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LIFE EXPECTANCY, HEAVY WORK AND THE RETURN TO EDUCATION : LESSONS FOR THE SOCIAL SECURITY REFORM

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Life expectancy, heavy work and the return to education: lessons for the social security reform

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Abstract

In most industrial countries, while the calculation of pension benefits is progressive, public pension systems redistribute weakly from high to low-income earners. They are close to actuarial fairness. This statement results from the following specificity: less paid jobs are also heavier and health-damaging jobs involving losses in life expectancy. As avoiding low earnings and hard-working conditions require acquisition of skills, we study conjointly in this article the impact of social security and the work-related life expectancy loss on the schooling decision. We then study macroeconomic and distributional consequences of global gain in life expectancy associated with different social security reforms, focusing particularly on spillover effects possibly generated by education.

Keywords: social security, human capital, inequality
JEL classification: H55, J31, D63

1 Introduction

In 1950, life expectancy at birth in Western Europe was 68 years. Nowadays, it is 80 years and should reach 85 years in 2050 (United Nations, 2009). However joyful, such a tendency is also associated with a serious threat that is hanging over the financing of our public retirement systems. Indeed, the latter are financed on a pay-as-you-go (PAYG) basis, i.e. pension benefits are paid through contributions of contemporary workers. Hence, they must cope with the increasingly larger number of pensioners compared to the number of contributors. In France for example, the ratio of old (aged 60 years and over) to active people (aged 17 to 59 years), the demographic dependency ratio, should reach 66% in 2050 whereas it was 36% in 2005 (see Figure 1). Changes are unavoidable. If we want to guarantee in the near future the current level of benefits within the same system, it will be necessary either to increase the contribution rate or the length of contribution (by delaying the age of retirement).

Such a potential increase of the Social Security burden has called into question the role of PAYG retirement systems in our societies. By reducing savings in the economy, some economists claim that the latter are inefficient and harm the financing of the whole economy. By evaluating the real pre-tax return on non-financial corporate capital at 9.3%[1] and the growth rate over the same period (1960 to 1995) at 2.6%, Feldstein unequivocally advocates the privatisation of retirement schemes and the change to fully funded schemes. He thus assesses the potential present-value gain to nearly $20

[1] This return combines profits before all federal, state, and local taxes with the net interest paid. The method of calculation is described in Feldstein, Poterba and Dicks-Mireaux (1983).

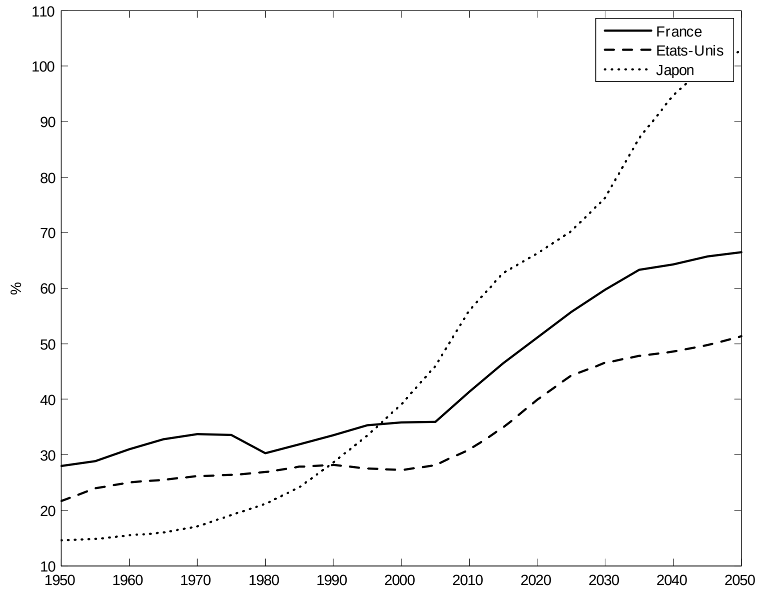

Figure 1: Demographic dependency ratio (age 60+ over age 17-60, source: United Nations, 2009, and author'calculation).

trillion for the United States.

To lower the forecasted increase of the Social Security burden and to preserve the existence of the public retirement systems, delaying the legal age of retirement has been privileged throughout industrialized countries. For example, Starting from 65 years, Australia and Germany have decided to postpone the legal age of retirement of 2 years, the UK of 3 years. In France which has one of the most generous retirement system, the legal age has been postponing in 2010 from 60 to 62 years. However, such a decision has been very conflicting, lots of people perceiving it as unfair. Unskilled workers having entered the labor market early, they argue indeed that they should continue to retire at 60 years. In addition, as their life expectancy is lower than skilled workers (see Table 1), increasing their working life appears actually on this point particularly unfair: they contribute longer to enjoy a less long retirement.

	Managers			Manual Workers		
	1991	2003	change	1991	2003	change
Life expectancy (age 60)	21.1	23	+1.9	18	19	+1
Compared with average	+1.9	+2.2	+0.3	-1.2	-1.8	-0.6

Table 1. Life expectancy at age 60 by occupational group in the French male population (number of years; source: Cambois et al., 2001, and Cambois et al., 2008, based on data from INSEE).

Analysed only under the contribution length and the time spent in retirement, retirement systems appear significantly regressive. Nevertheless, one can also observe that most pension benefit formulas are progressive, especially in Anglo-Saxon countries where pensions are weakly related to earnings (see OECD, 2007). When taking into account this progressivity, studies stress then (Burkhauser and Walick, 1981, and Garrett, 1995, Gustman and Steinmeier, 2001, Coronado et al., 1999, 2000, Brown et al., 2006) that most retirement systems in the industrial world are in fact close to actuarial fairness[2] (see Stahlberg, 1990, for the Swedish system, Gustman and Steinmeier, 2001, and Brown et al., 2006, for the American system). Delaying the retirement age for most workers except for unskilled ones is then not so fair from an actuarial perspective. In addition, a large increase of the Social Security progressivity is not necessarily in the advantage of the low-income earners. Indeed, by increasing the progressivity, this policy tends

[2]Strictly speaking, a retirement system is said actuarially fair if its return is equal to the interest rate (Lindbeck and Persson, 2003; Cigno, 2008). Considering that the economic growth rate, which is the retirement system return, is lower than the interest rate, retirement systems could be described more properly as quasi-actuarial fair as noted by Lindbeck and Persson (2003).

to reduce the incentive to invest in education to become a skilled worker. Considering that education can generate strong knowledge spillovers which have a positive influence on productivity (see Rauch, 1993, Acemoglu and Angrist, 2000, Moretti, 2004), reducing the private investment in education through an increase of the social security progressivity can then turn out harmfull for low-income earners. Investigating social security reforms must then cope with dimensions like progressivity, actuarial fairness, work penibility and the induced loss in life expectancy, investment in human capital, earnings inequality, productivity and savings.

The rest of the paper is organized as follows. In section 2, we present the model which is a version of the Ben-Porath model (1967). In section 3, we then study the impact of aging if no reform is implemented such as all the ajustement corresponds to an increase of the social security size. In section 4, compared to this baseline, we analyse the consequences of two alternative reforms: either delaying the legal age of retirement of 2 years or increasing the contribution years for the same duration but only for skilled workers. In the last section, we briefly conclude.

2 The Model

The model is an extended version of the Ben-Porath model (1967) in the spirit of Cahuc and Michel (1995) and Le Garrec (2011). Individuals live for two periods: they are respectively young and old. They work in both periods. Potentially the entire first period, but only a share l of the second period. After, they are retired during $\rho - l \geq 0$, where ρ represents longevity, $\rho \leq 1$. At each date, there is a constant number of young people normalized to one.

2.1 Individuals

When young in t, individuals are endowed with initial knowledge characterized by a human capital h_{it}^t. They can enter directly the job market. If they do so, following Lilliard (1977), Andolfatto et al. (2000) and Huggett et al. (2006), we will assume that their earnings profile is flat and then that their human capital when old stays equal to h_{it}^t. By contrast, before entering the job market they can make en effort $e_t = 1$ and continue school during a period z in order to increase their human capital when young such as $h_{it}^t(e_{it} = 1) = \lambda_y^H h_{it}^t$, where $\lambda_y^H > 1$. In addition, we will assume that skilled workers continue to increase their knowledge during their professional activity: $h_{it+1}^t(e_{it} = 1) = \lambda_o^H h_{it}^t$, where $\lambda_o^H > \lambda_y^H$. The latter will have then an increasing earnings profile, $\lambda_y^H w$ then $\lambda_o^H w$, as highlighted by Lilliard (1977), Andolfatto et al. (2000) and Huggett et al. (2006).

Preferences of an individual born in t are described by the following utility function:

$$U = \ln c_{it} + \beta \left[\rho_i \ln d_{it+1} + \ln \left(\rho_i - l_i \right) \right] - \varepsilon_i e_{it} \tag{1}$$

where c_{it} denotes the consumption when young, d_{it+1} the consumption when old, β the discount factor; ε_i denotes the utility cost of complementary schooling effort and represents learning ability. In particular, a talented child characterized by $\varepsilon_i = 0$ endures no cost in making the effort. By contrast, a lazy or untalented child characterized by $\varepsilon_i \to \infty$ will endure an infinite cost and will then always choose not to make the effort, i.e. $e_{t-1} = 0$.

Earnings heterogeneity can arise in this setting with different initial human capital or with different learning ability. However, as shown by Huggett et al. (2006), when individuals differ only in their initial human capital endowment, the model generates a counterfactual pattern regarding the US earnings distribution. By contrast, they show that the US earnings distribution can be replicated quite well when considering differences in learning ability across individuals[3]. Accordingly, we then assume that ε_i is distributed over the population according to a Pareto distribution $\mathcal{P}(\varepsilon_{\min}, \sigma)$ while each individual is endowed with the same initial human capital normalized to 1, $h_{it}^t = 1 \ \forall i \forall t$.

During their first period of life, individuals consume a part of their disposable income, and save such as:

$$c_{it} + s_{it} = (1 - \tau_t)(1 - ze_{it}) h_{it}^t (e_{it}) w_t \tag{2}$$

where s_{it} denotes the savings, w_t the wage index, and τ_t the contribution rate, $e_{it} = \{0, 1\}$.

In the second life period, individuals continue to work during a period l_i and therefore are retired the remaining $\rho_i - l_i$. They get back the savings lent to firms with interest, receive their pension from the public retirement system and consume their wealth. The budget constraint is then:

$$\rho_i d_{it+1} = (1 - \tau_{t+1}) h_{it+1}^t (e_{it}) w_{t+1} l_i + R_{t+1} s_{it+1} + (\rho_i - l_i) p_{it+1} \tag{3}$$

where R_{t+1} denotes the interest factor, and p_{it+1} the pension benefits.

[3] Stating that earnings are very significantly tied to the earnings of the parents (Bowles and Gintis, 2002, d'Addio, 2007), this suggests that the intergenerational earnings persistence is based on the inheritability of learning ability within families. Supporting such a view, education is a major contributor to intergenerational earnings mobility and educational differences tend to persist across generations (d'Addio, 2007). Nevertheless, as shown by Bowles and Gintis (2002), it does not imply that the intergenerational earnings determination is only based on genetic transmission. Learning ability also reflects non-cognitive personality traits such as, for example, a taste for learning at school which can be influenced by the family background as much as by the genes.

The maximization of the utility (1) subject to the budgetary constraints (2) and (3) leads to the following saving function:

$$s_{it} = (1 - \tau_t)(1 - ze_{it})\, h_{it}^t w_t - \frac{\Omega_{it}}{1 + \beta\rho_i} \tag{4}$$

where $\Omega_{it} = (1 - \tau_t)(1 - ze_{it})\, h_{it}^t (e_{it})\, w_{it} + (1 - \tau_{t+1})\, l_i \frac{h_{it+1}^t(e_{it}) w_{t+1}}{R_{t+1}} + (\rho_i - l_i) \frac{p_{it+1}}{R_{t+1}}$ denotes the lifetime income. By reducing at the same time the disposable income and the need for future income, private savings is reduced by the existence of a retirement system.

An individual chooses to make the effort for complementary schooling if it entails a utility benefit higher than the utility cost associated with the effort, i.e. if

$$\varepsilon_i \leq \ln \left[\left(\frac{\Omega_t^H}{1 + \beta\rho^H} \right)^{1+\beta\rho^H} \left(\frac{1 + \beta\rho^L}{\Omega_t^L} \right)^{1+\beta\rho^L} (\beta R_{t+1})^{\beta\left(\rho^H - \rho^L\right)} \frac{\rho^H - l^H}{\rho^L - l^L} \right] = X_t \tag{5}$$

where Ω_t^H denotes the lifetime income of a skilled worker and Ω_t^L the lifetime income of an unskilled worker. Assuming that $\varepsilon_i \sim \mathcal{P}(\varepsilon_{\min}, \sigma)$, it follows that the proportion of individuals who choose to make the effort in t to become skilled workers is defined, in the case of an interior solution, by:

$$\bar{e}_t = 1 - \left(\frac{\varepsilon_{\min}}{X_t} \right)^{\sigma} \tag{6}$$

where $\frac{d\bar{e}_t}{dX_t} > 0$. The structure of skills in the economy is thus determined by the life cycle welfare inequality between skilled and unskilled workers. The higher this inequality, the larger the proportion of individuals incited to be trained.

Traditionally, working decisions are also determined by utility maximization. However, one can note that retirement ages are significantly linked to the age at which pensions become available, the legal or normal age of retirement (see Blöndal and Scarpetta, 1998; Gruber and Wise, 1999). First, workers, especially low-income earners, can not leave the labor force without having any pensions. Second, continuation in the labor force after this age means forgoing pension benefits but also paying pension contributions with a little or no increase in benefits after retirement. As a consequence, in OECD countries, the implicit tax on continued labor force participation earnings after pensionable age amounts to 50 to 80 per cent. The legal age of retirement provides then a strong incentive to leave the labor force at this specific age. For example, in 1983 the legal age of retirement in France came from age 65 to 60. Shortly after, the modal age of retirement became 60 whereas it was 65 in the early 1970s. As a shortcut, to avoid modellizing explicitly the implicit tax on continued labor force participation earnings after pensionable age, we then assume that workers, at least unskilled workers, leave the labor force at the legal age of retirement. In the calibrated version of the model, we will then determine the skilled workers' age of retirement in order to reproduce the average age of retirement in the population.

2.2 The retirement system

Retirement systems have pay-as-you-go features, i.e. within one period, pensions are financed by contributions of workers of the same period. In other words, retirement systems transfer workers' income towards pensioners. Knowing that workers are either skilled or unskilled, the social security balanced budget is defined as follows:

$$\int_i p_{it} di = \left[L_t^{yH} \lambda_y^H + L_t^{yL} + L_t^{oH} \lambda_o^H + L_t^{oL} \right] \tau_t w_t \tag{7}$$

where L_t^j denotes the number of worker of type j in t, $j = L, H$.

The calculation of pension benefits is specific to each country, and sometimes can be very complex. In the theoretical literature on social security[4], two different parts are generally distinguished: a redistributive part (the Beveridgean part) characterized by a basic flat-rate benefit, and an insurance part (the Bismarckian part) characterized by earnings-related benefits. The latter is not generally proportional to all contributions and then not based on full lifetime average earnings (see OECD, 2007). It is particularly the case in Greece and Spain where benefits are only linked to final salary. It also used to be the case in Sweden before the 1994 legislation introducing NDC systems. In France, before the Balladur reform of 1993, earnings-related benefits were linked to the ten best years, then gradually to the 25 best years after the reform. In the United States, the 35 best years are considered to calculate the benefits, 20 in Norway.

Following Michel and Pestieau (2000), we assume that the representative earnings on which benefits are linked are the earnings when old. Assuming that the basic flat-rate benefit is based on the contemporary wage of unskilled workers[5], the calculation of pension benefits for any worker in t is then given by:

$$p_{it} = \theta_t \left(1 + e_{it-1}\lambda_o^H\right) w_t + \nu_t w_t \tag{8}$$

where ν_t represents the size of the flat-rate component of the pension benefits and θ_t the size of the earnings-related component.

Consistently with Table 1, the pension benefit formula (8) is progressive. Indeed, when considering an unskilled worker, $e_{it-1} = 0$, the gross replace-

[4] See Casamatta et al. (2000), Docquier and Paddison (2003), Sommacal (2006), Cremer et al. (2007), Hachon (2010), Le Garrec (2011).

[5] It is designed to ensure that pensioners achieve some minimum standard of living.

ment rate[6] is $\frac{p_t^L}{w_t} = \theta_t + \nu_t$ while it is $\frac{p_t^L}{\lambda_o^H w_t} = \theta_t + \frac{\nu_t}{\lambda_o^H}$ when considering a skilled worker, $e_{it-1} = 1$. Nevertheless, as noted in the introduction, most retirement systems of industrialized economies are close to actuarial fairness. In terms of the retirement system implicit return, i.e. the ratio between the pension benefits received by an individual and the actualized amount of his contributions, this means that:

$$\frac{\left(\rho^L - l^L\right) p_t^L}{\tau_{t-1} w_{t-1} + \tau_t l^L \frac{w_t}{R_t}} \approx \frac{\left(\rho^H - l^H\right) p_t^H}{(1-z)\, \tau_{t-1} \lambda_y^H w_{t-1} + \tau_t l^H \lambda_o^H \frac{w_t}{R_t}} \tag{9}$$

If $\frac{\left(\rho^L - l^L\right) p_t^L}{\tau_{t-1} w_{t-1} + \tau_t l^L \frac{w_t}{R_t}} > \frac{\left(\rho^H - l^H\right) p_t^H}{(1-z) \tau_{t-1} \lambda_y^H w_{t-1} + \tau_t l^H \lambda_o^H \frac{w_t}{R_t}}$, then the retirement system is fiscally favorable to low-income earners. In this case the system is progressive. In the opposite case, it is regressive even if the pension benefit formula appears progressive. In this setting, the existence of an actuarially fair retirement system is not straightforward. Indeed, if we consider that educated workers cotisate less long (they enter the job market later) and benefit of the pension for longer (they live longer), even a pure flat-rate system can be regressive if, at steady state, $\frac{\rho^H - l^H}{\rho^L - l^L} > \frac{(1-z)\lambda_y^H + \frac{l^H \lambda_o^H}{R}}{1 + \frac{l^L}{R}}$. On the other hand, assuming that skilled workers live longer while they leave the job market at similar ages, and have a steeper lifetime income profile, as explained by Lindbeck and Persson (2003), Bozio and Piketty (2008), and Le Garrec (2011), is sufficient to assert that a pure earnings-related system based on best or last years is regressive. An actuarially fair retirement system can then exist only if a pure flat-rate system is progressive and if a pure earnings-related system is regressive, i.e. if $\frac{(1-z)\frac{\lambda_y^H}{\lambda_o^H} + \frac{l^H}{R}}{1 + \frac{l^L}{R}} \leq \frac{\rho^H - l^H}{\rho^L - l^L} \leq \frac{(1-z)\lambda_y^H + \frac{l^H \lambda_o^H}{R}}{1 + \frac{l^L}{R}}$.

[6] Defined following the United Nations (2007) as the pension benefit divided by gross pre-retirement earnings, as in Table 1.

2.3 Firms

We consider a competitive sector characterized by a representative firm producing a good, which can be either consumed or invested, according to a Cobb-Douglas technology with constant return to scale:

$$Y_t = F\left(K_t, L_t\right) = A_t K_t^{\alpha} \left(L_t\right)^{1-\alpha},\ 0 < \alpha < 1, \tag{10}$$

where Y_t denotes the output, K_t the physical capital stock, $L_t = L_t^{yL} + L_t^{oL} + \lambda_y^H L_t^{yH} + \lambda_o^H L_t^{oH}$ the labor supply in efficiency units, and A_t the total factor productivity.

Denoting per capita efficient capital by $k_t = \frac{K_t}{L_t}$ and assuming a total capital depreciation, the optimal conditions resulting from the maximization of the profit are:

$$R_t = A_t \alpha k_t^{\alpha-1} \tag{11}$$

$$w_t = A_t \left(1-\alpha\right) k_t^{\alpha} \tag{12}$$

As fully documented in economics (see for example Mincer, 1993, 1997), the investment in education of an individual has a positive impact on his earnings. From a social perspective, education can also generate knowledge spillovers which have a positive influence on productivity and then on earnings (see Rauch, 1993, Acemoglu and Angrist, 2000, Moretti, 2004). We therefore assume that the productivity (and earnings) is positively linked to the proportion of educated individuals in the economy such as:

$$A_t = \tilde{A}\left(\frac{\bar{e}_t + \bar{e}_{t-1}}{2}\right)^{\gamma} \tag{13}$$

At steady state, earnings of a worker i is equal to $h_i(e_i)\tilde{A}\bar{e}^{\gamma}(1-\alpha)k^{\alpha}$. Moretti (2004) has then estimated that the elasticity γ of earnings with respect to the proportion of educated workers is robustly estimated between 0.6 and 1.2.

2.4 General equilibrium

The economy is composed of four markets corresponding to the young unskilled labor, the old unskilled labor, the young skilled labor, the old skilled labor, the capital and the good. In a closed-economy setting, general equilibrium can be then obtained by considering the simultaneous clearing of the following markets:
young unskilled labor:

$$L_t^{yL} = 1 - \bar{e}_t,\ \forall t, \tag{14}$$

old unskilled labor:

$$L_t^{oL} = (1 - \bar{e}_{t-1})\, l^L,\ \forall t, \tag{15}$$

young skilled labor:

$$L_t^{yH} = (1 - z)\, \bar{e}_t,\ \forall t, \tag{16}$$

old skilled labor:

$$L_t^{oH} = \bar{e}_{t-1} l^H,\ \forall t, \tag{17}$$

and capital:

$$K_{t+1} = \bar{e}_t s_t^H + (1 - \bar{e}_t)\, s_t^L,\ \forall t. \tag{18}$$

From (14), (15), (16), (17) and (18), we can then verify consistently with the Walras law that the good market also clears.

3 Rising longevity with unchanged pension benefit calculation

3.1 Life expectancy and education: a simple case

Consider a simplified configuration with $l^H = l^L = 0$ and $\rho^H = \rho^L = \rho$. In this case, with (8) and (9) we can show that an actuarially fair retirement system whose components are θ and ν, $\forall t$, is characterized by the following flat-rate share in the pension benefit calculation:

$$\frac{\nu}{\theta + \nu} = \frac{\lambda_o^H - (1 - z)\,\lambda_y^H}{\lambda_o^H - 1} \tag{19}$$

In this simple framework, the flat-rate share in the pension benefit calculation is increasing with the education length of high-skilled workers, $\frac{\partial \frac{\nu}{\theta+\nu}}{\partial z} > 0$ and with the slope of their earnings, $\frac{\partial \frac{\nu}{\theta+\nu}}{\partial \frac{\lambda_o^H}{\lambda_y^H}} > 0$. In the more general setting, it would be also determined by the length in retirement and then by the mortality differential between high and low-skilled workers. We also note that the share (19) is independent of the longevity ρ. With an unchanged pension benefit calculation, a retirement system which was actuarially fair stays actuarially fair when considering a rising longevity[7].

Considering an actuarially fair retirement system, the education decision characterized by (5) and (6) becomes:

[7] It is not necessarily the case if there exists a mortality differential. Indeed, if the latter stays unchanged in terms of years, a global rising longevity decreases the relative mortality difference and then necessarily the flat-rate share in the pension benefit calculation.

$$\bar{e}_t = 1 - \left(\frac{\varepsilon_{\min}}{X}\right)^{\sigma}, \forall t \tag{20}$$

where $X = (1 + \beta\rho) \ln \left[(1 - z) \lambda_y^H\right]$. From (20), we can deduce that the proportion of high-skilled workers jumps directly on its steady state level as soon as the (unforcasted) variation of longevity is known. From (20), it also follows that:

Proposition 1 *If $l^H = l^L = 0$ and $\rho^H = \rho^L = \rho$, an actuarially fair retirement system has no impact on the education decision.*

Starting from proposition 1, we can deduce that a progressive system will lower the incentive to invest in schooling and then the proportion of skilled workers. Besides, if education generates knowledge spillovers (Moretti, 2004, Rauch, 1993), a progressive system can reduce the global productivity in the economy. By contrast, a regressive system could enhance productivity and be beneficial even for unskilled workers by increasing their market earnings.

Proposition 2 *If $l^H = l^L = 0$ and $\rho^H = \rho^L = \rho$, a rising longevity when considering an actuarially fair retirement system increases the investment in schooling.*

The positive relation between life expectancy and education has been well documented in the literature[8]. As increased longevity raises the value of investments that pay over time, it first increases the return to initial investment in education. In addition, it increases the effective discount factor $\beta\rho$

[8] See de la Croix and Licandro (1999), Kalemli-Ozcan et al. (2000), Boucekkine et al. (2002), Cervellati and Sunde (2005, 2011), Soares (2005), Jayachandran and Lleras-Muney (2009). Challenging the conventional wisdom, Acemoglu and Johnson (2007) find no effect of life expectancy on schooling.

which favors savings and investment (see de la Croix, 2009, for an overview of the theories). For an economy with high life expectancy, Kalemli-Ozcan et al. (2000) have hence estimated the elasticity of schooling years with respect to life expectancy to 0.7. As an actuarially fair retirement system has no impact on the education decision (Proposition 1), the relation between life expectancy and investment in schooling stays unchanged in our simplified version of the model irrespective of the size of the retirement system.

Considering (20), the budget balance of the pension system, obtained with (7), (8), (14), (15), (16) and (17), is defined as:

$$\tau_t = \rho\left(\theta + \nu\right), \forall t \tag{21}$$

With eqs. (4), (11), (12), (18) (20) and (21), the dynamics of the model can then be summarized as:

$$k_{t+1} = \frac{\alpha\beta\rho\left[1 - \rho\left(\theta + \nu\right)\right] A\bar{e}^{\gamma}\left(1 - \alpha\right)}{\alpha\left(1 + \beta\rho\right) + \rho\left(\theta + \nu\right)\left(1 - \alpha\right)} k_t^{\alpha} \tag{22}$$

As $\alpha < 1$, given $k_0 > 0$[9], the model has the good dynamic properties and converges towards the unique steady state characterized by $k = \left[\frac{\alpha\beta\rho[1-\rho(\theta+\nu)]A\bar{e}^{\gamma}(1-\alpha)}{\alpha(1+\beta\rho)+\rho(\theta+\nu)(1-\alpha)}\right]^{\frac{1}{1-\alpha}}$ and then, following (11), by the interest rate:

$$R = \frac{\alpha\left(1 + \beta\rho\right) + \rho\left(\theta + \nu\right)\left(1 - \alpha\right)}{\beta\rho\left[1 - \rho\left(\theta + \nu\right)\right]\left(1 - \alpha\right)} \tag{23}$$

The interest rate does not depend on productivity and then on the social return to education γ. On the one hand, a higher productivity increases the demand for capital and then generates pressure on the interest rate. On the other hand, a higher productivity increases earnings of workers and then favor private savings. These two effects compensate each other and the interest rate stay unchanged with productivity variations.

[9] Or more exactly K_0 which is the only predetermined variable in the model.

Proposition 3 *If* $l^H = l^L = 0$ *and* $\rho^H = \rho^L = \rho$*, an increase of the size of an actuarial fair retirement system, everything else being equal, increases the interest rate.*

This effect is well documented in the literature (Feldstein, 1976). By reducing the need for income when retired, an increase of the pension benefits reduces private savings. As a consequence, the interest rate increases.

Proposition 4 *If* $l^H = l^L = 0$ *and* $\rho^H = \rho^L = \rho$*, considering an actuarially fair retirement system with an unchanged pension benefit calculation, a rising longevity increases the interest rate only if* $\theta + \nu > \frac{\sqrt{(2+\beta\rho)^2+4\frac{1-\alpha}{\alpha}}-(2+\beta\rho)}{2\rho\frac{1-\alpha}{\alpha}}$.

The effect of a rising longevity on the interest rate appears complex. On the one hand, increasing the time spent in retirement increases the need for future income and then private savings. If there is no retirement system, the interest rate decreases. However if there is a sufficiently generous retirement system, this incentive is lowered. In addition, such a generous system is associated with a significant increase of the contribution rate to fullfil its budget balance. If the pension benefits are sufficiently high, a rising longevity increases then the interest rate. Considering this complexity, and the fact that heavy work and its negative impact on longevity is central in the social security debate, we now consider the impact of the rising longevity on a calibrate version of the entire model as describe in the previous section.

3.2 Calibration

Let us calibrate the model on the French economy for the mid-2000[ies]. Consider first that high-school dropouts, who represent 30% of the population (Eurostat), enter the labor force at age 17 and leave it at the legal age of 60.

Assuming that a period of life represents 36 years, it follows that $l^L = \frac{7}{36}$. Stating that the average retirement age (in the private sector) is equal to 61.3, we set $l^L = \frac{8.9}{36}$. In addition, assuming that high-school dropouts life expectancy at age 60 corresponds to the one of manual workers, i.e. 19 years (INSEE, see Table 1), having the life expectancy of the total population at 20.8 years entails a difference of longevity between workers of 2.5 years. Getting the demographic dependency ratio of 36% in 2005 in France (United Nations, 2009, see Figure 1) corresponds then to the following longevity: $\rho^H = \frac{23.2}{36}$ and $\rho^L = \frac{20.7}{36}$. Observing that the average schooling time is equal to 16.1 years in 2005 (UNESCO), we then set $z = \frac{7.3}{36}$. In 2006, we can observe that the wage of an unskilled worker (manual worker) represents 73% of the average wage.

In 2005, the size of the retirement system corresponds to 13.2% of the GDP (Eurostat, 2009). In addition, following the OECD (2007), the gross replacement rate of low-income earners (those who earn 50% less than the average) is equal to 63.8% while the gross replacement rate of those who earn 50% more than the average is equal to 46.9%. In our model, we then want to be close to a progressivity of the pension formula apprehended by the following ratio: $\frac{\theta+\nu}{\theta+\frac{\nu}{\lambda_o^H}} = \frac{63.8}{46.9} = 1.36$.

Finally, as usual, we set the capital'share in outpout α to 0.3, and we calibrate the model in order to get an initial annual interest rate equal to 2.8%[10] which corresponds to the long term average over the period 1971-2004 in Europe (Banque de France; see Mésonnier, 2005). In addition, we

[10]Considering a period of 36 years, an annual interest rate of 2.8% corresponds to an interest factor of $R = (1.029)^{36} = 2.8$ for the period.

normalize $A = 1$ and we then set $\tilde{A} = \begin{cases} 1 & \text{if } \gamma = 0 \\ 1.239 & \text{if } \gamma = 0.6 \\ 1.534 & \text{if } \gamma = 1.2 \end{cases}$. Calibration is summarized in Table 2.

Target	data	model	Parameters
legal age of retirement	60	60	$l^L = \frac{7}{36}$
average age of retirement (private sector)	61.3	61.3	$l^H = \frac{8.9}{36}$
longevity differential	2.5 years	2.5	$\rho^L = \rho^H - \frac{2.5}{36}$
Demographic dependancy ratio	36%	36%	$\rho^H = \frac{23.2}{36}$
average schooling time	16.1 years	16.1	$z = \frac{7.3}{36}$
high-school dropout rate	30%	30%	$\varepsilon_{\min} = 0.146626$
Unskilled workers' wage (% of average wage)	73%	73%	$\sigma = 2.718$
Pension formula progressivity	1.36	1.36	$\theta = 22.9\%$
Actuarial fairness			$\nu = 36.4\%$
social security size (% of GDP)	13.2%	13.2%	$\lambda_y^H = 1.440$
			$\lambda_o^H = 1.757$
Capital's share in output	0.3	0.3	$\alpha = 0.3$
Annual interest rate	2.8%	2.81%	$\beta = 0.55$

Table 2. Calibrated values.

3.3 A baseline scenario

Regarding the initial equilibrium, consider a rising longevity (in $t = 0$) such as $\rho^H = 1$ and $\rho^L = \frac{33.5}{36}$, i.e. with an unchanged mortality differential corresponding to 2.5 years. Such a scenario corresponds to a rise of the demographic dependancy ratio from 36% to 66%, i.e. consistent with the forcasted rise in France from 2005 to 2050 (see Figure 1). In such a scenario, the workers to pensioners dependency ratio increases by 33%, going from 36% to 69% (Fig. 2a). With an unchanged pension benefit calculation, i.e. $\theta = 22.9\%$ and $\nu = 36.4\%$, the rising longevity leads to an increase of the social security size from 13.2% to 25.2% of the GDP (Fig. 2b). The relative rise of +91% of the economic dependancy ratio generates in this baseline scenario an equivalent relative rise of the social security size as highlighted by the average social security balanced budget $\tau = RD * \frac{p}{w}$ when considering an unchanged gross replacement rate $\frac{p}{w}$.

As stressed in the simplified version, in a generous system as in France, the rise of the social security size is the unsurprisingly dominant effect considering the evolution of the interest rate (Fig. 2c). As private savings is lowered, the interest rate increases from an annual rate of 2.81% to 3.04% at steady state. As already noted, the interest rate does not depend on the productivity A_t. However, as longevity rises, the return to investment in human capital increases and the average schooling time increases of a maximum of 8 months if the social return to education is at its maximum[11], i.e. $\gamma = 1.2$, of approximatively 7 months and 6 months respectively for $\gamma = 0.6$ and $\gamma = 0$ (Fig. 2d). Everything else being equal, such a variation corresponds to an increase of the proportion of skilled workers of 7.5% to 9.5% starting from 70%. If the social return to education is strong ($\gamma = 1.2$), we can then observe a non monotonic evolution of the interest rate. Indeed, in such a

[11] We have also calibrated $\varepsilon_{\min}$ and σ such as the average school years increases at a maximum of 8 months. Indeed, following Kalemli-Ozcan et al. (2000) the elasticity of schooling years with respect to life expectancy for an economy with high life expectancy is 0.7. Knowing that in France life expectancy should increase from 81.2 years in 2005 to 86 years in 2050, i.e. 5.9%, the average schooling years should increase in 2050 of 4.1% and reach 16.7 years, i.e. an increase of 8 months compared to 2005.

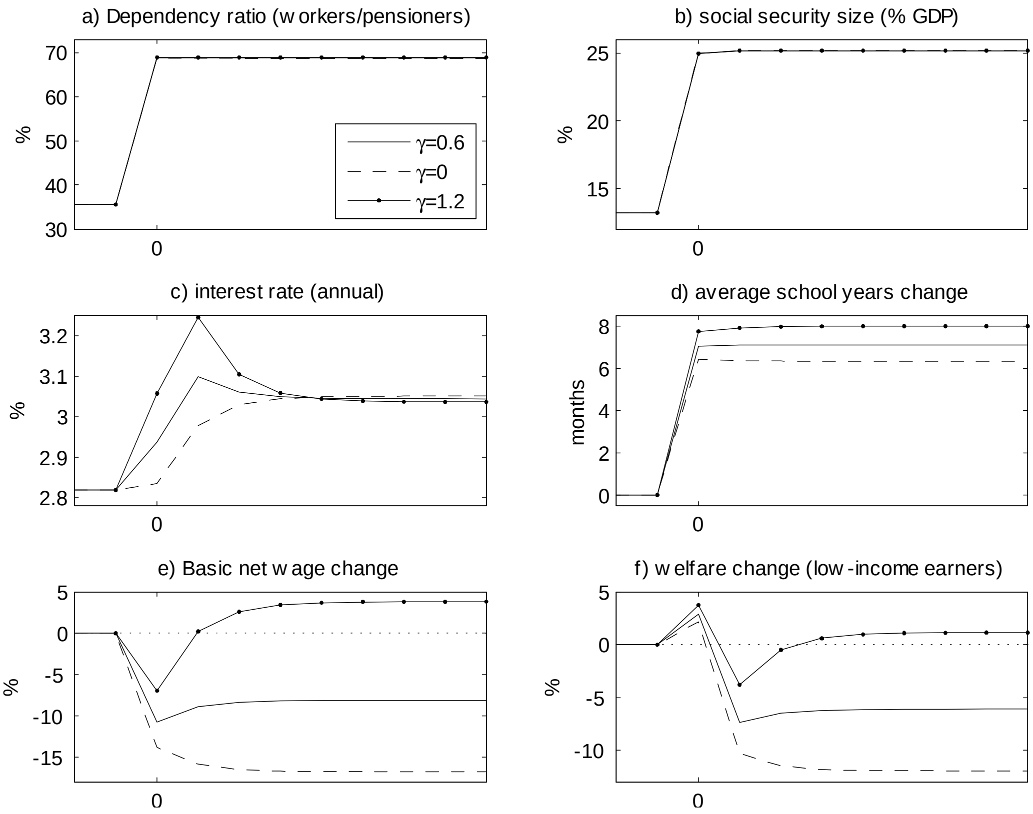

Figure 2: Rising longevity with unchanged gross replacement rates

case an increase of the proportion of skilled workers generates a productivity boost and then an increase of the demand for capital. The interest rate first increases then decreases towards its stationary level. By contrast, if the social return to education is zero, the interest rate increases monotonously towards its stationary level.

From a social perspective, the welfare change of the low-income earners is crucial (Fig. 2f). For the first generation enjoying the rising longevity, the impact is similar to a free lunch. They have to cotisate more during a very limited period of time (equal to l^L) to enjoy a longer retired life with unchanged pension benefits. Considering the other generations, their welfare change depends crucially on the social return to education (Fig. 2e). If the latter is zero, the welfare of the low-income earners decreases despite the rising longevity. It is obviously due to the rise of the social security size. The return of a PAYG retirement system corresponds to the wage bill growth. At steady state, with no population growth it means that the return is zero. In this context, the rising longevity means at steady state both an increase of the size and of the (relative) inefficiency of the PAYG retirement system (compared to private savings). As the market income of workers is positively related to productivity whatever their skill, this negative effect can be reduced if productivity is enhanced by an increase in the human capital investment. We can therefore observe on Figure 2f that if the social return to education is strong ($\gamma = 1.2$), the net wage and the welfare of low-income earners can slightly increase in the long term with the rising longevity.

In the baseline scenario, we consider the impact of the rising longevity with unchanged pension benefits and retirement age. Different types of reform can be analysed with respect to this baseline: the progressivity of the pension benefit formula, the decrease of the benefits or the postponing of the retirement age. Observing that the latter is the privileged reform in most countries, we investigate in what follows its economic and distributional consequences

4 Delaying the retirement age

In most OECD countries, the legal age of retirement is 65 (and is currently increasing as in Australia, Germany, the UK and Denmark). In France, it used to be age 60. France has one of the most generous system both in terms of pension benefits and age of retirement. The current debate over the retirement system in France is then unsurprisingly strongly related to the age of retirement. In October 2010, it has been voted to delay the latter from age 60 to 62. However, from a social perspective, it has raised the debate of education and heavy work. As high-income earners cotisate less long (because of their longer schooling time) and live longer, it has been supported that such a uniform delay of the retirement age is unfair for low-income earners. In the following, we then investigate both a uniform delay of the retirement age, and a delay supporting only by high-income earners, i.e. skilled workers.

4.1 The legal retirement age

Delaying the legal age of retirement from age 60 to 62, assuming that it increases the effective age of retirement of two years for both skilled and unskilled workers, has beneficial effects at least on two aspects. First and obviously, such a reform decreases the dependancy ratio. Thereafter, it decreases the required social security size from 25% to 22% to maintain unchanged the pension benefits, i.e. a decrease of 3% compared to the baseline (Fig. 3b). Second, as the length of the working life is significantly increased, the private return to schooling is increased and the average school time increases of more than two months compared to the baseline, irrespective of the social return to education (Fig. 3d). Everything else being equal, such an increase corresponds to an increase of the skilled workers' proportion of 2.8% compared to the baseline. Therefore, if the social return to education is not zero, productivity is enhanced. In addition, as private savings is predetermined, an increase of the labor force first increases the interest rate compared to the baseline, then decreases it driven by a lower social security size (Fig. 3c). At steady state, we can then observe that delaying the legal age of retirement

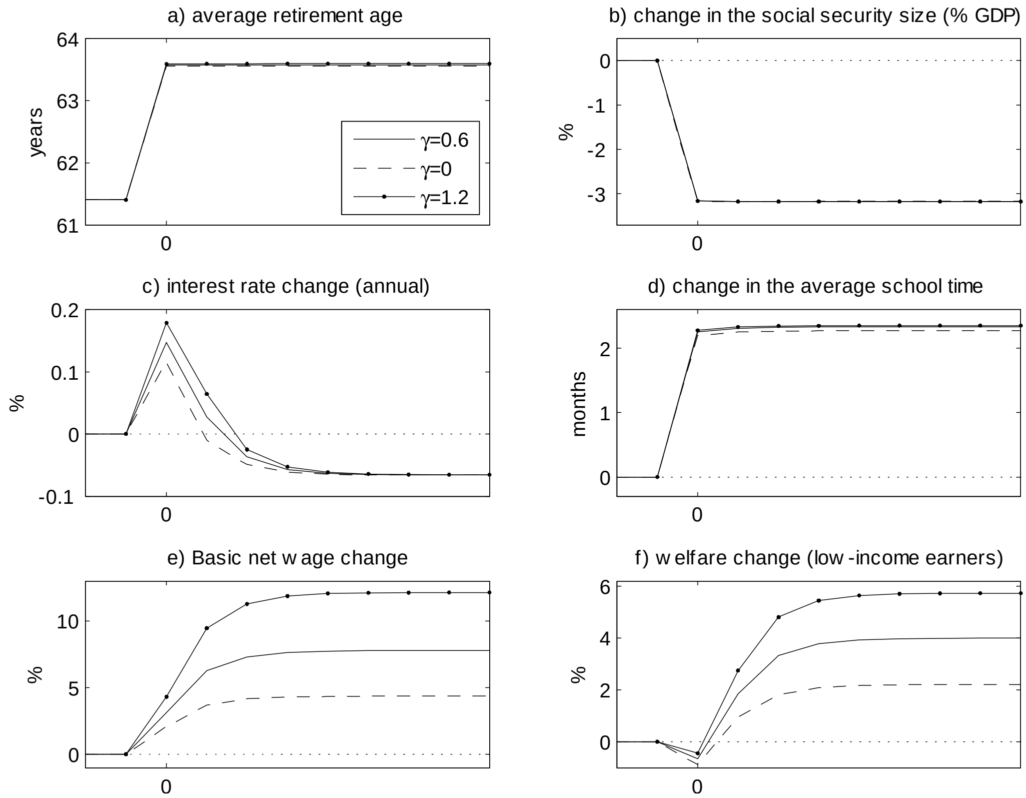

Figure 3: Increasing the legal age of retirement of 2 years (w.r.t. the baseline)

increases the net wage and then the welfare of low-income earners all the more that the social return to education is high (Figs. 3e and 3f).

Delaying the legal age of retirement has nevertheless one major disadvantage. The welfare of the first old low-income earners generation decreases from 0.5% ($\gamma = 0$) to 0.9% ($\gamma = 1.2$) compared to the baseline (Fig. 3f). This observation stresses the political and social difficulty to implement such a reform. The latter strengthens the feeling that the system is not fair considering mostly the longevity loss associated with the hard work conditions. Some therefore claim that the delay of retirement age should be supported only by skilled workers.

4.2 Taking into account hard work conditions

As unskilled workers enters the job market before skilled workers and as they live less long, letting them retiring at age 60 while skilled workers should contribute two years more compared to the baseline can appear at first glance fairly justified. Compared to a uniform increase of the retirement age, such a reform of course reduces the decrease of the dependancy ratio and then of the social security size. However, the main impact is not there. With unchanged gross replacement rates, the system becomes strongly progressive and favors low-income earners. Such a reform lowers then the incentives to be trained. It results in a drop in the average schooling time from 8 months ($\gamma = 0$) to 11 months ($\gamma = 1.2$) compared to the baseline (Fig 4d), or equivalently to a drop in the skilled workers' proportion of respectively almost 10% to more than 13%.

If the social return to education is zero, it has no impact on productivity and both the net wage and the welfare of low-income earners increases compared to the baseline (Figs. 4e and 4f). In addition, we can note that the welfare of low-income earners in the long term equals their welfare when they have to delay their retirement of 2 years. However, it does not decrease the first generation's welfare. It stresses in this case the political facility in implementing such a reform. Nevertheless, considering that the social return to education is between 0.6 and 1.2 gives opposite results. For the first old generation of low-income earners, the loss of welfare compared with the baseline is slightly higher. More important is the effect for future low-income earners. The drop in productivity resulting from the drop in skilled workers' proportion would lead to a decrease of 5% to 16% of their welfare whereas it would have increased of 4% to 5.9% if they have delayed their retirement age of two years. In such a configuration, the postponement of the legal age

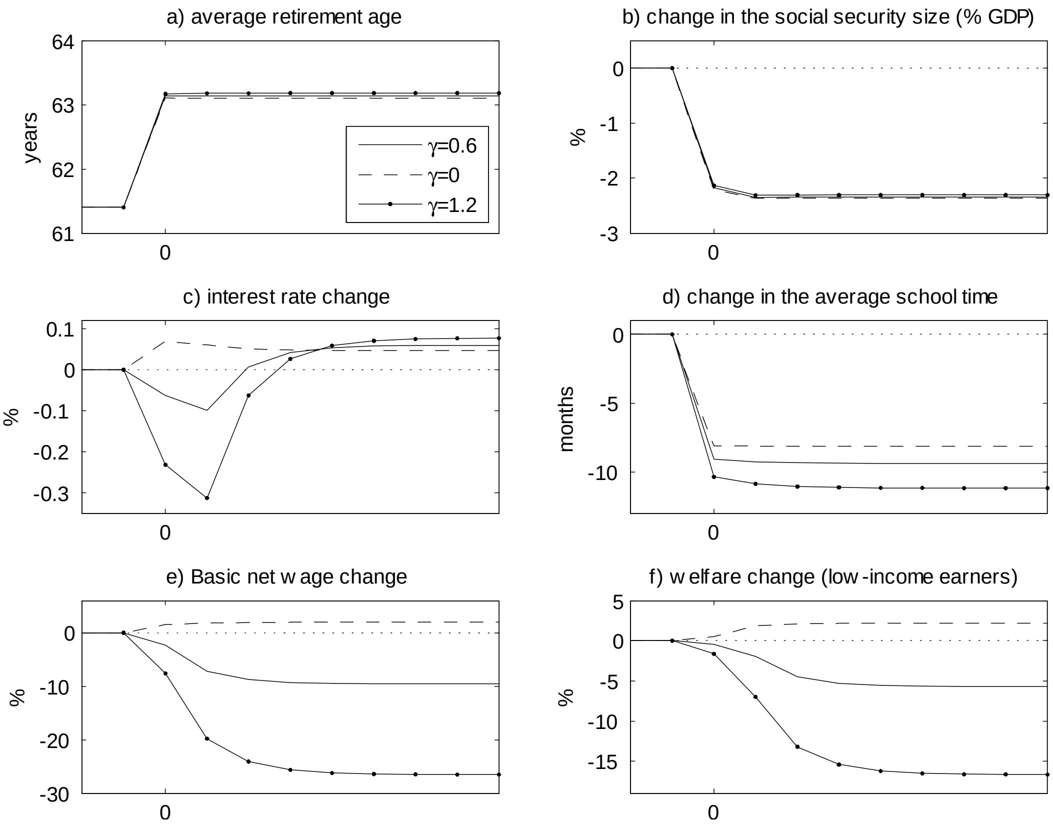

Figure 4: Increasing the skilled workers' contribution length of 2 years (w.r.t. the baseline)

of retirement of two years is then better than letting unskilled workers still retiring at age 60, even for the latter

5 Conclusion

As a fact, population in the industrialized countries is aging. The threat associated with that is hanging over the financing of our public retirement systems can not be ignored. Changes are unavoidable. To lower the forcasted increase of the Social Security burden and to preserve the existence of the public retirement systems, delaying the legal age of retirement has been privileged in most countries. In France the legal age has been postponed in 2010 from age 60 to 62. However, such a decision has been very conflicting, lots of people seeing it as unfair. Unskilled workers having entered the labor market early, they argue indeed that they should continue to retire at age 60. In addition, as their life expectancy is lower than skilled workers, increasing their working life appears actually on this point particularly unfair: they cotisate longer to enjoy a less long retirement. In this article, we analyse the consequences of two alternative reforms: either delaying the legal age of retirement of 2 years or increasing the contribution years for the same duration but only for skilled workers. We then show that the choice of the best reform considering low-income earners depends crucially of the social return to education. If the latter equals zero, the most socially preferable reform corresponds to letting unskilled workers retiring at age 60. By contrast, if the social return to education is as estimated by Moretti (2004), the most socially preferable reform corresponds to a delay of the legal age of retirement.

In the present article, we have analysed a delay of two years in the age of retirement as chosen by the French government. However, regarding the aging process characterized by the increase of the dependancy ratio as illustrated in Figure 1, one can only deduce one thing: this reform is only a first step and the legal age of retirement should be delayed to at least age 65 at the half century, and even more if following other OECD countries.

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