The Macroeconomic Consequences of Public Finances: A potential Explanation for the Reduction in Effective Retirement Age.*

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Abstract

In order to study the macroeconomic effects of public finances, we construct a computable general equilibrium model with overlapping generations, endogenous growth and endogenous retirement age. We calibrate this model on Belgian data. We show that it is able to replicate the observed increase in labor income tax and a substantial part of the drop in the retirement age recorded over the last fifty years. In addition, we find that the sharp increase in government expenditures financed by labor income taxation and the building up of a high level of public debt may have significantly contributed to this evolution. This model further suggests that a policy aimed towards a reduction in the public debt as well as a pension reform implying a lower taxation on old workers would constitute politically feasible alternatives to reduce the negative impact on aging by generating an endogenous increase of the retirement age.

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1 Introduction

The first part of the last century has been characterized in the majority of OECD countries by the development of the Welfare State and by an increase of public intervention in the economy. After World War II, government becomes

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a major actor of the society, likely to affect the economy through the evolution of its finances and its financing methods.

Regarding this aspect, Belgium constitutes an interesting case study, as it represents for many aspects an extreme case of the European sample. The role of the state in the economy and its finances have indeed recorded major evolutions in the socio-economic history of Belgium after World War II. In addition, as far as the evolution of public finances is concerned, Belgium has represented and/or can still be considered as the "dunce" of the class of OECD countries (in particular for the high level of taxation and public debt, see Appendix A.2).

Ample movements of public finances, as in Belgium, are likely to have affected the past pattern of macroeconomic variables but also their future outcome by requiring major reforms of public finances. Our aim is therefore to develop a computable model with a detailed description of the public finances aggregates, in order to study the *past* and *future* effects of such public policies.

In particular, one striking feature of the *last* fifty years is the sharp decrease in the labor participation of old workers in various OECD countries (see table A.1). Such an evolution is problematic as it challenges the future sustainability of PAYG pension systems, already put under pressure by the drop in fertility. This phenomenon happens with an extreme intensity in Belgium where the current average retirement age (57.6 years) is the lowest among those countries.

May such an evolution be related to the movements of public expenditures and their financing method? Over this period, the generosity of pension scheme (measured by the gross replacement rate[1]) does not have sharply increased, while a substantial rise of the after-tax replacement rate[2] has been recorded[3]. This suggests that, rather than the increased generosity of the pension scheme, the evolution of the labor income taxation, which influences the incentives to work, may be an important element to consider when trying to explain the decline in the labor force participation. Hence, a question our model aims at answering is *whether and to what extent the drop in the participation rate of old workers might have been induced by expansionist fiscal policies.*

Such a model could be considered as complementary to the microeconomic models, which, in partial equilibrium, analyze the impacts of the level of transfers on the individual retirement decision[4]. This model would then fill a voice in the literature by analyzing the general equilibrium effects of retirement behavior[5] and underlying the potential macroeconomic interactions between public

[1] The ratio of mean gross (before-tax) pension receipts over mean gross (before-tax) wage

[2] The ratio over mean after-tax pension receipts over mean after-tax wages

[3] The gross (after-tax) replacement rate rose from 50% (72%) in 1975 to 55.07% (84.8%) in 1995, see Pestieau and Stijns (1999).

[4] See Atkinson (1987), Diamond and Gruber (1997) for surveys of this literature; Rust and Phelan (1997), Samwick (1998), Stock and Wise (1990 a,b), for recent analyses and Dellis, et al. (2001) for the Belgian case. From such analyses, Samwick (1998) concludes that 'although it is possible to estimate statistically significant relationship between the level of Social Security benefits and the likelihood of retirement at various ages, these estimated relationships typically imply a small economic impact of altering Social Security benefits on the average age of retirement or likelihood of retirement. These results suggest that the trend towards lower labor force participation has other explanations'.

[5] Endogenous retirement decision in a general equilibrium framework are theoretically ana-

finances, financing methods and retirement decisions.

On the other hand, looking towards the *future*, reforms of public policies are expected to occur for at least two reasons. First, Maastricht Treaty requires the European governments to reduce public debt - output ratio to 60 %. Second, the ageing of population requires some adjustment of the pension schemes in most of the OECD countries. We investigate what are the predicted macroeconomic effects of various scenarios of public debt reductions and pension reforms, including the effects on the retirement age in contrast to the majority of empirical contributions in this field.

For such a purpose, we use a calibrated general equilibrium model with overlapping generations, which according to Miles (1999) is probably the only reliable tool for conducing experiments connected with public policy affecting different generations in different ways. While this model is of similar type to that developed by Auerbach and Kotlikoff (1987), there are important differences. First, our model allows for technological progress, which affects the earnings profiles and is therefore a major determinant of the impact of demographic shifts. Second, in contrast to the majority of the applications of calibrated OLG models[6], growth is endogenized through a specification à la Lucas (1988). Human capital investment made by young agents is the engine of growth. This specification allows to account for the large increase in education investment from the sixties to the nineties. Third, the retirement decision is made endogenous. In addition to choose his investment in education and his consumption profile, each agent cares about leisure when old and decides over his optimal retirement age [7]. Our model extents the model of Bouzahzah, de la Croix and Docquier (2001) to include endogenous retirement decision. Fourth, our model differs from Auerbach and Kotlikoff (1987) in the age-productivity relationship and in the nature of the public pension scheme. The age specific productivity growth reflects the agent's productivity change over his life-cycle and is based on micro evidence. The public pension scheme is modeled as a PAYG Beveridgean system.[8]

We proceed as follows. We calibrate the public finances aggregates so as to match their evolution in Belgium between 1960 and 2000 and determine the evolution of the retirement age, education investment and other macroeconomic variables predicted by the model. We then compare this reference scenario to others where some of the public aggregates stay constant over time (in % of GDP). In this way we can compute the contribution of each public policy to

lyzed by Hu (1979), Michel and Pesticau (1999) and de la Croix, Mahieu and Rillaers (2000).

[6] One exception is the paper of Docquier and Michel (1999) that provides a simulation exercise of a three periods OLG model. Another is Bouzahzah, de la Croix and Docquier (2001) that develops a similar model calibrated on Europe, but where retirement age is exogenous.

[7] While the legal (mandatory) retirement age is fixed in Belgium at the age of 65 for men, there exist widespread early retirement plans, even before 60, the age of eligibility for social security benefits. This system leads to a variety of *effective* retirement ages. The empirical evidence suggest that at least of fraction of these departures can be considered as individual decisions. See appendix B for details.

[8] An assumption justified by the low linkage between contributions and benefits in the Belgian public pension scheme (see appendix B).

the past evolution and in particular assess its potential responsibility in the reduction of the effective retirement age. Finally, we perform some simulations illustrating the effects of various government policy reforms, including the effect on the retirement age.

We show that such a model is able to replicate the observed increase in labor income tax and a substantial part of the drop in the retirement age recorded over the last fifty years. This therefore suggests that the observed reduction of labor participation of old workers can be considered, at least partially, as an optimal adjustment of individuals confronted with increased labor income taxation, even in absence of any enlargement of the generosity of pension scheme. We find that the sharp increase in government expenditures financed by labor income taxation and the building up of a high level of public debt may have significantly contributed to this evolution. This model further suggests that a policy aimed towards a reduction in the public debt as well as a pension reform implying a lower taxation on old workers would constitute politically feasible alternatives to reduce the negative impact on aging by generating an endogenous increase of the retirement age.

The rest of this paper is organized as follows. The second section details the economic model. In section 3, we present our calibration procedure. Simulation results are detailed in section 4, while section 5 concludes.

2 A Computable OLG Model

We consider a closed economy with six overlapping generations of adults[9]. Time is discrete and goes from 0 to infinity. Agents are homogenous within generations and live for six periods of ten years each (i.e. from age 18 to age 78). The size of each generation t, N_t, (which includes all agents between 18 and 27 years old at time t) grows over time at a rate n_t:

$$n_t = \frac{N_{t+1}}{N_t}.$$

Each agent is born with an inherited level of human capital and decides the share of the first period he will devote to education. This will affect his life-cycle earnings profile and will also produce an intergenerational externality: the human capital investment of young at time t will be partially transmitted to the next generation. This endogenous growth specification allows to account for the large increase in education investment from the sixties to the nineties, which affects the evolution of public expenditures. It also constitutes an important element to consider in a debate concerning the pension system. Longer education period, by delaying entry into the labor market, reduces the average contribution period and hence requires an increase in the contribution rate, which could have influenced the retirement age.

[9] While keeping the model tractable, this number of generations allows to model the retirement decision in an appropriate period of time (between 58 and 68 years old).

2.1 The Household Behavior

The representative individual reaching age 18 at time t (belonging to generation t) has a utility function that depends on the sequence of consumption over his whole lifetime and on leisure. We suppose a time separable utility function:

$$U_t = \frac{1}{1-1/\sigma} \sum_{j=1}^{j=6} \beta^{j-1} \left[\left(c^j_{t+j-1} \right)^{1-1/\rho} + \varepsilon^j \left(h^1_t \eta^j_{t+j-1} \right)^{1-1/\rho} \right]^{\frac{1-1/\sigma}{1-1/\rho}} \tag{1}$$

where j refers to the j-th period of life, $\beta \in (0,1)$ is the psychological discount factor, $\sigma \in \Re_+$ measures the elasticity of inter-temporal substitution, $\rho \in \Re_+$ measures the elasticity of intra-temporal substitution, ε^j is a preference parameter for leisure, c^j_{t+j-1} is the individual consumption of generation t at the j-th period of life, h^1_t is the inherited stock of human capital at time t, and $(\eta^j_{t+j-1}) \in (0,1)$ denotes the share of the j–th period of life devoted to leisure.

The time endowment of each period being one, h^1_t represents the maximum amount of time measured in efficiency units that individuals of generation t can split between leisure and work. The formulation in (**??**) therefore insures that the marginal rate of substitution between consumption and leisure in the individual utility function is invariant with respect to the technological progress. By this way, the steady-state growth of productivity does not distort the individual life-cycle choice of leisure.

In their first period of life, individuals may devote a share e of their time endowment to human capital accumulation. Following the idea of Lucas (1988), education improves the skills of workers. We denote by $\varphi(e_t)$ the production function of human capital which transforms units of time invested in education into units of efficient labor. As there is no real evidence concerning the choice of this technology specification, we adopt a simple concave function production function:

$$\varphi(e_t) \equiv 1 + \zeta e_t^{\psi} \tag{2}$$

where $\zeta \in \Re_+$, $\psi \in (0,1)$ are two parameters. Their values will be set in order to replicate aggregates observed in Belgium.

The sequence of human capital of generation t is therefore given by:

$$(h^1_t, h^2_{t+1}, h^3_{t+2}, h^4_{t+3}, h^5_{t+4}, h^6_{t+5}) = (1, \theta_2\varphi(e_t), \theta_3\varphi(e_t), \theta_4\varphi(e_t), \theta_5\varphi(e_t), 0) * h^1_t \tag{3}$$

with θ_j $(j = 2, ...5)$ representing the relative productivity of age j with respect to the productivity of age one. This age changing productivity over life-cycle reflects learning by doing effects and age depreciation. The parameters θ_j will be set so as to match micro evidences of age-wage relationship. θ_6 is set equal to 0, as it is forbidden to work after the legal retirement age of 65 years old in Belgium.

The inter-temporal budget constraint of individuals equalizes the present value of life-cycle income to the present value of life-cycle expenditures. For

simplicity, we denote by π_t^{t+1} the discount factor to apply to period $t+1$ in order to express income and expenditures in time t value:

$$\pi_t^{t+j} = \prod_{s=t+1}^{t+j} \frac{1}{1+r_s(1-\tau_s^k)} \quad \forall j \in (1,\infty) \text{ and } \pi_t^t = 1$$

where r_{t+1} denotes the interest rate between dates t and $t+1$ and $0 \leq \tau_t^k \leq 1$ is the capital income tax at time t.

The intertemporal budget constraint is given by:

$$E_t \leq \Omega_t \tag{4}$$

with the discounted value of life-cycle spending given by:

$$E_t = \sum_{j=1}^{6} c_{t+j-1}^j (1+\tau_{t+j-1}^c) \pi_t^{t+j-1} \tag{5}$$

and the discounted value of life-cycle income by:

$$\Omega_t = \sum_{j=1}^{6} \left((1-\tau_{t+j-1}^w) w_{t+j-1} l_{t+j-1}^j h_{t+j-1}^j + T_{t+j-1}^j \right) \pi_t^{t+j-1} \tag{6}$$

where $0 \leq \tau_t^c \leq 1$ denotes the consumption tax at time t, $0 \leq \tau_t^w \leq 1$ is the labor income tax (including all social security charges) at time t, w_t denotes the gross wage rate per efficiency unit of labor at time t and T_t^j represents the public transfers received at age j at time t and l_t^j denotes the labor supply in the j-th period of life at time t.

The vector of public transfers by age is:

$$\begin{aligned} & \left(T_t^1, T_{t+1}^2, T_{t+2}^3, T_{t+3}^4, T_{t+4}^5, T_{t+5}^6\right) \\ = & \begin{pmatrix} \nu_t e_t (1-\tau_t^w) w_t h_t^1 + G_t^1 + G_t^{e\,1} m_t, \\ G_{t+1}^2 + G_{t+1}^{e2} m_t, G_{t+2}^3, G_{t+3}^4, \eta_{t+4}^5 p_{t+4} + G_{t+4}^5, \eta_{t+5}^6 p_{t+5} + G_{t+5}^6 \end{pmatrix} \end{aligned} \tag{7}$$

where $0 \leq \nu_t \leq 1$ denotes the public subsidy to individual education (expressed as a share of the individual opportunity cost), p_t represents the pension benefit received at time t, G_t^j includes all other public transfers devoted to each agent at age j, $G_t^{e\,1}$ denotes the public transfer to children between 0 and 7 years old (assumed to be raised by parents aged between 18 and 27 years old), G_t^{e2} is the public transfers to agents aged from 8 to 17 years old (assumed to be raised by parents aged between 28 and 37 years old) and m_t is the fecundity rate at time t (which is closely related to the population growth rate, see appendix C). Individuals receive a pension benefit for the fraction of time spent in retirement. The public pension scheme is modeled as a PAYG Beveridgean system. Each agent receives the same pension (adjusted for productivity growth), which is not related to past contributions. This assumption is justified by the low linkage between contributions and benefits in the Belgian public pension scheme[10].

[10] See appendix B for explanations and also Dellis et al.(2001).

Individuals belonging to generation t maximize the utility function (**??**) subject to the budget constraint (4), and the time constraints[11], given the sequences of human capital and public transfers. See appendix D for a complete characterization of the individuals' problem.

The education investment that maximizes the intertemporal utility of generation t is given by:

$$e_t^* = \left(\zeta\psi \frac{\sum_{j=2}^{6} \theta_j w_{t+j-1}(1-\tau^w_{t+j-1}) l^j_{t+j-1} \pi_t^{t+j}}{(1-\nu_t) w_t (1-\tau^w_t)} \right)^{1/(1-\psi)} \tag{8}$$

As can be seen in (8), the education investment increases with the public subsidy rate. It also depends positively on the future after-tax wage profile but decreases with the current after-tax wage which represents an opportunity cost. This optimal amount of education defines the maximal level of lifetime income.

In order to replicate the empirical evidence of labor supply and retirement decision[12], we assume that the taste for leisure varies with age according to the following pattern:

$$(\varepsilon^1, \varepsilon^2, \varepsilon^3, \varepsilon^4, \varepsilon^5, \varepsilon^6) = (0, 0, 0, 0, \varepsilon, \varepsilon) \tag{9}$$

The utility maximization with respect to leisure gives the optimal sequence of leisure:

$$(\eta^1_t, \eta^2_{t+1}, \eta^3_{t+2}, \eta^4_{t+3}, \eta^5_{t+4}, \eta^6_{t+5}) = (0, 0, 0, 0, \eta^5_{t+4}, 1) \tag{10}$$

and therefore the sequence of labor supply:

$$(l^1_t, l^2_{t+1}, l^3_{t+2}, l^4_{t+3}, l^5_{t+4}, l^6_{t+5}) = (1-e_t, 1, 1, 1, 1-\eta^5_{t+4}, 0) \tag{11}$$

with $1-\eta^5_{t+4}$ representing the optimal retirement age given by:

$$1 - \eta^5_{t+4} = 1 - \frac{c^5_{t+4}}{h^1_t} \left(\frac{\varepsilon(1+\tau^c_{t+4})}{(1-\tau^w_{t+4}) w_{t+4} \theta_5 \varphi(e_t) - \frac{p_{t+4}}{h^1_t}} \right)^{\rho} \tag{12}$$

During their last period of life, individuals are retired and devote all their time endowment to leisure. However, they can freely choose to be retired earlier

[11] Namely labor supply must be non negative for $j = 1..5$ and equal to 0 in period 6.

[12] Rust and Phelan (1997) summarizes several key facts of labor supply and retirement behavior. The cross-sectional distributions of hours worked show that most individuals work either 0 or 40 years per week. In addition, the majority of workers make discountinuous transition from full time work to not working. Such a discoutinuous retirement behavior also occurs in Belgium. Dellis et al. (2000) find indeed that the transition to retirement is absolutely not progressive and that 'part time work plays a totally marginal role in the Belgian retirement landscape' (see appendix B). Note also that such a 'zero-one' characterization of labor supply has also been used by Kingston (2000) and pioneerd by Burbidge and Robb (1980), Fields and Mitchell. (1984), and Mitchell and Fields (1984) in partial equilibrium models.

by working only a share $1-\eta^5$ of their fifth period (between age 58 and age 68), which reflects, at least partially, the reality in Belgium (see appendix B). The fraction of time $1-\eta^5$ therefore determines the optimal retirement age of the individuals of generation t. To determine the optimal retirement age, individuals equalize the marginal disutility of working with the marginal utility of consuming the additional revenue they will get by working[13]. The larger the after-tax replacement rate, the lower is the marginal gain obtained in case of work and the lower will be the retirement age. The larger the intertemporal elasticity of substitution, the more retirement age decision is sensitive to a change in the after-tax replacement rate.

The individuals' stream of consumption expenditures over the lifetime is determined by maximizing utility with respect to the levels of consumption:

$$\frac{c_{t+j}^{j+1}}{c_{t+j-1}^{j}} = \left[\beta(1+r_{t+j})\frac{\xi_{t+j}^{j+1}(1+\tau_{t+j-1}^{c})}{\xi_{t+j-1}^{j}(1+\tau_{t+j}^{c})}\right]^{\sigma} \tag{13}$$

with

$$\xi_{t+j-1}^{j} = 1 \quad \forall j = 1..4$$

$$\xi_{t+4}^{5} = \left[1+\varepsilon\left[\frac{\varepsilon(1+\tau_{t+j-1}^{c})}{(1-\tau_{t+4}^{w})\omega_{t+4}\varphi(e_t)\theta_5 - \frac{p_{t+4}}{h_t^1}}\right]^{\rho-1}\right]^{\frac{1/\rho-1/\sigma}{1-1/\rho}}$$

$$\xi_{t+5}^{6} = \left[1+\varepsilon\left(\frac{h_t^1}{c_{t+5}^{6}}\right)^{1-1/\rho}\right]^{\frac{1/\rho-1/\sigma}{1-1/\rho}}$$

By difference, we can compute the level of assets at the end of each period $\forall j = 1...5$:

$$\begin{aligned} s_{t+j-1}^{j} &= s_{t+j-2}^{j-1}(1+r_{t+j-1}(1-\tau_{t+j-1}^{k})) + (1-\tau_{t+j-1}^{w})w_{t+j-1}l_{t+j-1}^{j}h_{t+j-1}^{j} \\ &\quad + T_{t+j-1}^{j} - c_{t+j-1}^{j}(1+\tau_{t+j-1}^{c}) \end{aligned} \tag{14}$$

with s_{t+j-1}^{j} denoting the asset level of individual of age j. Since there is no bequest motive, the level of asset in the last period (s^6) is equal to 0.

2.2 The Firm Behavior

There exits one representative firm using physical capital (K_t) and human capital (L_t , labor in efficiency units) to produce one physical good (Y_t) that can

[13] This is consistent with the Mitchell-Fields rule: 'The optimal retirement date equates the marginal utility from an additional year of work with the marginal utility of leisure' (1984, p 87).

be consumed or stored in the form of capital. This good is taken as numeraire. The production function is assumed to be Cobb-Douglas:

$$Y_t = AK_t^{\alpha} L_t^{1-\alpha} \tag{15}$$

with α measuring the share of capital income in production and A an exogenous scale parameter.

Labor supply in efficiency units at time t is given by:

$$L_t = \sum_{j=1}^{6} N_{t-j+1} l_t^j h_t^j \tag{16}$$

The competitive behavior of the firm leads to the equalization of marginal productivities to marginal costs:

$$w_t = A(1-\alpha) K_t^{\alpha} L_t^{-\alpha} \tag{17}$$

$$\delta + r_t = A\alpha K_t^{\alpha-1} L_t^{1-\alpha} \tag{18}$$

with δ representing the capital depreciation rate.

2.3 The Government

The government has five types of expenditures: education subsidies, pension benefits, other transfers to households (G_t), other spending (G_t^A)[14] and public debt (D_t). In order to finance these spending, it levies labor income, capital income and consumption taxes and issues bonds. The government budget constraint in period t is therefore given by :

$$\begin{aligned} & \tau_t^w w_t L_t + \tau_t^c C_t + \tau_t^k r_t (K_t + D_t) + D_{t+1} \\ = \; & N_t \nu_t e_t (1-\tau_t^w) w_t h_t^1 + N_{t-4} \eta_t^5 p_t + N_{t-5} p_t \\ & + G_t + G_t^A + (1+r_t) D_t \end{aligned} \tag{19}$$

with D_t representing the public debt falling due in period t, G_t the aggregate transfers to household (other than pension benefits and higher education subsidies) at time t and C_t the aggregate private consumption at time t, as given by:

$$G_t = \sum_{j=1}^{6} N_{t-j+1} G_t^j + E_t^1 G_t^{e1} + E_t^2 G_t^{e2} \tag{20}$$

$$C_t = \sum_{j=1}^{6} N_{t-j+1} c_t^j \tag{21}$$

[14] Which mainly includes public consumption and some other transfers and operations in capital.

where E_t^1 denotes the number of children aged between 0 and 7 years old and E_t^2 represents the number of children between 8 and 17 years old at time t. As can be seen in (20), the splitting of public transfers per age allows to take into account the impact of a change in population structure on the government spending. To keep the ratio of public spending over output constant in the long run in this growing economy, we assume that the ratio of age specific public spending to human capital is constant over time:

$$\frac{G_t^j}{h_t^1} = g^j; \frac{G_t^{e1}}{h_t^1} = g^{e1}; \frac{G_t^{e2}}{h_t^1} = g^{e2} \tag{22}$$

In order to respect its budget constraint, the government can adjust expenditures, taxes, or public debt. In our baseline model economy, labor income taxes are periodically adjusted to finance the observed stream of public expenditures and the evolution of the public debt-output ratio ($d_t = \frac{D_t}{Y_t}$).

2.4 The Dynamics

Capital stock in $t+1$ is determined by the aggregation of savings made by the agents in period t . Public debt diverts part of the savings and must be subtracted from productive capital, which is then given by:

$$K_{t+1} = \sum_{j=1}^{5} N_{t-j+1} s_t^j - D_{t+1} \tag{23}$$

Human capital investment produces an intergenerational externality which is the source of growth. The human capital level acquired by the adult of generation $t-1$ is transmitted to the next generation and corresponds to the inherited human capital level of generation t:

$$h_t^1 = h_{t-1}^1 \varphi(e_{t-1}) = h_{t-1}^1 (1 + \zeta e_{t-1}^{\psi}) \tag{24}$$

2.5 The Competitive Equilibrium

The initial conditions of the economy (when $t=0$) are $(h_{-1}^1, h_{-1}^2, h_{-1}^3, h_{-1}^4, h_{-1}^5)$ and $(s_{-1}^1, s_{-1}^2, s_{-1}^3, s_{-1}^4, s_{-1}^5)$ corresponding respectively to the stock of human and physical capital of the five old generations, while the initial stock of physical capital is given by:

$$K_0 = \sum_{j=1}^{5} N_{-1} s_{-1}^j - D_0$$

with D_0 the initial stock of public debt.

Definition 1 *A competitive, perfect foresight, intertemporal equilibrium is a vector of individual positive quantities* $(c_t^j, s_t^j, e_t, \lambda_t, l_t^j, T_t^j, G_t^j)_{t\geq 0, j=1\ldots 6}$ *, aggregate positives quantities* $(C_t, K_{t+1}, L_t, Y_t, G_t, D_t, G_t^A, \tau_t^w, \tau_t^k, \tau_t^c)_{t\geq 0}$ *and prices* $(w_t, r_t)_{t\geq 0}$ *satisfying equations (3), (4), (7), (8), (9), (10), (11), (12), (13), (14), (15), (16), (17), (18), (19), (20), (21), (22), (23), (24).*

3 Calibrating the Model

In calibrated overlapping generations models, which are theory-based, the aggregate outcomes are the result of the sum of individual rational decisions. They are a useful tool to analyze the effects of past and future policy shifts. Such an exercise requires to choose values for parameters and exogenous variables so as to match a series of empirical moments computed on Belgian data. As there are more targets than parameters, this calibration is realized in an overidentification situation. For parameters for which a consensus exits, we choose in the range of estimates used in the literature the values that generate realistic values for Belgium. As we aim at reproducing the evolution from 1960, our reference period for calibration is 1960. Parameters and exogenous values are summarized in table 1.

Table 1: Parameters and exogenous variables

Total factor productivity A	8.0	Relative productivity parameter θ_2	1.397
Share of capital income α	.29	Relative productivity parameter θ_3	1.476
Subjective discount factor β	.84	Relative productivity parameter θ_4	1.385
Inter-temporal elasticity of substitution σ	1.5	Relative productivity parameter θ_5	1.125
Intra-temporal elasticity of substitution ρ	.8	Relative public spending 0-7 $\frac{G^{e1}}{G_1}$	1.622
Capital depreciation δ	.4	Relative public spending 8-17 $\frac{G^{e2}}{G_1}$	2.228
preference for leisure ε	.05	Relative public spending 8-17 $\frac{G_1}{G_1}$	1
Education parameter ζ	.269	Relative public spending 28-37 $\frac{G_2}{G_1}$	.85
Education parameter ψ	.143	Relative public spending 38-47 $\frac{G_3}{G_1}$	.901
Consumption tax τ^c	19%	Relative public spending 48-57 $\frac{G_4}{G_1}$	1.286
Capital income tax τ^k	16%	Relative public spending 58-67 $\frac{G_5}{G_1}$	1.421
Fecundity rate m	1.27	Relative public spending 68+ $\frac{G_6}{G_1}$	.74
Pension Benefit p	2.21	Public Transfers G	8%
High Education Subsidy ν	.215	Other public spending G^A	18%
		Public Debt over GDP d	70%

The share of capital income in national revenue amounts to 29%, which corresponds to the average share observed over the last twenty years. The rate of time preference corresponds to an annual rate of time preference of 0.983. This is in line with the discount rate of 0.015 used by Miles (1999) and Auerbach and Kotlikoff (1987). This is also consistent with the empirical evidence of Hurd (1989) who suggests a time discount rate somewhat above 1%. The elasticity of substitution belongs to the upper part of the range used in the literature. Since there is no bequest in our model, a high elasticity of substitution and a low time preference are necessary to generate realistic values for the savings rate and the interest rate. The intratemporal elasticity of substitution is identical

to the one used by Auerbach and Kotlikoff (1987), though we also experiment a lower degree of substitutability (see section 5.4.4). The preference for leisure is set in order to generate the retirement age observed in 1960. The rate of depreciation of the capital stock corresponds to an annual rate of 4%. This is in line with the computations of de Biolley and A. Gilot (1987) for Belgium over the last fifty years. The age-specific part of the labor productivity has been estimated using the quadratic equation of Miles (1999) which is based on micro-evidences.[15] Concerning the parameters influencing the education investment and human capital accumulation, there is no real consensus in the literature. We therefore base on Bouzahzah, de la Croix and Docquier (2001). They undertake a sensitivity analysis for the values of these parameters and determine different sets of parameters values giving very similar steady states. In this set, we select parameters that produce endogenous values for the annual growth rate and for educational attendance closed to the ones actually observed. The value of the pension benefits has been fixed in order to be in line with the share of pension benefits in GDP. The computations of Pestieau and Stijns (1999) suggest that while the gross replacement rate stays relatively constant over time (50% in 1975 and 55, 07% in 1995), the after-tax replacement rate has risen since years 1975 (where it was equal to 72%) to reach almost 85% in 1995. We therefore assume that pension benefits remain at their initial level (adjusted to the productivity growth), but we let the labor income tax rate adjust, influencing endogenously the after-tax replacement rate. Consumption tax is set to 19% and capital income tax to 16% and stay constant over time. The public transfers (which include family allowance, education expenditures for children below 18 years old, health care and unemployment benefits) are split by age groups using the study on generational accounting of Docquier, Liégeois and Stijns (1999)[16] and the age profile of the public transfers is assumed to be constant over time. The fecundity rate is chosen so as to replicate the dependency ratio and the growth rate of population (see appendix C for details). As the government largely subsidizes the monetary cost of education rather than the opportunity cost of education, there is no real evidence on an aggregate concept of education subsidy rate. However, the public subsidy to education must be such that it generates both an education investment and a share of education expenditures in GDP close to the observed values[17]. In our model, individuals can only choose their education investment from the age of 18 years old. An appropriate reference data concerning the public education expenditures is therefore the ratio of public expenditures for *higher* education over GDP. We approximate this ratio by the expenditures devoted by the Belgian Ministry for National Education and Culture to higher education in percentage of GDP. With the parameters chosen for human capital accumulation, a subsidy of .215 reproduces this ratio (equal

[15] The quadratic function used is : $\theta_{age} = 0.05 * age - 0.0006 * age^2$

[16] See tables A.8. and A.9. for details of the splitting by age.

[17] Data concerning education that could be used as a reference in a calibration exercice are however difficult to find for such a long period. The data we use are therefore the best approximation we could find.

to 0.2% in 1960[18]) together with realistic values for interest rate and growth rate. Public transfers, other public expenditures and public debt in percentage of GDP correspond to their actual value in 1960[19].

The economy is assumed to be on the balanced growth path in 1960[20]. Table 2 shows the endogenous variables in the initial steady state obtained with the parameters and exogenous values detailed in table 1.

Table 2: Initial Steady State

Endogenous variables	**Simulated values**	**Target values**
Retirement age	63.3	63.3
Fraction of Time devoted to education	6.9%	6.9%
Pension benefits over GDP	4%	4%
Education expenditures over GDP	0.26%	0.2%
Annual growth rate	1.7%	1.7%
Annual interest rate	4.89%	$4-5\%$
Labor income tax	24.1%	24.1%
Replacement rate	57.6%	57.6%
Private consumption - output ratio	61%	61%

The characteristics of the baseline economy at the initial steady state closely correspond to the ones observed in 1960. In particular, the retirement age and educational investment exactly match the actual data, while labor income tax, replacement rate and the share of private consumption in output reach realistic values[21].

This steady state is locally stable in the saddle-point sense. The number eigenvalues larger than one[22] corresponds to the number of independent predetermined lead variables. There is therefore a unique trajectory that converges to the steady-state. Figure 1 depicts the eigenvalues at the steady-state (with the real part of the X-axis and the imaginary part on the Y-axis).

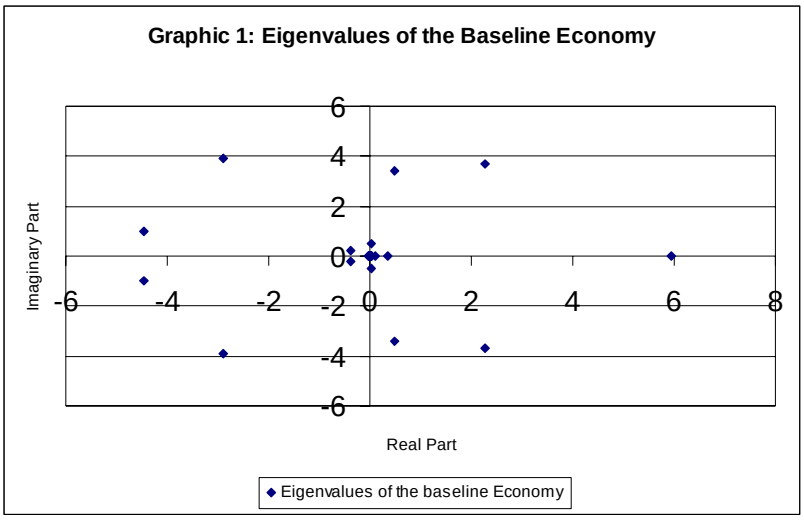
[18] Data source: Annuaires Satistiques de la Belgique (Tomes 82).

[19] Source Savage (2000)

[20] As we do not have the data on assets holding per age in 1960, we assume that the economy is at steady state in 1960. However, the results are not modified if the inital capital stock is 10% below or above its steady state value.

[21] The data concerning taxation were computed in EC (2000) with a specific methodology but back to 1970 only. It should however be somewhat lower than in 1970 and presumably close to 25%. The computations of after-tax replacement rate is not trivial and homogenous data were not available before 1975. However, the after-tax replacement rate in 1960 must be lower than its value in 1975 (as computed by Pestieau and Stijns (1999)) and probably around 60%.

[22] The eigen values were computed by Dynare and there are 9 eigenvalues larger than 1.



4 Simulation Results

In this section, we use the economic environment described above in order to investigate whether it is able to replicate the observed evolution of the economy between 1960 and 2000. We particularly focus on the evolution of labor income tax rate, education investment and retirement decision. We then assess the potential contribution of public policies in accounting for such an evolution. In addition, the simulation tool is used to compute the potential effects of various reforms, including the effect on the future retirement pattern.

We proceed as follows. The economy is assumed to be on the balanced growth path in 1960. We then introduce shocks on the exogenous variables in order to replicate the observed and projected policy changes between 1960 and 2050. In order to compute the expectations of the agents living in period 2050, we need to anticipate the policy variables until 2110. We therefore assume that after 2050, the exogenous variables remain constant and that the new steady-state is reached 10 periods later (namely in 2150)[23]. The values taken by these policy variables are summarized in table 3.

[23] This long transition period makes the approximation error due to the forced convergence to the final steady state small.

Table 3: Exogenous public policy variables

years	1960	1970	1980	1990	2000	2010	2020	2030	2040	2150
m	1.27	1.06	0.84	0.88	0.97	0.92	0.89	0.91	0.96	1.0
ν	.215	.32	.43	.54	.65	.65	.65	.65	.65	.65
$G(\%)$	8	9.1	12.3	11.7	12.1	12.1	12.1	12.1	12.1	12.1
$G^A(\%)$	18	22.1	26.1	19	19.5	19.5	19.5	19.5	19.5	19.5
$d(\%)$	70	70	64.3	123.4	122	90	60	60	60	60

Sources: Savage (2000), Federal Planning Bureau (1997a, b), INS: Labor Market survey and Population Census (1960-1999), Annuaires Statistiques de la Belgique (Tomes 73, 82, 91, 101, 113).

Appendix C details the subsequent evolutions of the population growth and dependency ratio implied by the fecundity rate. The subsidy to higher education increases between 1960 and 2000 in line with the share of higher education expenditures in GDP and is assumed to be constant after 2000. The evolution of public transfers and other public expenditures in percentage of GDP follow their actual trend. As D_t represents the public debt falling due at time t, the public debt is the average stock of public debt of the last five years. Concerning the future evolution of public debt, in the baseline model economy we assume that Belgium satisfies the Maastricht criteria in 2020 and that public debt - output ratio stays constant thereafter[24]. We also investigate the effects of the very rapid and optimistic debt reduction projected by the Federal Planning Bureau as well as the impact of maintaining public debt - output ratio at its the current level (see section 4.4.3).

We simulate the transitory and long-run effects of these changes on the endogenous variables of the model, with a special focus on the labor tax rate and retirement age evolution. This determines the baseline model economy or 'reference scenario' as it acts as a reference with respect to the other experiments. The first section details the key features of this scenario. Comparing the dynamics with and without these exogenous shocks allows us to determine the effects of each policy variable on all endogenous variables of the model. In particular, we can assess the potential contribution of each government policy to the observed drop of retirement age. This is the purpose of the second section. Finally, the comparison of the reference scenario with the simulated evolution under different policy reforms for the periods 2000-2150 allows us to make some conjecture for the future.

4.1 Findings: the Baseline Model Economy

In this section, we describe the main features of the baseline model economy. The question is: 'Is such a model able to reproduce the pattern observed in the

[24] This corresponds to the numbers that seem to be admitted in most discussions concerning the fulfillment of Maastricht criteria, see Liégeois and Ginsburgh (2000).

data between 1960 and 2000 for the endogenous variables of the model, and in particular for the retirement age?'.

As can be seen in figures of appendix E and in table 4, the model generates a sharp reduction of the optimal retirement age between 1960 and 2000 in accordance with the pattern observed in the data. It goes from 63.3 years in 1960 to 58.2 years in 2000. This corresponds to a reduction of 8.1% of the retirement age, while the reduction observed in the data between 1960 and 1995 is around 9%. The model replicates therefore relatively well the value as well as the pattern of the retirement age. This reduction is caused by the increasing labor income tax, which in turn raises the effective replacement rate even if the pension benefits remain constant. The after-tax replacement rate increases indeed dramatically, in line with its actual evolution over this period (see Pestieau and Stijns (1999)). The endogenous evolution of the labor income tax closely follows the observed growth and predicts for 2000 a value very similar to the actual one (see table 4). Note that labor income tax strongly rises between 1990 and 2000 while the public expenditures stay relatively constant. The future reduction of the public debt indeed augments temporarily the expenditures to be financed by labor income taxation. This phenomenon is even exacerbated by the reduction of labor participation which increases the pension expenditures to be financed on a shrinking working population. The share of pension expenditures in output rises from 4% in 1960 to 7% in 2000 (which represents almost 60% of the observed increase, the actual share of pension expenditures in output in 2000 being 9.2%) and this without any increase in the level of pension benefits.

The evolution of higher education investment also closely follows the observed pattern (see table A.10). It depends on the education subsidy but also on the expected after-tax wage profile over the lifecycle, hence on labor income taxation. This explains why education investment stays virtually unchanged between 1960 and 1970, although the education subsidy increases. The expected net wage profile is decreasing and augments the relative opportunity cost of education. From 1980 onwards, the increase in education subsidy rate and the expected slightly increasing net wage profile lead to an increase in education investment to a level equal to the actual attendance ratio. The path of education investment (with one lag) combined with the evolution of the output determines the growth rate pattern. The population growth drives the evolution of labor supply together with the evolution of retirement age. The reduction of retirement age leads to a decrease of labor supply in the sixties and seventies, while the labor supply of generations from the baby boom more than compensates this effect in the eighties and nineties. The baby boom also explains the growth of capital stock in the eighties and nineties and is therefore partially responsible for the large output growth rate in 1990 and 2000.

This model is able to replicate fairly well the observed pattern of endogenous variables, especially labor income tax, education investment and labor market participation of the old. It may therefore offer another potential explanation for the reduction in labor force participation of older workers than the increase in the level of pension benefits traditionally put forward. According this model, the observed pattern of retirement age could be considered, at least partially,

as an *optimal adjustment of the workers* to expansionary fiscal policies, even *without* any change in the pension scheme. This analysis may further imply that were pension legislation changed to allow people to retire at a free age (a policy actually suggested by some French politicians), the retirement age would continue to be as low as currently, *if* no concomitant change in the pension formula is introduced.

Table 4: The baseline model economy in 2000

Endogenous	**Reference scenario**
Retirement age	58.2
Education Investment	19.4%
Pension benefits / GDP	7%
Education subsidies / GDP	1.83%
Annual growth rate	3%
Annual interest rate	4.72%
Labor income tax	45.7%
Replacement rate	64.9%

4.2 The Past: The impact of Public Finances

4.2.1 The Contribution of the Increase in Public Expenditures

To assess the potential effects of the path of public expenditures on the endogenous variables, and in particular on the evolution of labor income tax and retirement age in Belgium, we compare the dynamics of the baseline model with a scenario where the share of total public expenditures in GDP stays constant over time at the level of 1960[25]. Notice that while we implement this change we keep all the remaining variables and parameters identical to the ones calibrated in the baseline model economy. In this case, the evolution of the labor tax is essentially driven by the pattern of public debt (see figures in appendix F). Consequently, initially lower labor income taxation is required to finance lower government expenditures, especially in the eighties. The increased public debt ratio in this period offers an additional source of financing, while reporting expenditures on the future. On the other hand, the rising public debt ratio still requires an increase in labor income tax after 1980, which in turn induces a reduction of retirement age. After 1980, labor income tax follows a similar path than in the baseline economy but at a lower level. Hence, labor supply and output have similar paths than in the baseline case but at a higher level. With a lower income tax, the net gain of education is higher. The pattern of education investment is similar to its evolution in the baseline model up to 1990,

[25] With the notation used above, the total public expenditures correspond to $(G + G^A)$, where the main composants driving the evolution of the sum are the transfers to households (G) and the public consumption.

but slightly higher from 2000. As can be seen in figure 2, the retirement age decreases in a much lower extent and even slightly increases in the seventies. The model predicts in this experiment a retirement age of 61.6 years old in 2000, which corresponds to a decrease of 2.7% from 1960 (see table 5).

We can therefore conclude that the path of public expenditures (essentially driven by government consumption and transfers others than pension and education subsidies) may have partially contributed to the drop in retirement age, by inducing a higher labor income tax and hence reducing the incentives to work.

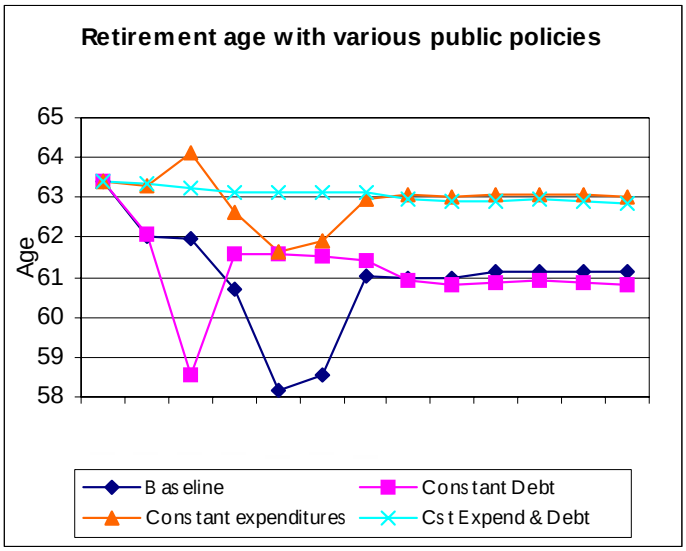


Figure 2: Contribution of public policies to the decrease in retirement age

4.2.2 The Contribution of the Public Debt Financing

We investigate next to what extent the evolution of the endogenous variables is related to the financing method of public expenditures. Building up public debt allows the government to pay for increased public expenditures in the short run while reporting the cost on the future. Hence, such a financing method also contributes to increase future expenses. Adopting the same methodology, the figures in appendix F also compare the evolution of the endogenous variables in the reference scenario with their evolution if the public debt - output ratio was remained constant at its initial level, while other exogenous variables and parameters remain identical than in the baseline model economy.

Were the public debt maintained constant at its initial level (70% of GDP), the retirement age in 2000, as predicted by the model, would have been much higher than in the reference scenario and hence than its actual current value. It would only be reduced from 2.7% compared to its initial value (see table 5),

implying a higher level of labor supply and output. While labor income tax would have been lower from 1990 onwards (as taxation does not have to finance the interests on public debt nor its reduction), we would still have observed a rise during the eighties to finance the expansion of government expenditures. This explains the rise in education investment in the eighties (as the opportunity cost is lower in this period), as well as the drop in retirement age, labor supply and output in this period. The education level is slightly lower from 1990 to 2020 than in the baseline as the labor income tax pattern is increasing.

This analysis therefore suggests that public expenditures evolution and public debt financing are two elements that may have contributed to the increase in labor income tax and hence to the decline in the retirement age of old workers. As can be seen in figure 2, with constant public debt (at 70%) and constant share of public expenditures in output, retirement age would have remained essentially unchanged and would have been equal to 63.1 years old in 2000.

Table 5: Economy in 2000 with constant fiscal policies

Endogenous	**Cst spending**	**Cst debt**	**Cst debt & spending**
Retirement age	61.6	61.6	63.1
Education Investment	19.8%	17.8%	18.5%
Pension benefits / GDP	5.5%	5.6%	4.8%
Education subsidies/ GDP	1.8%	1.6%	1.6%
Annual growth rate	3%	3.4%	3.2%
Annual interest rate	4.64%	4.9%	4.67%
Labor income tax	35.3%	36.3%	27%
Replacement rate	58%	67.1%	59.6%

4.2.3 Contribution of Education Investment: Exogenous versus Endogenous Growth

An important demographic phenomenon observed during the last fifty years is the lengthening of the education period. This is reflected in the increase in public education expenditures over these years. Such an evolution has important consequences for a pay-as-you-go pension system, as it reduces the average contribution period and requires an increase in the contribution rate. While this element could be put forward to justify a postponement of the legal retirement age, it could also have influenced the optimal retirement age through its effect on the labor income tax. In addition to its impact on the taxation basis, higher education investment raises the public expenditures, which also leads to an increase in labor income tax. To study the potential impact of such a phenomenon, we run a simulation where education investment is kept constant at its initial level of 6.9%[26], while all other exogenous variables remain identical to their values in the baseline model. As can be seen in the figures of appendix G, larger labor supply and lower education transfers allow to reduce

[26] Growth is hence exogenous

labor income tax and hence increase the incentives to go on working, which in turn contributes to further increase labor supply. Retirement age would have decreased to 59.1 years old only in 2000 in this case (see table 6). According to this model, this element would account for 18% of the decrease in the retirement age (1.4 percentage point).

Table 6: Economy in 2000 with constant education investment

Endogenous	**Cst Education**
Retirement age	59.1
Education Investment	6.9%
Pension benefits / GDP	6.4%
Education subsidies/ GDP	0.6%
Annual growth rate	3.15%
Annual interest rate	4.81%
Labor income tax	44.1%
Replacement rate	63.7%

4.3 And the Future?

In this section, we use the model to assess the potential impacts of some reforms actually considered by European governments, including the effect on the retirement age.

4.3.1 Reduction of the Public Debt

Maastricht criteria require the European governments to reduce public debt-output ratio to 60%. A reduction of public debt is thus expected in Belgium, but predictions about the extent and the speed of such a reduction vary among economists. As public debt pattern may have influenced the past evolution of retirement age, it is interesting to investigate the effects various public reduction scenarios could produce in the future, especially for the retirement age pattern.

By comparing the baseline model economy[27] to a scenario where public debt - output ratio remains at its level in 2000 (110%) and to another one where public debt sharply decreases to the level of 15% of GDP in 2050, as predicted by the Federal Planning Bureau[28], we can compute the effect of such reductions in public debt on all endogenous variables of the model.

As can be seen in figures H.1, a public debt reduction generates a substantially lower taxation level, hence replacement rate in the long run. It however requires an initial increase of the taxation (the larger the sharper is the planned reduction in public debt) by temporary augmenting the share of expenditures to be financed by labor income taxation. Education investment initially increases

[27] Remember that such a scenario implies a reduction of the public debt ratio to a value of 60% from 2020 onwards.

[28] The stream of public debt-output ratio reduction assumed in this case is 90% in 2010, 56% in 2020, 30% in 2030, 20% in 2040, 15% in 2050, see Federal Planning Paper (1997b).

because of the increasing wage profile and stays higher in the long run as lower labor income taxation rate increases the gain of higher education.

Concerning the retirement age, two lessons can be drawn from such an exercise. On one hand, a policy aimed at reducing public debt *endogenously* increases the retirement age, without requiring any change in the legal retirement age, which might be politically difficult. The retirement age increases to 61.2 in 2150 if public debt is reduced to 60% and to 62.2 if public debt reaches 15% of GDP (see table 7). This policy, through the numerous positive effects that it produces (higher labor supply, higher human capital, higher output, higher growth and higher public transfers per head, see appendix H) may therefore constitute a politically feasible alternative to partially reduce the negative impact of aging in the OECD countries. Indeed, according to OECD (1998), should the average retirement age rise to 70 most of the adverse consequences on living standards could be avoided. On the other hand, while public debt reduction would be very beneficial in the long term, the analysis underlines the potential negative effect this policy could *initially* produce on the retirement age. This explains the strong decrease of retirement age in 2000-2010 observed in the scenario with accelerated public debt. If agents expect the public debt - output ratio to remain at its 2000 level, the retirement age would be around 59.9 years old in 2000 but would continue to decrease thereafter (to 59.3 years old in 2150) due to the higher labor tax necessary to pay interests on debt. With a public debt ratio at 15%, the long-term level of taxation is lower while retirement age, education and output are higher than in the baseline economy model.

By increasing the after-tax wage and reducing the interest rate, a public debt reduction increases the lifecycle income but also modifies the individual consumption profile. Individuals are less willing to save and prefer to consume in their first period of life. Compared to the initial steady state, individuals enjoy in the final steady-state a higher level of consumption when young and a lower level when old (see figure H.2.). The smaller the debt reduction, the lower will be the shift of consumption from old to young age. If the debt remains at its current level, no substantial reallocation of consumption across time occurs and consumption level of every period decreases.

Table 7: Long term effects of various debt reduction patterns

Endogenous	**Reference**	**debt 15%**	**Debt 2000**
Retirement age	61.2	62.2	59.3
Education Investment	17.8%	18.8%	16.6%
Pension benefits / GDP	7.14%	6.6%	8.26%
Education subsidies / GDP	1.8%	1.9%	1.71%
Annual growth rate	1.93%	1.94%	1.91%
Annual interest rate	4.8%	4.5%	5%
Labor income tax	37.9%	35.6%	41.6%
Replacement rate	76.5%	73.1%	82.1%
Output	51.9	53.2	49.9

4.3.2 Pension Reforms

Although opinions differ about the extent of the problem of the ageing of population, it is a general consensus that some adjustment of the pension schemes will be necessary in most of the OECD countries. Various empirical evaluations have been carried out to highlight the impact of demographic change and the effect of potential reforms (see for example Miles (1999), Kotlikoff (1996), Conesa and Krueger (1999), Auerbach et al. (1989), De Nardi et al. (1999), Huang et al. (1997), Kotlikoff et al. (2001), and for the Belgian case, Docquier (1994), Docquier et al. (1999), Liégeois and Ginsburgh (2000)). However, in all of these contributions, retirement age is considered as an exogenous parameter[29]. It is therefore interesting to investigate what are the predicted macroeconomic effects (included the effect on the retirement age) of various pension reforms. Two pension reforms will be considered: a drastic reform towards a fully-funded scheme and a parametric reform implying a change in the structure of taxation.

Fully-Funded Scheme

We first compute the effect of a drastic transition towards a fully-funded pension system. It is assumed that from year 2010 onwards no pension benefits are paid. The exercise is realized in the likely case where public debt converges towards the Maastricht criteria and in case public debt remains at its 2000 level (respectively called d60% and d2000 in appendix I).

The shift towards a Fully-Funded pension scheme has two direct effects: it increases savings, hence capital and it lowers labor income taxation. The reduction of taxation augments income and increases further savings. In addition, it raises human capital and labor supply, which in turn reinforces its lowering by enlarging the tax basis. The effects on capital and labor supply combine to generate a higher output level than in the baseline scenario, and this even

[29] The only exception is Kotlikoff et al.(2001) that, among other policy options, considers the effect on the payroll tax of an increase of retirement age modeled as an endogenous response to an assumed exogenous increase in old age productivity.

if public debt remains at its high current level, hence still diverting a part of savings (see figures I.1). The increased output allows to increase *in both cases* the per capita transfers level (G^j), while keeping the share of transfers in GDP constant. This could be used to compensate the loss of pension benefits at the end of life. In these experiments, the splitting of public transfers by age is kept identical to the baseline model economy. Therefore, the share devoted to the last generations might not be large enough to fully compensate the experienced loss. Compared with the baseline scenario a reform towards a fully funded pension scheme generates in both cases higher long-term consumption levels in the four first periods of life (see figure I.2). If Maastricht criteria are respected, long-term consumption levels in the fifth and sixth period of life (in a smaller extent) are lower than in the baseline case. The share of public transfers devoted to individuals older than 58 years old is indeed not large enough to overcome the loss of income induced by a longer working period at a low productivity level and by the loss of pension benefits. If debt remains at its current level only the fifth generations lose in the long-run, compared with the reference case. However, in view of the total consumption gains in the first periods of life, in both cases an intergenerational transfer could be designed in order to make everybody better off in terms of consumption.

Parametric Reform

While a reform of pension system towards a fully-funded scheme may be subject to political resistance, some parametric reforms[30] can also produce an increase of the retirement age but avoid social or political unrest. A straightforward reform would be to increase the *statutory* retirement age (a reform considered by the empirical studies cited above and also by Sayan and Kiraci (2001), Bütler (2000)). However, this may be difficult to implement for political reasons (see Bütler (2001)). By changing the parameters of the pension formula, a reform could reduce the incentives to leave labor market and therefore produce an *endogenous* increase in the labor supply. As our model advocates, labor income taxation may have significantly contributed to the drop of labor market participation. An interesting reform would hence involve a change in the structure of taxation in order to decrease the after-tax replacement rate, without requiring any change in the pension benefits. For illustrative purpose, we compute the effects of very drastic reform that totally exempts labor income from taxation in the last period of work.

This reform produces two effects on the labor income tax. On one hand, by significantly reducing the after-tax replacement rate, it raises retirement age, hence labor supply. The tax paid by a increased number of contributors and necessary to finance a reduced number of pension beneficiaries is therefore lower. On the other hand, it requires its increase as taxation is now supported by four generations only and the gross wage is reduced due to the fall in capital-labor ratio. If Maastricht criteria are respected, the second effect slightly dominates

[30] a term often employed to denote changes in the parameters of the existing pension system, see Chand and Jaeger (1996).

the first one, requiring an increase in labor taxation in comparison with the baseline model (see figure I.1). The higher level of taxation leads to a slightly lower capital level than in the baseline scenario. However, the higher labor supply compensates the lower capital level to generate a higher output and therefore a higher transfer per head in the long run[31]. Due to its large positive labor supply effect, such a policy (if coupled with a fulfillment of the Maastricht criteria) seems therefore a good alternative to solve the baby bust.

This reform has different consequences in term of consumption profile. While a transition towards a fully-funded scheme exacerbates the reallocation of consumption towards the early years of life occurring in the baseline case, such a reform shifts consumption towards the end of life. Compared to the baseline scenario, this reform generates higher consumption levels in the four last periods of life during the transition as well as in the long run, while the short-run and long run consumption losses in the two first periods of life are very limited (see figures I.2.). In contrast to a reform towards a Fully-Funded pension system, the loss for the 'transition generations' can be easily avoided, which would then ease the political implementation of such a reform.

Table 8: Long term effects of pension reforms

Endogenous	**FF debt 60%**	**FF high debt**	**Parametric**
Retirement age	65.9	65.7	65
Education Investment	20.2%	19.2%	18.6%
Pension benefits / GDP	0%	0%	5.35%
Education subsidies / GDP	1.9%	1.8%	1.8%
Annual growth rate	1.96%	1.94%	1.94%
Annual interest rate	4.4%	4.7%	5.3%
Labor income tax	28.2%	30%	38.9%
Replacement rate	0%	0%	71.3%
Output	56.1	55.3	53.5

4.4 Sensitivity Analysis

4.4.1 Small Open economy assumption

While the assumption of closed economy allows to fully take into account the general equilibrium effects of public policies, one could however wonder whether this hypothesis is accurate for an open and small country such as Belgium. We therefore run the same exercise but we keep prices constant. We fix the interest rate so that the income share of capital matches that under endogenous factor prices.

[31] As pension benefits must be financed by labor tax and still diverts part of the savings, such a reform generates a lower capital and output level than a Fully-Funded reform.

Table 9 summarizes the numerical findings in this case. As can be noticed, even with constant prices, the model reproduces the observed evolution of education, labor income tax and retirement age. In particular, it is able to generate a substantial reduction in the retirement age in line with what has been observed between 1960 and 2000. Appendix J displays the graphics in these cases and compare it with the baseline scenario.

Table 9: Endogenous values under the small open economy assumption

Endogenous	**1960**	**2000**	**2150**
Retirement age	63.8	58	61.5
Education Investment	7.4%	20.9%	18.5%
Pension benefits / GDP	4.1%	7.6%	7.2%
Education subsidies / GDP	.29%	2%	1.91%
Annual growth rate	1.72%	3%	1.94%
Annual interest rate	5.8%	5.8%	5.8%
Labor income tax	23.4%	47.6%	37.5%
Replacement rate	57.4%	63.7%	77%

4.4.2 The Value of ρ

Any calibration exercise requires to make assumptions about the values of some parameters. They were chosen in order to match a series of empirical moments computed on Belgian data and in conformity with the range provided by the literature. However, one parameter for which no consensus exists is the intertemporal elasticity of substitution (ρ). A last step in this paper is to do some robustness analysis for the value of such a parameter. Although, we use the same parameters as Auerbach and Kotlikoff (1987), we also perform the analysis with a lower value. The lower this parameter, the less sensible is the retirement age decision to a change of the opportunity cost of working. On the other hand, changing the value of ρ requires to adjust the parameter ϵ (the value of leisure) in order to generate an initial retirement age close to the observed value in 1960.

For lower values of ρ, the path of every variable is exactly the same, but the magnitude of variation of retirement age is lower. For example, with $\rho = 0.5$, in the baseline model economy the retirement age would be reduced to 60.8 in 2000[32]. As in the previous case, this evolution is explained by the combination of increasing public debt - output ratio and expansionary fiscal policies. The two pension reforms considered significantly improve the output level through their positive effects on the labor market participation and generate the same reallocation of consumption patterns. The only difference is that with a lower

[32] For concision, appendix J only contains the table corresponding to the case of $\rho = 0.5$. The graphics for this and other values are available on request.

intratemporal elasticity of substitution the adjustment to an exogenous change occurs more through a change in consumption than in leisure. Therefore, the variation of consumption in 2000 is larger the lower is ρ.

These results confirm the capacity of such a model to generate the pattern observed between 1960 and 2000. It shows also that, even if agents are reluctant to substitute between consumption and leisure, the observed reduction of labor participation of old workers could be interpreted, at least partially, as an optimal individual adjustment, no matter the evolution of pension scheme. In addition, they corroborate that improvements in labor market participation could be generated through reduction in public debt as well as through pension reforms.

5 Conclusion

From World War II, government has become an influential actor of the economy in the majority of OECD countries. Regarding this aspect, Belgium constitutes an interesting case study as the role of the state and its finances have recorded major evolutions in the socio-economic history of Belgium after World War II. In addition, the compliance to the Maastricht criteria still requires major reforms of the Belgian public finances, whose effects are likely to affect the economy in the future. We therefore develop a computable model in order to study the past and future effects of public policies.

A particular question our model aims at addressing is whether and to what extent the drop in the effective retirement age, occurring in most OECD countries and with an extreme intensity in Belgium, may have been induced by the expansionist fiscal policies and its financing method. In addition, we investigate the macroeconomic impacts (included the effect on the retirement age) of public policy reforms in order to fulfill Maastricht criteria and to adjust the current PAYG pension system challenged by the ageing of population. This model fills a voice in the literature by analyzing the general equilibrium effects of retirement behavior and underlying the potential macroeconomic interactions between public finances, financing methods and retirement decisions.

To investigate these questions, we use a calibrated general equilibrium model with overlapping generations in the spirit of Auerbach and Kotlikoff (1987)) with endogenous growth, endogenous retirement age and with a detailed description of the public finances aggregates. We calibrate them so as to match their evolution in Belgium between 1960 and 1995.

Our model is able to replicate the observed evolution of the main macroeconomic variables of the economy between 1960 and 2000. In particular, it can reproduce the observed increase in labor income tax and a substantial part of the drop in the retirement age recorded over the last fifty years. This therefore suggests that the observed reduction of labor participation of old workers can be considered, at least partially, as an optimal adjustment of individuals confronted with increased labor income taxation, even in absence of any enlargement of the generosity of pension scheme. We find that the sharp increase in government ex-

penditures financed by labor income taxation and the building up of a high level of public debt may have significantly contributed to this evolution. This model also suggests that a policy aimed towards a reduction in the public debt would constitute a politically feasible alternative to reduce the negative impact on aging by generating an endogenous increase of the retirement age. However, the speed of public debt reduction may be a crucial factor regarding the retirement age. Finally, our results show also that a parametric pension reform implying a lower taxation on old workers, while probably less politically controversial than a transition towards a fully-funded pension scheme, substantially amplifies the positive effects of Maastricht criteria on the retirement age without implying a loss for the 'transition generations'.

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A Some Stylized Facts in Europe and in Belgium

A.1 Average Retirement Age in Europe

A striking feature of the last fifty years is the sharp decrease in the labor market participation of old workers in various European countries. This happens with an extreme intensity in Belgium where the average retirement age is the lowest among those countries, as can be seen in table A.1.

Table A.1: Average retirement age for men in European countries

	1960	1970	1980	1990	1995
Austria	63.9	62.7	60.1	58.7	58.6
Belgium	**63.3**	**62.6**	**61.1**	**58.3**	**57.6**
Denmark	66.7	66.3	64.5	63.3	62.7
Finland	65.1	62.7	60.1	59.6	59.0
France	64.5	63.5	61.3	59.6	59.2
Germany	65.2	65.3	62.2	60.3	60.5
Greece	66.5	65.6	64.9	62.3	62.3
Ireland	68.1	67.5	66.2	64.0	63.4
Italy	64.5	62.6	61.6	60.9	60.6
Luxembourg	63.7	62.5	59.0	57.6	58.4
Netherlands	66.1	63.8	61.4	59.3	58.8
Norway	67.0	66.5	66.0	64.6	63.8
Portugal	67.5	67.2	64.7	63.9	63.6
Spain	67.9	65.2	63.4	61.6	61.4
Sweden	66.0	65.3	64.6	63.9	63.3
Switzerland	67.3	66.7	65.5	64.8	64.6
United Kingdom	66.2	65.4	64.6	63.2	62.7

Source: Blöndal and Scarpetta (1998)

A.2 Evolution of Some Public Finances Aggregates in Belgium: a Good Case Study

Over the period 1960-2000, Belgian public finances have experienced some major evolution (see table A.2).

Table A.2: Public Finance Aggregates in Belgium

	1960	1970	1980	1990	2000
Public debt/GDP[1]	80.8%	63.3%	72.8%	122.1%	115%
Interest on public debt/GDP	2.8%	3.2%	6%	10.5%	7%
Primary expenditures/GDP	30.6%	37.6%	48.9%	40.5%	41.6%
*Transfers to households/GDP	12.4%	14.9%	21.5%	20.7%	21.3%
-Pensions/GDP	4%	5.8%	9.2%	9%	9.2%
*Public consumption/GDP	12.4%	13.4%	17.6%	14%	14.4%
-Education/GDP	3.8%	5.2%	7.1%	5.8%	5.9%
-Higher education/GDP	0.2%	0.571%	1.025%	.815%	.815%
*Public expenditures in capital/GDP	3.5%	5.3%	5.3%	2.1%	2.5%
*Other public expenditures/GDP	2.3%	4%	4.5%	3.7%	3.4%
Primary Surplus (deficit)	−2%	+1%	−2.2%	+4.8%	+6.5%

1. The public debt refers to the total debt of public administration including local government.

Sources: OECD(2000), Savage (2000), Bureau Federal du Plan (2000), INS: Labor Market survey, Annexes Statistiques de la Belgique (Tomes 73, 82, 91, 101, 113).

On one hand, the last fifty years have been characterized by a dramatic increase in public expenditures until 1981, followed by a moderate reduction. Over the period 1960-73, the main culprit was the rise in primary expenditures, largely caused by the increase of the transfers to households (and in particular of social security transfers), but also due to a rise in public consumption (particularly though education expenditures). This ascending evolution was supplemented during the second part of this period by the interests to paid on the public debt[33]. Public debt increased indeed from 80% of GDP in 1960 to almost 85% in 1981 and continued to increase thereafter to reach a maximum of almost 134% of GDP in 1993. The increase of public debt between 1981 and 1990 is due to the well know 'snowball effect', which only reverses since 1993. Since 1982, the public policy was indeed fundamentally reoriented towards a reorganization of public finances. Primary expenditures were significantly reduced, rather through a reduction in public consumption and public investment than via a reduction of the transfers to households.[34]

This change in public policy can also be noticed by looking at the evolution of the primary surplus: it has now reached in Belgium a higher percentage of GDP than in the majority of the OECD countries (see table A.3). However, even with such a cleansing, the Belgian public debt - output ratio is still the

[33] In 1981, primary expenditures represented 51.7% of GDP, while the interests on public debt absorbed 8% of GDP.

[34] The share of transfers to household in primary expenditures has indeed risen over time, from 37.5% in 1953 to 44.7% in 1981 and to 51.8% in 1999.

highest of the European sample, making the Maastricht critical level of 60% of GDP still very far away (see table A.4).

Table A.3. Primary Surplus (Deficit) - % of Nominal GDP

	95	98
Belgium	4.97	6.53
Germany	0.21	2.12
France	−1.76	1.57
Netherlands	1.73	5.39
EU-15	0.23	3.46
Japan	0.13	−4.84
US	1.78	4.89

Source: E.C. (DG II): AMECO database.

Table A.4. Government Debt - % of Nominal GDP

	96	99
Belgium	120.53	115.89
Germany	59.78	61.06
France	55.67	58.62
Netherlands	75.23	62.87
EU-15	72.16	67.52
Japan	80.49	97.40
US	74.50	65.24

Source: E.C. (DG II): AMECO database. Japan data for 1998.

On the other hand, to finance these growing public expenditures, taxes levied by the government were constantly augmented over the last fifty years, particularly on labor income. The effective tax rates on labor rose from 28.3% in 1970 to 44.2 % in 2000[35], making the current Belgian tax rate well above the European average (for which a comparable but more moderate ascending evolution was recorded) and almost double than the US tax rate (see table A.5).

Table A.5. Effective Tax Rates on Labor (%)

	70	80	90	2000
Belgium	28.3	38.0	41.9	44.2
Germany	29.4	38.1	38.3	43.6
France	26.6	34.6	39.7	41.8
Netherlands	29.9	37.8	38.5	36.3
EU-15	25.5	32.5	35.7	36.9
Japan	10.7	16.3	22.5	21.0
US	16.7	20.6	21.8	23.9

Source: E.C. (2000).

[35] While tax rates on capital income increased in a moderate extent and tax rates on consumption stay relatively stable (see tables A.6 and A.7)

Table A.6. Effective Tax Rates on Capital (%)

	70	80	90	2000
Belgium	16.0	21.3	20.1	23.7
Germany	18.3	19.0	16.2	16.0
France	15.5	17.7	17.9	22.0
Netherlands	19.5	22.5	21.5	24.0
EU-15	15.5	17.5	18.8	20.6
Japan	19.0	30.1	29.5	23.5
US	26.3	22.4	19.9	22.7

Source: E.C. (2000).

Table A.7. Effective Tax Rates on Consumption (%)

	70	80	90	2000
Belgium	23.2	17.8	18.3	20.6
Germany	19.2	17.7	17.8	18.0
France	23.6	23.3	23.1	24.1
Netherlands	15.9	15.6	16.7	19.5
EU-15	20.0	18.6	19.4	20.7
Japan	13.2	12.2	13.7	13.5
US	11.9	9.6	9.5	9.2

Source: E.C. (2000).

A.3 The Splitting of Public Transfers by Age

The splitting of public transfers by age groups is based on the study of generational accounting of Docquier, Liégeois and Stijns (1999). This study determines the total public transfers received by an individual at each year of his life in Belgium in 1997. Using the population structure in Belgium in 1997, we can determine the total transfers received by each age group (Total) as well as its decomposition by types of transfers.

Table A.8. Public Transfers by Age Group in % of Total Public Transfers

	Fam.All	**Edu<18**	**Health**	**Unemp**	**Edu>18**	**Pensions**	**Total**
0-7	3.49	2.76	1.17	0	0	0	7.42
8-17	3.43	7.98	1.21	0.11	0	0	12.73
18-27	1.57	0	2.66	2.04	3.68	0	9.95
28-37	0.07	0	3.99	2.27	0.14	0.12	6.58
38-47	0	0	4.62	1.63	0	0.51	6.76
48-57	0	0	4.65	2.45	0	2.13	9.24
58-67	0	0	5.02	2.19	0	11.58	18.79
68+	0	0	4.61	0	0	23.92	28.53
Total	8.56	10.74	27.92	10.71	3.81	38.26	100

Data are expressed in percentage of total public transfers. The first column includes Family allowance and birth allocation, the second (Edu<18) includes education transfers for individuals younger than 18, the third column includes health care, the fourth includes unemployment benefits, the fifth includes education transfers for individuals older than 18, the sixth includes pension benefits, the last is the total transfers received by each age group.

We can then construct our restrictive aggregate of public transfers, $N_{t-j+1}G_t^j$, which only includes family allowance, education transfers for individuals younger than 18, health care and unemployment benefits (expressed in table A.9 in percentage of total public transfers). Finally, the ratio of *average* transfer per head in each age group determines the relative transfer per head in each age group. Note that G^6/G is smaller than G^5/G due to the suppression of unemployment benefits which cannot be paid after 65 years old and whose beneficiaries come then under the pension scheme.

Table A.9. Relative Public Transfers by Age Group

	Total	$\mathbf{N}_{t-j+1}\mathbf{G}_t^j$	$\frac{G^j}{G^1}$
0-7	7.42	7.42	1.622
8-17	12.73	12.73	2.228
18-27	9.95	6.27	1.00
28-37	6.58	6.33	0.85
38-47	6.76	6.25	0.901
48-57	9.24	7.11	1.286
58-67	18.79	7.21	1.421
68+	28.53	4.61	0.74
Total	100	57.93	

A.4 Evolution of Attendance Ratio

In order to confront it with the simulated values, table A.10 displays the evolution of attendance ratio for higher education observed in Belgium.

Table A.10. Attendance Ratio for higher education in Belgium

	71	81	91	98
Attendance Ratio*	6.9	9.4	14	18.5

* Share of individuals having received higher education

Source: Population Survey (INS, 1970,1981,1991) and Labor Market Survey (INS, 1998).

B Some Elements of the Belgian Pension System

This appendix mentions some features of the Belgian pension system which justify the assumptions made in the macroeconomic model. As explained below, the Belgian pension system allows in some extent to choose the retirement age, so that retirement decision can be considered, at least partially, as an *individual* decision. In addition, there exists a relatively *low linkage* between contributions and pension benefits, a fact that justifies the assumption of a Beveridgean pension system (flat pension benefits). Finally, pension benefits are *hardly taxed* in

Belgium, which makes our assumption reasonable. For detailed explanations, refer to Dellis, et al (2000)[36], Pestieau and Stijns (1999) and De Callatay E. and B. Turtelboom (1997).

The Belgian retirement income system essentially relies on the public social security programs, which is financed on a PAYG basis (through contributions - amounting to 16.36% for wage-earner's shared by employers and employees and to 7.5% for public servants- and by federal Government). This first pillar mainly consists of four components: the programs for wage-earners, for public sector workers, for self-employed and a guaranteed minimum pension system operating on a mean-tested basis. We essentially detail the two first ones, as the two others only concern a small fraction of population. In addition to these retirement programs, there also exist early retirement provisions, which operate either under the name of early retirement schemes, or as a form of old-age unemployment, or disability programs.

The wage-earner's scheme has the largest number of affiliates. It allows for retirement between 60 and 65, and the choice of retirement age does not induce any actuarial adjustment. Until 1992, there existed an actuarial adjustment of 5% per year of retirement before 65, while no adjustment was made in case of delayed retirement. However, the choice of the retirement age is not totally neutral with respect to the pension benefits. Full earnings history consists indeed of 45 years of work for men[37] and many people does not satisfy such a condition at the age of 60.

The benefits are based on the earnings during the periods of affiliation according to the following formula :

$$\text{Benefits} = \min[n/45, 1] * \text{average wage } * \text{ replacement rate}$$

where the replacement rate is 0.6 or 0.7, depending on whether the recipient is single or the head of household and the average wage is the average wage over the period of affiliation, indexed on the price index and on some discretionary adjustments for the evolution of growth. However, periods spent on replacement income (unemployment benefits, disability benefits, worker compensation, ...) fully count as years worked and the imputed wages are set equal in real terms to those earned before entering the replacement income programs.

The benefits are subject to some minimum approximately equal to 56% of the average after-tax wage. There also exists a cap on pension benefits (120% of the average gross wage) and an earnings test (of approximately 300.000 bef).

In addition to this retirement schemes, there also exist several forms of early retirement programs, which can be divided in two groups: mandatory collective retirements and individual early retirements.

The *mandatory retirement schemes* are based on collective agreements, which are negotiated with the active involvement of employees and employers, either

[36] Most of the information mentioned in this appendix comes from this contribution.

[37] Note that for women a full carreer consisted before of 40 years of work but is now increased progressively towards 45 years.

at the sectorial level or at the individual company level. For some companies in difficult economic position, mandatory retirement at 50 years old was introduced. These programs aim at reducing the unemployment of the young but the beneficial effects on the labor market have been very moderate or almost absent. These programs are very costly for the government because they reduce the contribution periods and induce an additional cost as a large fraction of the early retirement compensation is paid by the federal government. In addition, retiring early *does not induce any loss of income* for the individual as years spent on retirement income count as working periods. Furthermore, during this time individuals do not have to pay retirement contributions.

The *individual early retirement scheme* is based on an individual's decision to retire. The most prevalent way is to pass through the unemployment system in which people aged fifty and more are considered as 'aged unemployed' and do not have to look for a job. Hence, the people that are unwilling to continue working can ask their employer to lay them off. This allows the employer to replace the costly old worker by a cheaper young one. Some people attempt to proceed though disability insurance scheme. However this does not seem a very frequent way to retiree in the private sector according Dellis et al. (2000), as screening is relatively severe and benefits are not significantly more interesting than early retirement provisions.

The public sector employees' scheme

The retirement is compulsory at 65 years old but there also exists a multitude of ways to retire early than this normal age of 65. It is possible to opt for an incomplete career and retire at 60. For some categories of workers, the normal retirement is lower than 65 and early retirement provisions are sometimes extremely generous (for example, secondary schools teachers can retire at the age of 55 if they have sufficient years of service).

The public sector pension benefits are based on income earned during the last 5 years before retirement and computed according a complicated formula, but can never exceed 75 percent of the average wages over the last five years. The pension is also limited by a ceiling corresponding to three times the average gross wage of the economy. The minimum pension is fixed to 56 percent of average wage for single individuals and 70 percent for one-earner couple. In addition, the public pension benefits are indexed on the average wage (and not only on the price index as in the wage-earner's scheme), enjoying the benefits of increased productivity.

Aside this official route, public servants can also retire through disability protection, which is more likely than for the private sector employees as screening is less severe.

Labor market participation and retirement patterns

We reproduce here some tables computed by Dellis et al. (2000). The first one illustrates the low labor market participation of workers even at the early ages of 50-55. It also highlights that part-time working is a totally marginal way to retire for men in Belgium.

Table B.1:Labor Market and Benefit Programs Participation for Men (%)

	$50-54$	$55-59$	$60-64$	$65-69$	*Total*
Working full-time	24.71	15.39	6.64	1.59	48.33
Working part-time	1.53	0.93	0.45	0.19	3.10
Not working	0.73	1.10	0.74	0.03	2.60
Unemployment benefits	0.63	0.62	0.52	0.01	1.78
Disability Benefits	0.82	1.23	1.57	0.02	3.64
Early retirement benefits	0.45	3.94	6.63	1.41	12.43
Public retirement benefits	0.55	1.80	7.93	17.84	28.12
Total	29.42	25.01	24.48	21.09	100.00

Source : Dellis et al. (2000)

The table B.2. shows the ways to retire for male wage-earners (as the lack of data makes it impossible to separate the path for civil servants). We notice the importance of early retirement provisions and the important role of unemployment system, which includes some mandatory early retirees but also voluntary early retirees.

Table B.2: Pathways to retirement for men (%)

	Wage-earners
Directly to SS	34.85
Early Retirement then SS	46.97
Disability then SS	8.21
Unemployment then SS	9.97
Total	100.00

Source : Dellis et al. (2000)

This confirms the findings of OECD (1998) reporting that, while some early departures from labor market are definitely initiated by employers[38], this scenario only represents *a fraction* of the transitions to inactivity. Different elements indeed suggest that the observed reduction of labor participation *also reflects the wish of the workers*. As shown in OECD (1998)[39], in Belgium as in many other European countries more than half of inactive men in the 55-64 year-old age group claimed that the reasons to leave their job were due to early retirement and normal retirement and only less than 5% for dismissal or redundancy. Moreover, the patterns of early retirement are related to employees' characteristics. The computations of OECD (1998) suggest that some categories of workers, such as lower earners and those with unstable jobs, have a greater propensity to retire early. In Belgium, 53.4% of male workers with no further

[38] The pattern of early retirement in Belgium seems indeed to mirror to some extent sectorial employment trends, with a higher proportion of retired males aged 55-64 in declining and slow-growing sectors such as manufacturing, mining and quarrying.

[39] Table II.2

education and 57.4% of workers with vocational training in the age group 55-64 are retired while this proportion is only 36.9% for males with third level education. Finally it is also interesting to notice that early retirement schemes were negotiated by unions. They may thus be interpreted, not as an exogenous change, but as the expression of the desire of earlier transition to inactivity of workers.

Hence, these empirical evidence show that retirement decision constitutes in some extent an individual decision. It is therefore important to look for reasons that could explain an increased individual taste for earlier retirement.

Taxation of Pensions Benefits

While wages incomes are subject to high and progressive taxes, pension benefits are hardly taxed in Belgium, as there exists an important tax exemption on the income tax and very small payroll tax.

There are three components of tax on social security benefits: a health care payroll of 3.55 %, a solidarity income tax of at most 2% and the personal income tax that can be very high (the marginal tax rate is 25%). However, for those whose reported income is restricted to the social security benefits, there is a tax exemption that amounts to about 90% of the mean household income. This seems to be the case for most aged people in Belgium as the dominance of public programs in old age resources is striking (see Pestieau and Stijns (1999)). As can be seen in table B.3., the average tax on the maximum pension is lower than 10% . A pension between the minimum and the maximum is tax at 4%.

Table B.3. Aggregate Taxation Rate on Social Security Benefits (%)

	Relative Gross Amount	Global Taxation Rate
Maximum Pension[1]	168	9.8
(Floor+Max)/2	134	4.0
Highest Zero Tax Pension	127	0.0
Floor[2]	100	0.0

1.Married Worker with the ceiling-wages from 20 to 64. 2. Married worker with a complete career (45 years)

Source: Pestieau and Stijns (1999)

C Modeling Demography

In this model individuals always live until 78 years old and are modeled only from the age of 18. In order to take explicitly into account the influence of the evolution of the share of children on the public finances, we introduce the fecundity rate (m_t) as a determinant of the population growth rate (n_t). If we denote $m_t = E_t^1/N_t$, where E_t^1 represents the number of children between 0 and 7 years old, then the growth factor between generation t and $t+1$, can be written as:

$$n_t = \frac{N_{t+1}}{N_t} = \frac{E_t^2}{N_t} = \frac{E_{t-1}^1}{N_t} = \frac{N_{t-1}m_{t-1}}{N_t} = \frac{m_{t-1}}{n_{t-1}}$$

where E_t^2 denotes the number of children aged between 8 and 17 years old at time t, who were born in $t-1$ (belonging to E_{t-1}^1) and who will constitute the generation $t+1$. This formulation allows to explicitly take into account the evolution of the population structure, which is an important determinant of the evolution of the public transfers across time.

We then calibrate the evolution of the fecundity rate in order to replicate as closely as possible the evolution of the growth rate of population and of the dependency ratio, two crucial variables in this debate. Starting from the evolution of the fecundity computed by the Federal Planning Bureau (1997a), we adapt the evolution of this variable in order to minimize the sum of the squared error between the observations and the predicted values for the dependency ratio and the population growth of the age group 18-27. Table C.1. reproduces the subsequent evolutions of the population growth and dependency ratio.

Table C.1.: Demographic variables

years	1960	1970	1980	1990	2000	2010	2020
m_t	1.27	1.06	0.84	0.88	0.97	0.92	0.89
n_t	1.13	1.13	0.94	0.89	0.99	0.98	0.94
$\frac{58+}{18-57}$	0.35	0.35	0.35	0.37	0.41	0.47	0.55

2030	2040	2050	2060	2070	2080	2090	2100-2150
0.91	0.97	1.0	1.0	1.0	1.0	1.0	1.0
0.95	0.96	1.0	1.0	1.0	1.0	1.0	1.0
0.6	0.57	0.56	0.57	0.56	0.53	0.51	0.5

D Maximization Program of individuals

The Lagrangian of the individuals' maximization program at time t can be written as follows:

$$
\begin{aligned}
L_t \;=\; & \frac{1}{1-1/\sigma}\sum_{j=1}^{j=6}\beta^{j-1}\left[\left(c_{t+j-1}^{j}\right)^{1-1/\rho}+\varepsilon^{j}\left(h_t^1\eta_{t+j-1}^{j}\right)^{1-1/\rho}\right]^{\frac{1-1/\sigma}{1-1/\rho}} \\
& +\gamma_t\left[\begin{array}{c}\omega_t(1-\eta_t^1-e_t)h_t^1+T_t^1 \\ +\sum_{j=2}^{6}\left(\omega_{t+j-1}(1-\eta_{t+j-1}^{j})h_{t+j-1}^{j}+T_{t+j-1}^{j}\right)\pi_t^{t+j-1} \\ -\sum_{j=1}^{6}c_{t+j-1}^{j}(1+\tau_{t+j-1}^{c})\pi_t^{t+j-1}\end{array}\right] \\
& +\gamma_t\;\mu_t^1(1-\eta_t^1-e_t)h_t^1+\sum_{j=2}^{5}\pi_t^{t+j-1}\;\gamma_t\;\mu_{t+j-1}^{j}(1-\eta_{t+j-1}^{j})h_t^1 \\
& +\pi_t^{t+5}\;\gamma_t\;\overline{\mu}_{t+5}^{6}(1-\eta_{t+5}^{6})h_t^1
\end{aligned}
$$

where $\omega_t=(1-\tau_t^w)w_t$ denotes the after-tax wage and where the first constraint is the intertemporal budget constraint (γ_t is the Lagrange multiplier for

agents of generation t), while the other constraints concern leisure. These are non-negativity constraints in period $j = 1, ...5$ (with μ^j_{t+j-1} the Kuhn-Tucker multipliers which will be equal to zero if there is no corner solution) and equality constraint for period $j = 6$ (with $\overline{\mu}^6_{t+5}$ the associated Lagrange multiplier).

The first order conditions with respect to e_t is:

$$\zeta\psi e_t^{\psi-1}\sum_{j=2}^{6}\theta_j\omega_{t+j-1}l^j_{t+j-1}\pi_t^{t+j} = (1-\nu_t)\omega_t$$

The first order conditions with respect to c^j_{t+j-1} is:

$$\beta^{j-1}\left[\left(c^j_{t+j-1}\right)^{1-1/\rho}+\varepsilon^j\left(h^1_t\eta^j_{t+j-1}\right)^{1-1/\rho}\right]^{\frac{1/\rho-1/\sigma}{1-1/\rho}}\left(c^j_{t+j-1}\right)^{-1/\rho} = \lambda_t\pi_t^{t+j-1}(1+\tau^c_{t+j-1}) \tag{25}$$

and with respect to $\eta^j_{t+j-1}$is:

$$\begin{aligned}&\varepsilon^j h^1_t\frac{\beta^{j-1}\left[\left(c^j_{t+j-1}\right)^{1-1/\rho}+\varepsilon^j\left(h^1_t\eta^j_{t+j-1}\right)^{1-1/\rho}\right]^{\frac{1/\rho-1/\sigma}{1-1/\rho}}}{\left(h^1_t\eta^j_{t+j-1}\right)^{1/\rho}}\\ =\;& \lambda_t\pi_t^{t+j-1}(\omega_{t+j-1}h^j_{t+j-1}-p_{t+j-1}\chi+\mu^j_{t+j-1}h^1_t)\end{aligned} \tag{26}$$

with $\chi = 1$ if $j \geq 5$ and $\chi = 0$ otherwise.

The ratio of these conditions gives:

$$h^1_t\eta^j_{t+j-1} = \left[\frac{\varepsilon^j(1+\tau^c_{t+j-1})}{\omega_{t+j-1}\varphi(e_t)\theta_j+\mu^j_{t+j-1}-\frac{p_{t+j-1}}{h^1_t}\chi}\right]^{\rho}c^j_{t+j-1} \tag{27}$$

Substituting this expression in (25), we get:

$$\begin{aligned}&\beta^{j-1}\left[1+\varepsilon^j\left[\frac{\varepsilon^j(1+\tau^c_{t+j-1})}{\omega_{t+j-1}\varphi(e_t)\theta_j+\mu^j_{t+j-1}-\frac{p_{t+j-1}}{h^1_t}\chi}\right]^{\rho-1}\right]^{\frac{1/\rho-1/\sigma}{1-1/\rho}}\left(c^j_{t+j-1}\right)^{-1/\sigma}\\ \equiv\;& \beta^{j-1}\xi^j_{t+j-1}\left(c^j_{t+j-1}\right)^{-1/\sigma} = \lambda_t\pi_t^{t+j-1}(1+\tau^c_{t+j-1})\end{aligned}$$

which allows to determine the life-cycle consumption profile:

$$\frac{c^{j+1}_{t+j}}{c^j_{t+j-1}} = \left[\beta(1+r_{t+j})\frac{\xi^{j+1}_{t+j}(1+\tau^c_{t+j-1})}{\xi^j_{t+j-1}(1+\tau^c_{t+j})}\right]^{\sigma}$$

From (27), we can determine the value of the μ^j_{t+j-1} and $\overline{\mu}^6_{t+5}$:

$$\mu^j_{t+j-1} = 0 \quad \text{for } j = 1, ..., 5 \tag{28}$$

$$\overline{\mu}^6_{t+5} = \varepsilon(1+\tau^c_{t+5})\left[\frac{c^6_{t+5}}{h^1_t}\right]^{1/\rho}+\frac{p_{t+5}}{h^1_t} \tag{29}$$

The Lagrange multiplier $\overline{\mu}^6_{t+5}$ can be interpreted as the implicit wage required for individuals to devote 1 unit of time to leisure in period 6.

From (28), (29) and with $(\varepsilon^1, \varepsilon^2, \varepsilon^3, \varepsilon^4, \varepsilon^5, \varepsilon^6) = (0, 0, 0, 0, \varepsilon, \varepsilon)$, we can deduce the values of variables ξ^j_{t+j-1}:

$$\begin{aligned}
\xi^j_{t+j-1} &= 1 \text{ for } j = 1, ...4 \\
\xi^5_{t+4} &= \left[1 + \varepsilon \left[\frac{\varepsilon(1+\tau^c_{t+4})}{\omega_{t+4}\varphi(e_t)\theta_5 - \frac{p_{t+4}}{h^1_t}}\right]^{\rho-1}\right]^{\frac{1/\rho-1/\sigma}{1-1/\rho}} \\
\xi^6_{t+5} &= \left[1 + \varepsilon \left(\frac{h^1_t}{c^6_{t+5}}\right)^{1-1/\rho}\right]^{\frac{1/\rho-1/\sigma}{1-1/\rho}}
\end{aligned}$$

and the optimal leisure supply:

$$\begin{aligned}
\eta^j_{t+j-1} &= 0 \text{ for j=1,...,4} \\
\eta^5_{t+4} &= \left[\frac{\varepsilon(1+\tau^c_{t+4})}{\omega_{t+4}\varphi(e_t)\theta_5 - \frac{p_{t+4}}{h^1_t}}\right]^{\rho} \frac{c^5_{t+4}}{h^1_t} \\
\eta^6_{t+5} &= 1
\end{aligned}$$

E Baseline Scenario

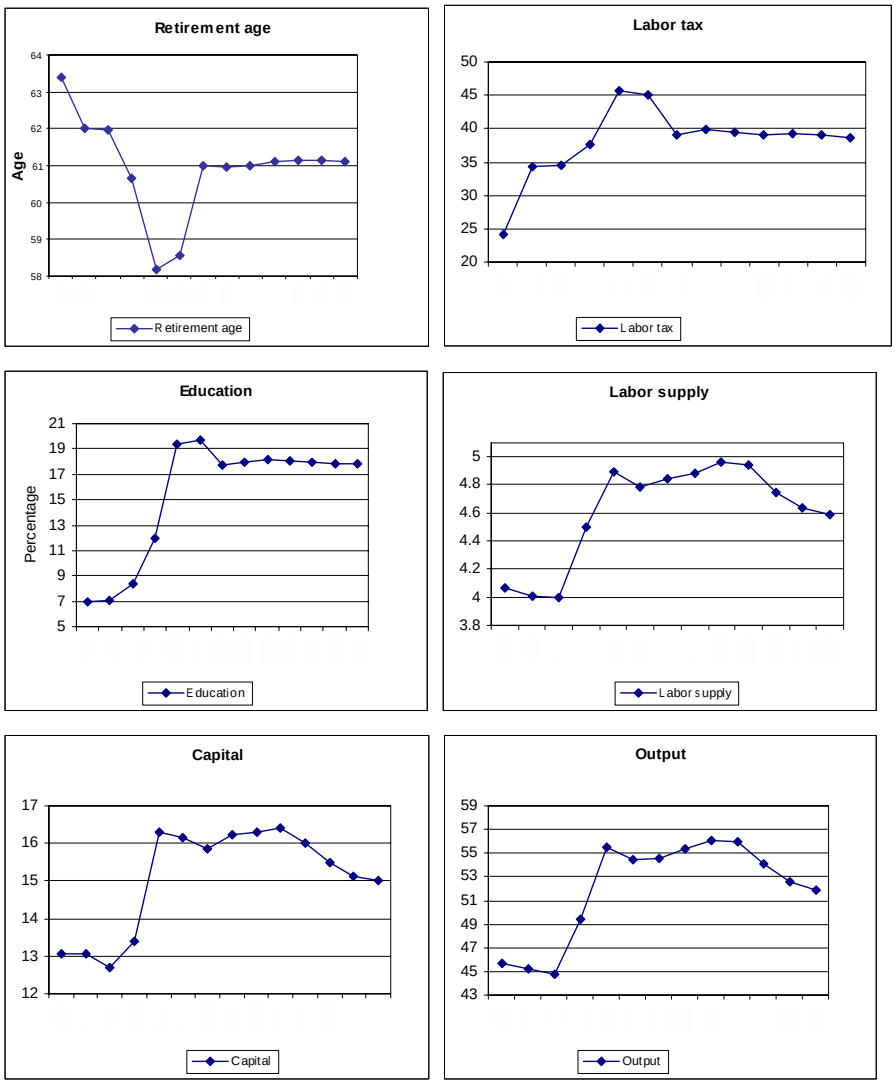

Figure E.1: Baseline Economy Model (1)

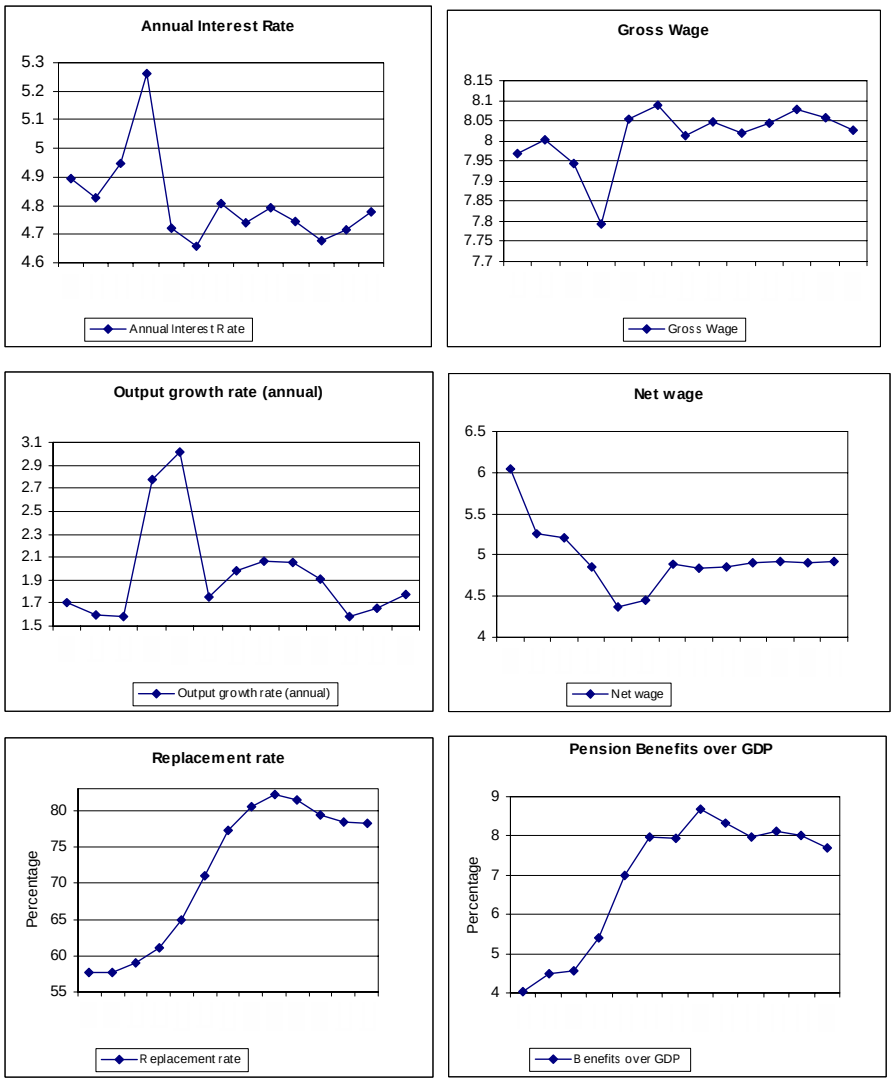

Figure E.2: Baseline Economy Model (2)

F Fiscal Policies

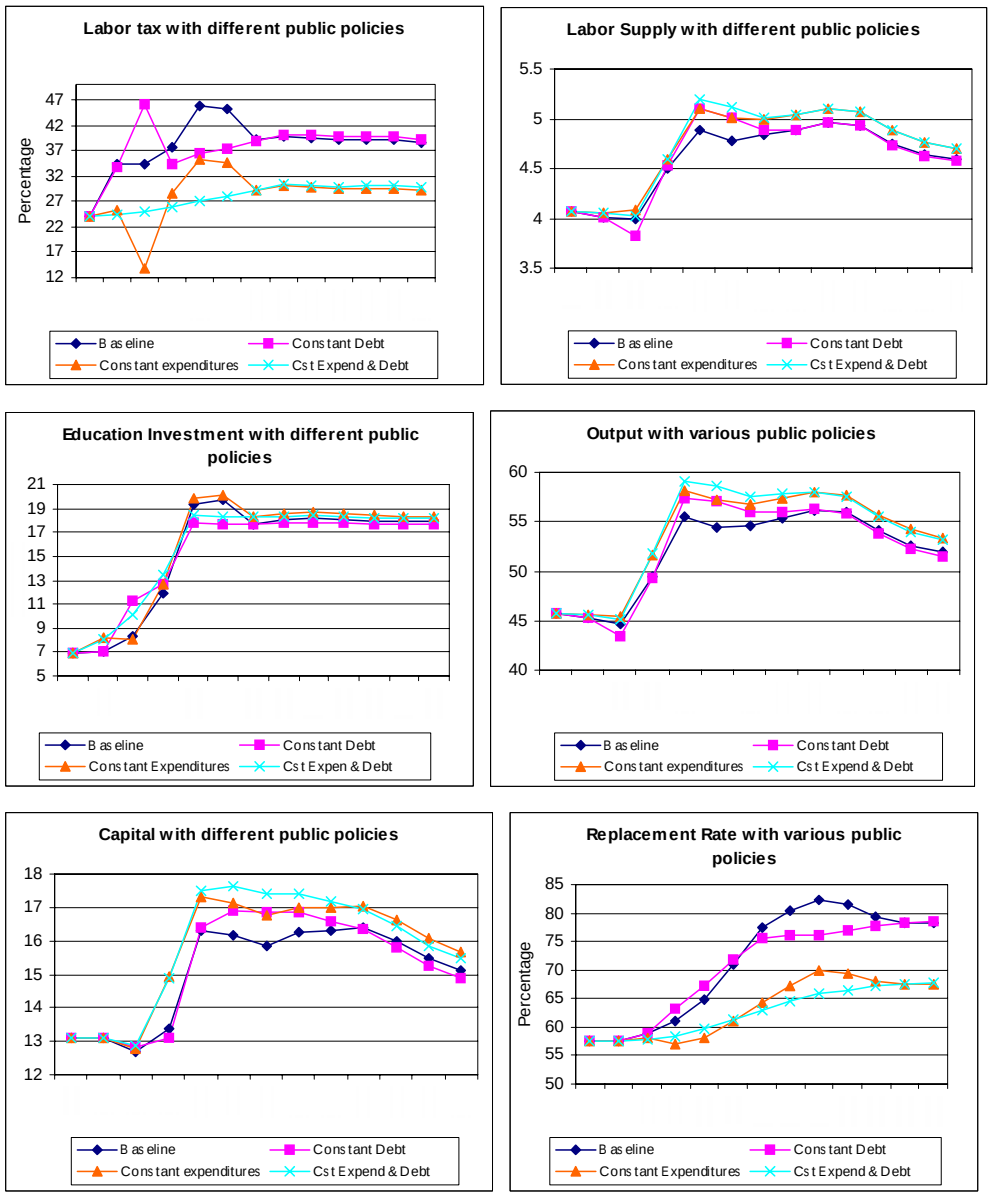

Figure F.1: Contribution of Fiscal Policies to the Past Evolution

G Endo- vs Exogenous Growth

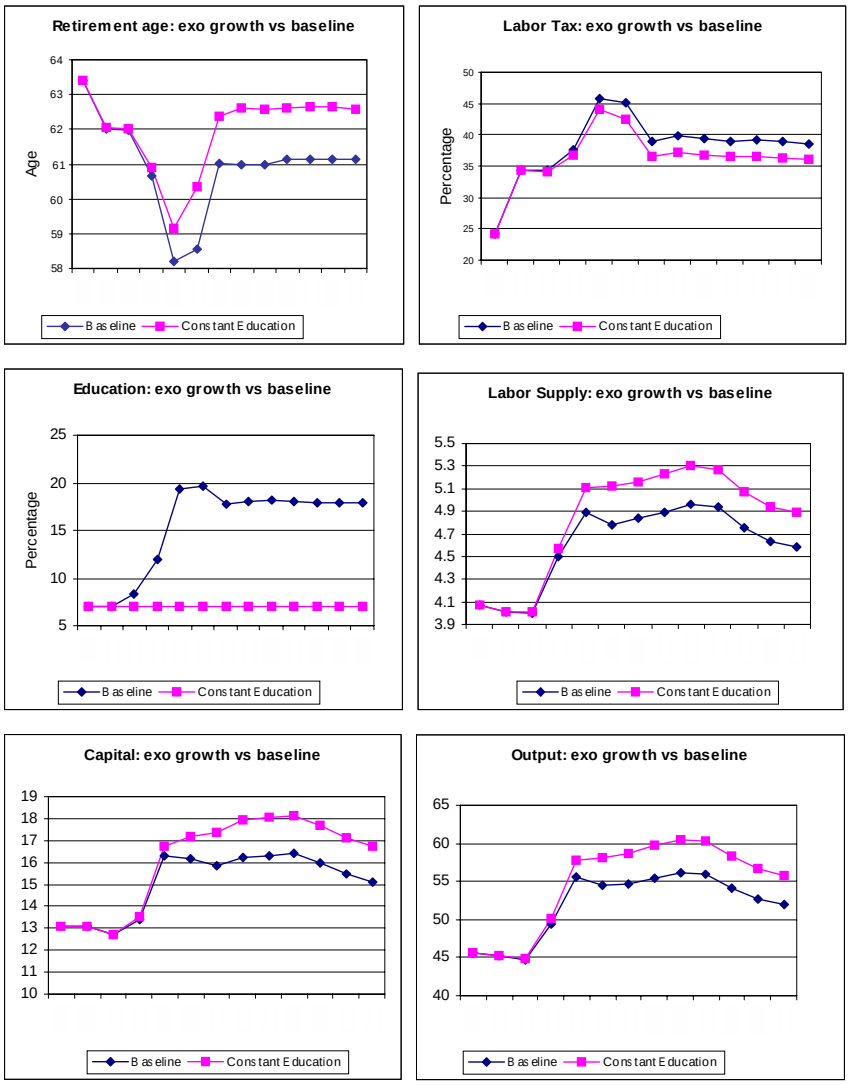

Figure G.1: Exogenous vs Endogenous Growth Model (1)

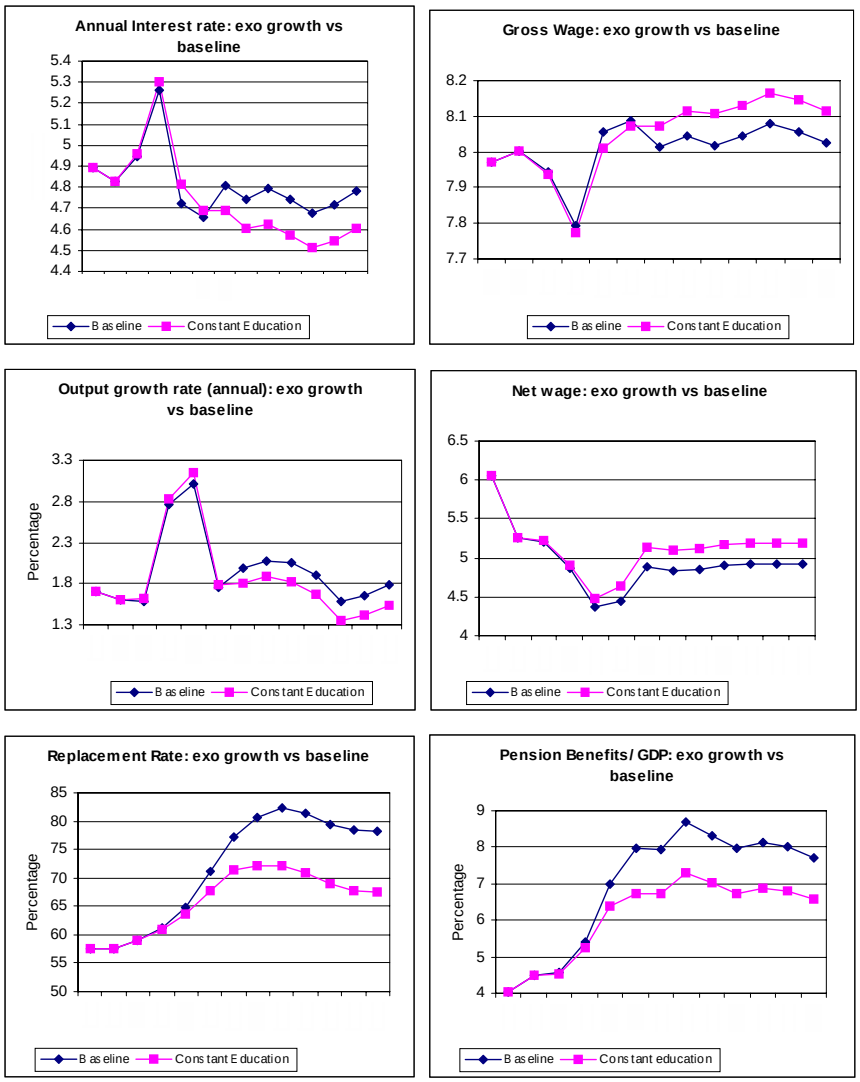

Figure G.2: Exogenous vs Endogenous Growth Model (2)

H Public Debt Reductions

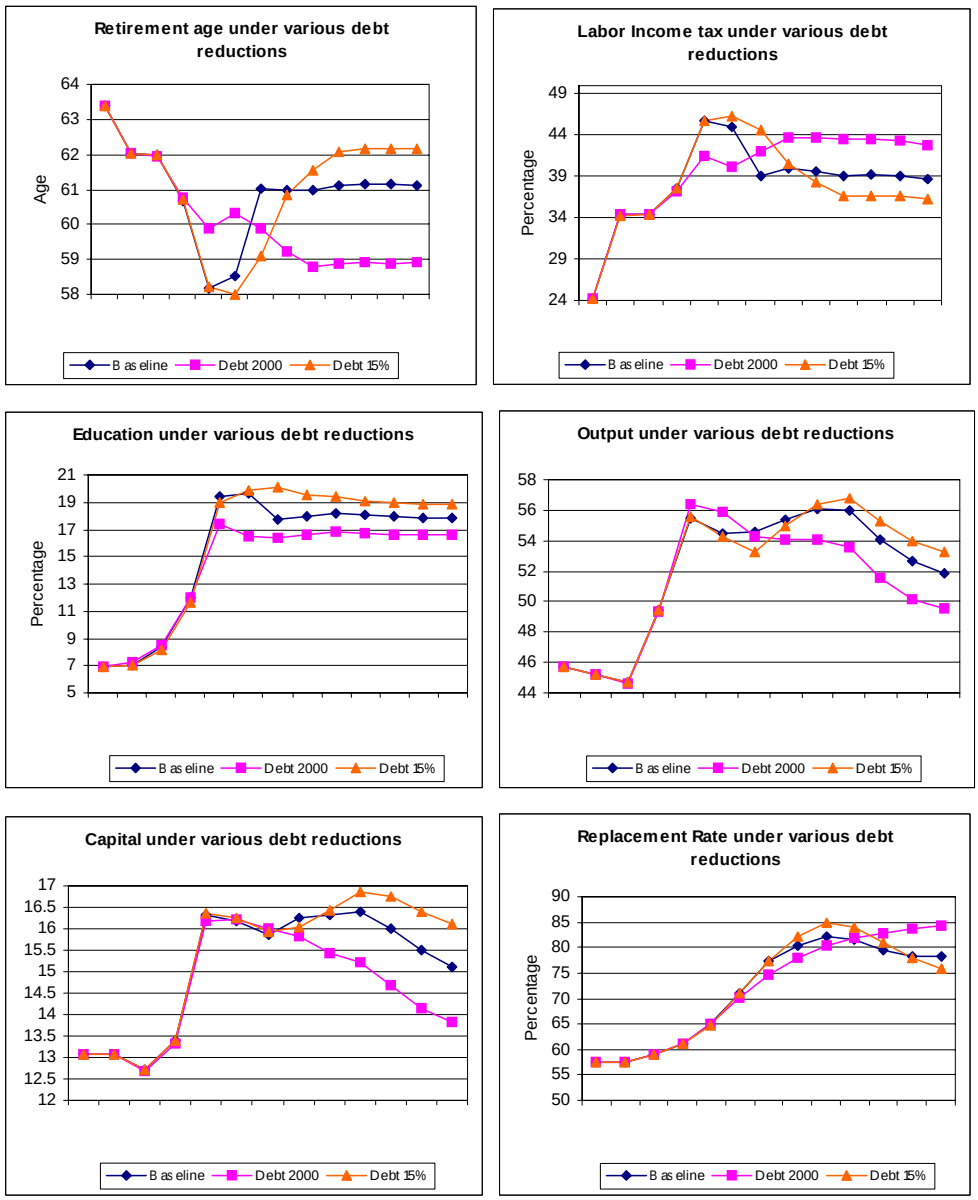

Figure H.1: The Future: Effect of Various Reductions in Public Debt

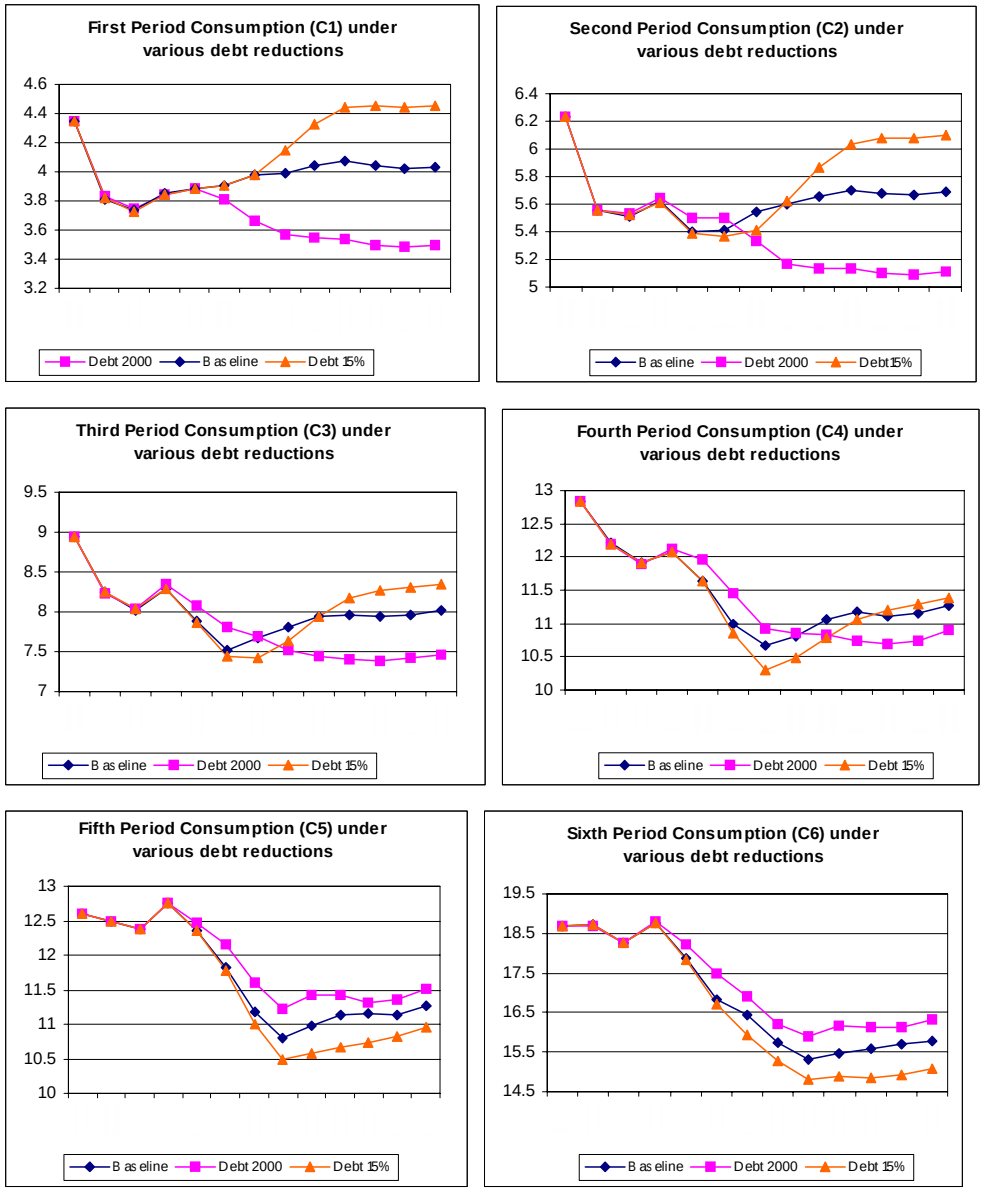

Figure H.2: Evolution of Consumptions under Public Debt Reductions

I Pensions Reforms

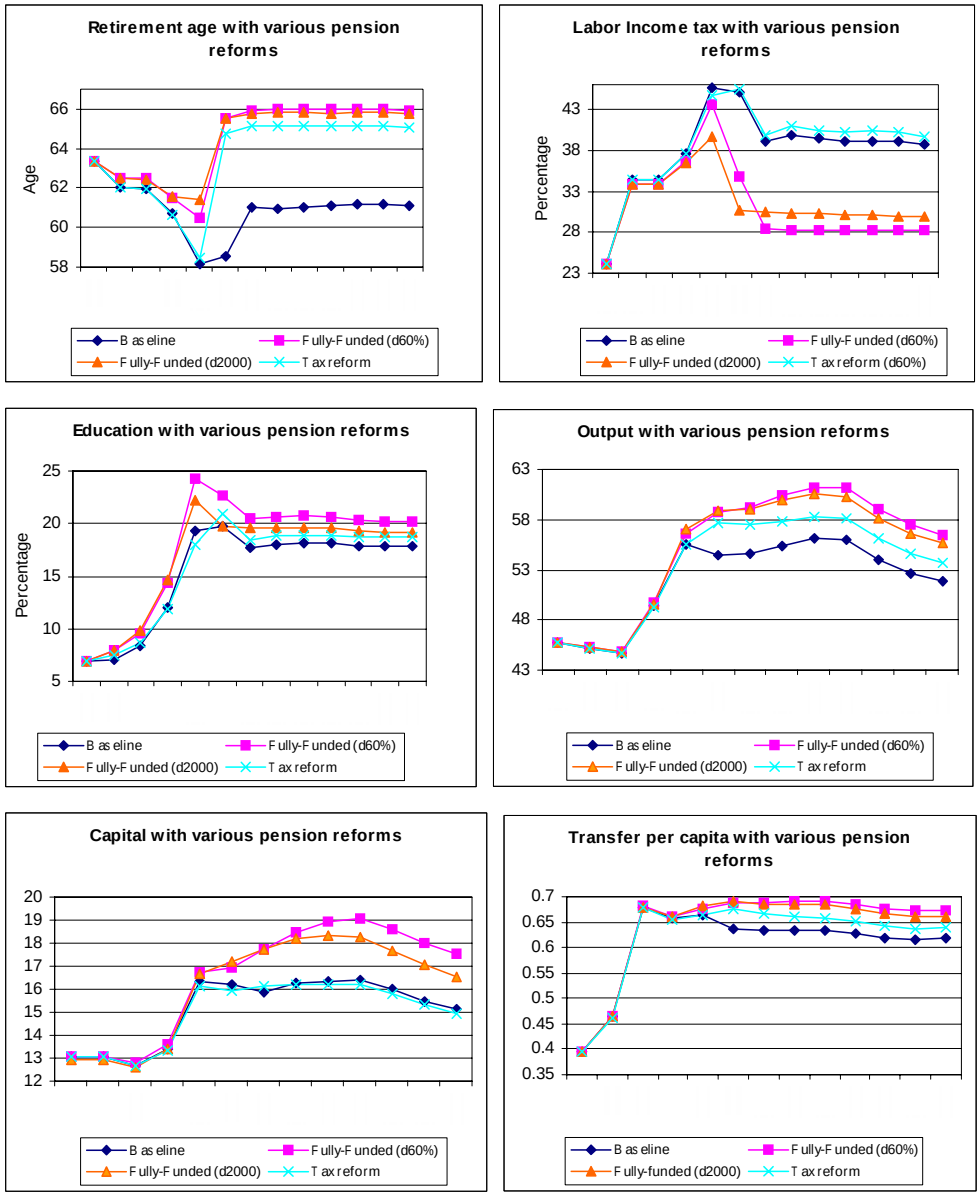

Figure I.1: The Future: Effects of Various Pension Reforms

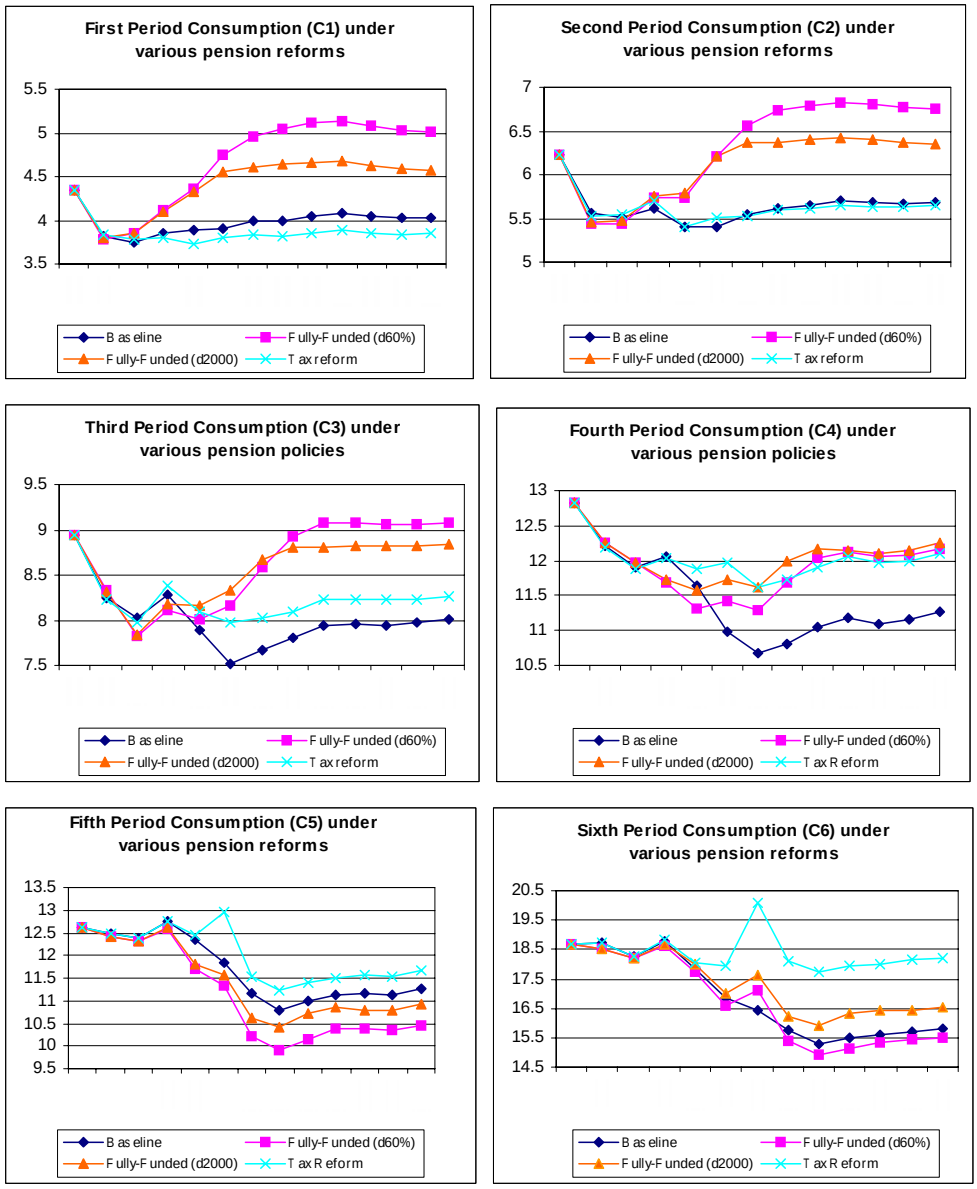

Figure I.2: Evolution of Consumption under Pension Reforms

J Sensivity Analysis

J.1 Small Open Economy

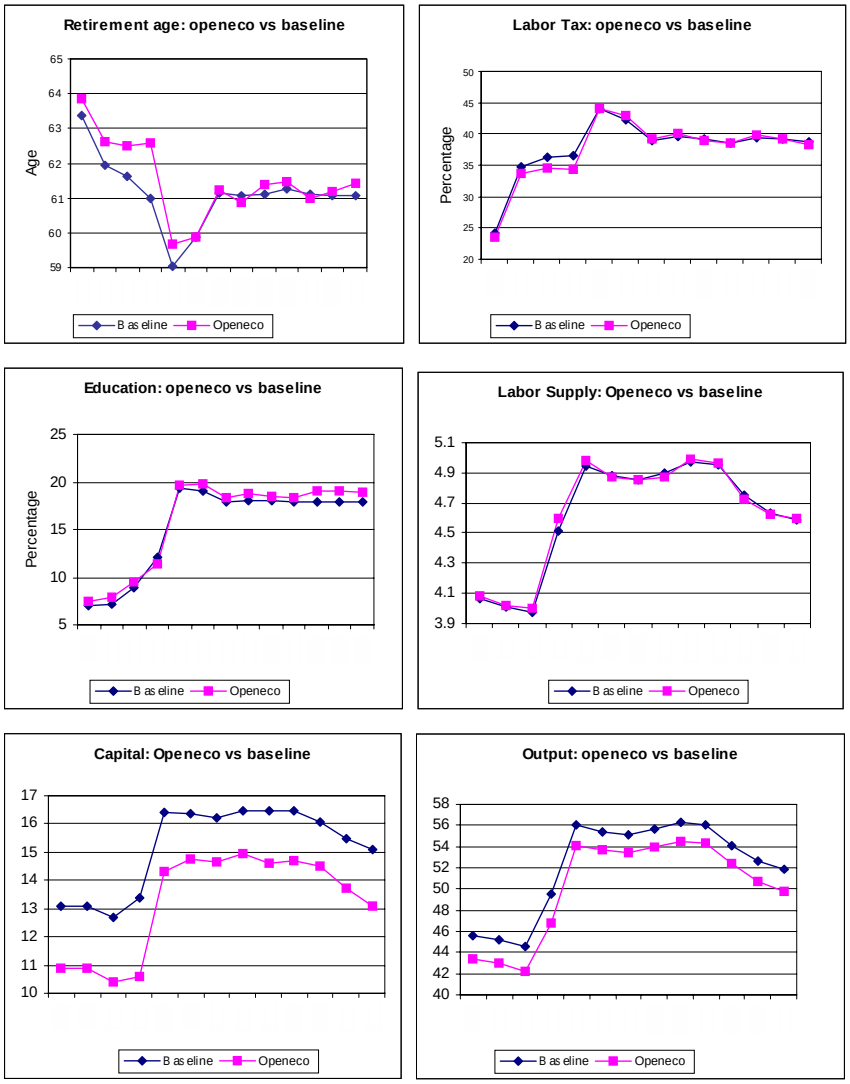

Figure J.1: Open Economy Scenario (1)

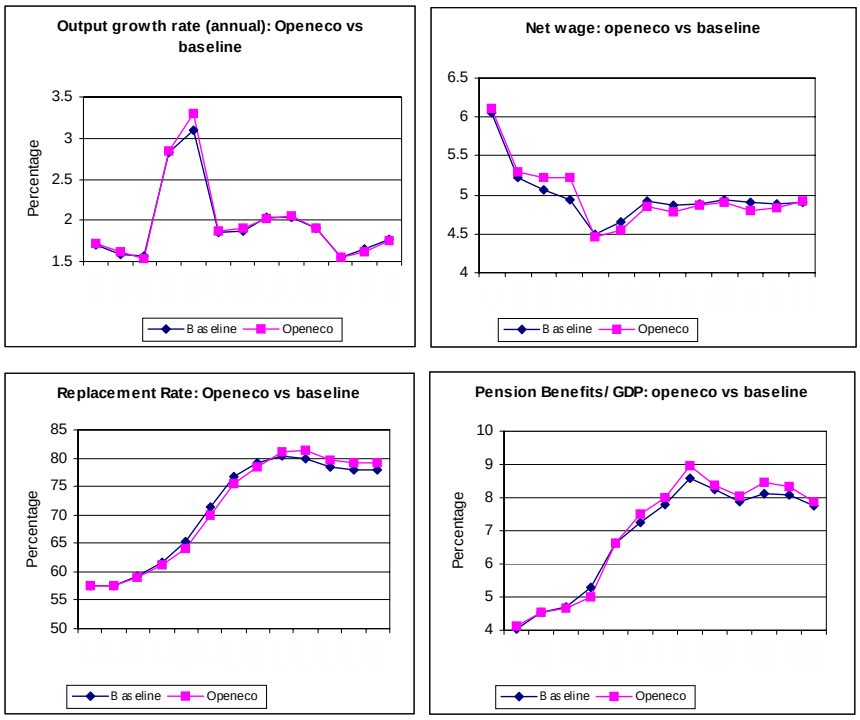

Figure J.2: Open Economy Scenario (2)

J.2 The Value Of ρ

This table details the baseline scenario with an alternative value of the parameter $\rho = .5$.

Table J.1: Endogenous variables $\rho = 0.5$

Endogenous variables	**1960**	**2000**	**2150**
Retirement age	63.3	60.8	62.3
Fraction of Time devoted to education	7.3%	20.8%	19.1%
Pension benefits over GDP	4%	5.8%	6.47%
Education expenditures over GDP	0.27%	1.9%	1.9%
Annual output growth rate	1.71%	3.19%	1.94%
Annual interest rate	4.6%	4.5%	4.5%
Labor income tax	24%	43.9%	37.1%
Replacement rate	56.8%	63.9%	74.6%