\tau} = \frac{(1+n)(1+g)\bar{w} - (1+r)w^a}{2(1+n)(1+g)\bar{w} - (1+r)w^a} + \quad (16)$$

$$- \frac{\sqrt{(1+n)^2(1+g)^2\bar{w}^2 - A[2(1+n)(1+g)\bar{w} - (1+r)w^a]}}{2(1+n)(1+g)\bar{w} - (1+r)w^a} \quad (17)$$

Simple algebra shows that  $\bar{\tau} \in [0, 1/2)$  and that  $\partial\bar{\tau}/\partial n < 0$ . Hence, aging increases the social security contribution rate at steady state and – by eq. 4– early retirement. **Q.E.D.**

### 5.3 Proof of proposition 4

Consider the steady state social security contribution rate at eq. 16. Simple algebra shows that  $\partial\bar{\tau}/\partial g < 0$ . Hence, productivity slow-downs increase the social security contribution rate at steady state and – by eq. 4– early retirement. **Q.E.D.**

### 5.4 Proof of proposition 5

At time  $t$ , when the adults' and young's labor income drops, the median voter will not change the social security contribution rate from its steady state level, in order to validate the expectations of the previous median voter at time  $t-1$ . She will however expect the tax rate to be changed at  $t+1$  due to this drop in labor income. By eq. 12, it is thus immediate to see that  $z_t = 1 - \bar{\tau} - \delta w_t^a > \bar{z} = 1 - \bar{\tau} - \delta w_{t-1}^a$ , since  $w_t^a < w_{t-1}^a$ .

To evaluate the impact of the drop in the labor income on the early retirement at time  $t+1$ , we need to consider eq. 14, which describes the dynamics of the social security tax rate. In particular, define  $w_t^a = w_{t+1}^a = w$  and  $w_t^y = w_{t+1}^y = w\varphi$ , then we have that

$$\frac{\partial \tau_{t+1}}{\partial w} = -\frac{\delta}{(1+n_{t+1})\varphi+1} + \frac{\Theta}{2\sqrt{\left(1 - \frac{\delta(w_{t+1}^a)^2}{\bar{w}_{t+1}}\right)^2 - \frac{2[A-(1+r)w_t^a(1-\tau_t-\delta w_t^a)^2]}{(1+n_t)\bar{w}_{t+1}}}}$$

where

$$\begin{aligned} \Theta = & \frac{\delta}{(1+n_{t+1})\varphi+1} \left(1 - \frac{\delta(w_{t+1}^a)^2}{\bar{w}_{t+1}}\right) - \frac{(1+r)z_t(z_t - 2\delta w_t^a)}{(1+n_t)\bar{w}_{t+1}} \\ & - \frac{[(1+n_{t+1})\varphi+1][A-(1+r)w_t^a z_t^2]}{(1+n_t)(\bar{w}_{t+1})^2} \end{aligned}$$

Notice that we cannot sign  $\partial \tau_{t+1}/\partial w$ ; however, it is easy to show that a sufficient condition for  $\Theta > 0$  is that  $A < (1+n_t)\delta(w_t^a)^2 \left(1 - \frac{\delta(w_{t+1}^a)^2}{\bar{w}_{t+1}}\right)$ , which is satisfied by the restrictions on A at eq.14 if  $3\delta(w_t^a)^2 > \bar{w}_{t+1}$ .

By eq. 12, we thus have that

$$\begin{aligned} \frac{\partial z_{t+1}}{\partial w} &= \frac{\delta}{(1+n_{t+1})\varphi+1} - \frac{\Theta}{2(1+n_{t+1})(\bar{w}_{t+1})^2} - \delta = \\ &= -\delta \frac{(1+n_{t+1})\varphi}{(1+n_{t+1})\varphi+1} - \frac{\Theta}{2(1+n_{t+1})(\bar{w}_{t+1})^2} < 0 \end{aligned}$$

since  $\Theta > 0$ . **Q.E.D.**

**Table 1. The variables (basic statistics)**

Variable	Obs	Mean	STD Error	Min	Max
OLD population over 65 years old/total population	106	8.487	4.935	2	18.2
ACTOT activity rate of individuals 55-64	110	0.488	0.139	0.19	0.87
ACM activity rate of man 55-64	110	0.69	0.159	0.29	0.93
AC1TOT activity rate of individuals 40-55	110	0.747	0.106	0.48	0.93
AC1M activity rate of man 40-55	110	0.921	0.074	0.35	1
DAC= AC1TOT-ACTOT	110	0.258	0.154	0	0.62
DACM=AC1M-ACM	110	0.231	0.16	0	0.55
PENSEXP Pension Expenditures as % of GDP	84	4.917	4.125	0	14.26
NUMPENS %of pensioners/ total population	53	10.503	10.41	0.01	29.7
AVPENS per capita average pension	50	1.049	1.94	0	11
GDP per capita GDP (U.S. \$)	101	10850.12	9305.93	6	42769

**Table 2. Determinants of pension expenditures (All countries)**

Independent variables	Dependent variable		
	PENSEXP (a)	PENSEXP (b)	PENSEXP (c)
CONSTANT	2.05 (0.91)	-2.28 (0.42)	-2.42 (0.42)
ACTOT	-6.8(1.45)***		
DAC		6.51 (1.77)***	
DACM			6.57 (1.55)***
OLD	0.6 (0.05)***	0.51 (0.07)***	0.56 (0.057)***
GDP	0.00005 (0.00002)**	0.00006 (0.00002)**	0.00004 (0.00002)**
N. Obs	84	84	84
R**2	0.837	0.823	0.83

\*\* significant at 5%, \*\*\* significant at 1%

**Table 3. Determinants of pension expenditures (OECD countries)**

Independent variables	Dependent variable		
	PENSEXP (a)	PENSEXP (b)	PENSEXP (c)
CONSTANT	0.39 (2.36)	-7.34 (2.02)	-6.9 (1.69)
ACTOT	-10.49 (2.51)***		
DAC		11.33 (3.42)***	
DACM			12.26 (2.54)***
OLD	0.76 (0.12)***	0.7 (0.13)***	0.69 (0.11)***
GDP	0.0001 (0.00004)**	0.0001 (0.00005)*	0.00008 (0.00004)**
N. Obs	26	26	26
R**2	0.79	0.76	0.82

\*\* significant at 5%, \*\*\* significant at 1%

**Table 4. Number of pensioners**

INDEPENDENT VARIABLES	DEPENDENT VARIABLE	
	NUMPENS (a)	NUMPENS (b)
CONSTANT	4.53 (3.54)	-8.72 (1.21)



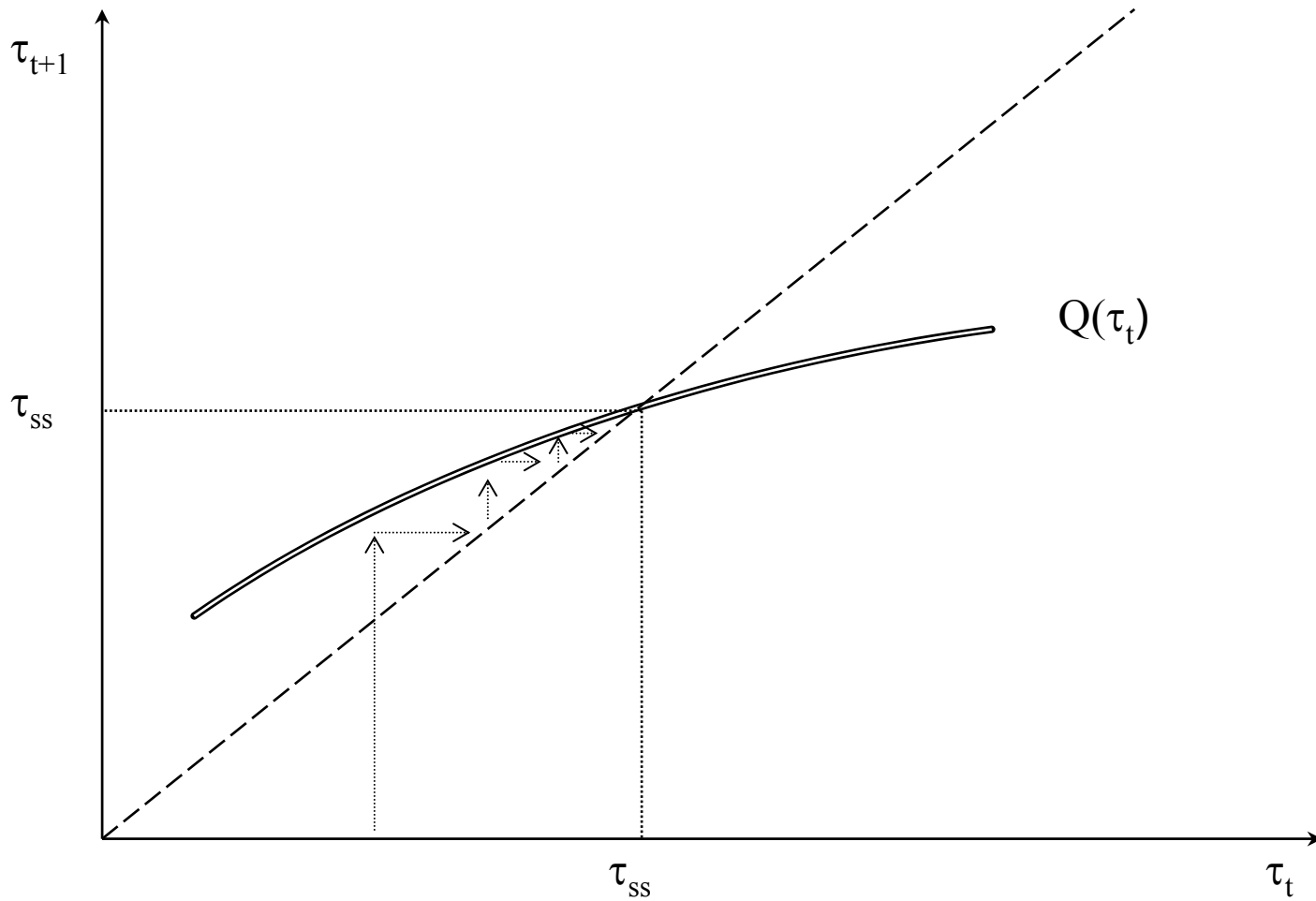
OLD	1.84 (0.14)***	1.46 (0.17)***
ACTOT	-20.65 (5.95)***	
DAC		24.25 (5.13)***
N. Obs	53	53
R**2	0.84	0.87

\*\*\* significant at 1%

**Table 5. Average pension**

INDEPENDENT VARIABLES	
	AVPENS
CONSTANT	2.31 (0.62)***
DAC	-0.34 (2.52) <sup>1</sup>
OLD	-0.13 (0.086) <sup>1</sup>
N. Obs.	50
R**2	0.1

\*\*\* significant at 1% , <sup>1</sup> not significant



**Figure 1**