Differential mortality, aging and social security: delaying the retirement age when educational spillovers matter

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Abstract

To lower the forecasted increase of the social security burden linked to population aging, delaying the legal age of retirement has been privileged throughout industrialized countries. Compared to a uniform delay, some argue that those who have entered precociously the labor market should be allowed to retire earlier. They assert that such a "long career" exception is all the more justified that those unskilled workers live also less long due to heavier and potentially health-damaging jobs. In this article, we then study macroeconomic and distributional consequences of global gain in life expectancy, with or without the postponement of the legal age of retirement, and with or without a "long career" exception. By considering a framework where individuals decide to acquire skills depending on economic incentives and differential mortality, we focus particularly on spillover effects possibly generated by education. We show in particular that introducing a "long career" exception can not be to the advantage of future unskilled workers unless education yields no spillover effects.

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.

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 postponed 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 precociously the labor market, some argue indeed that they should continue to retire at age 60. In addition, as their life expectancy is lower than skilled workers (see Table 1), increasing their working life appears,

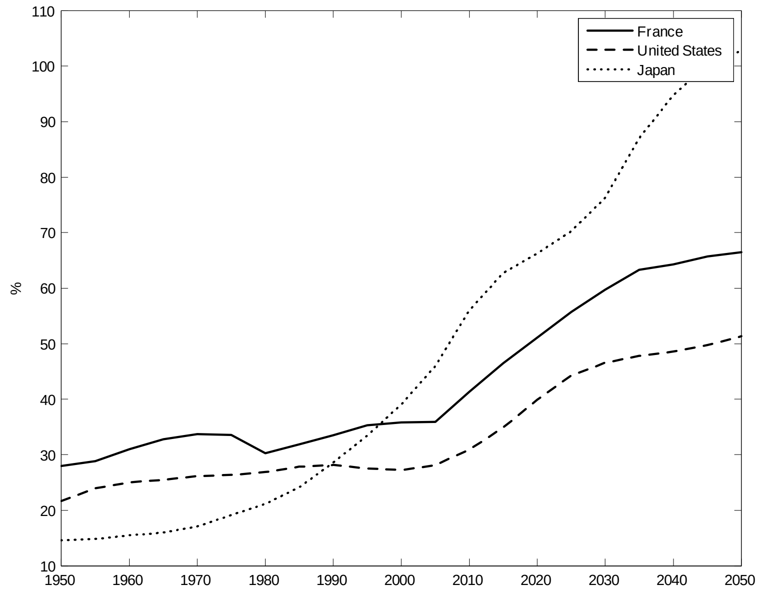

Figure 1: Demographic dependency ratio (age 60+ over age 17-60, source: United Nations, 2009, and author's calculation).

on this point, particularly unfair: they contribute longer to enjoy a less long retirement. That is why in 2012 the newly elected French government (left wing) has introduced an exception to the new legal age of retirement by allowing workers who have entered precociously the labor market, and then have a "long career", to continue to retire at age 60.

	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).

The debate that has occured in France in 2012 during the presidential election considering aging and the retirement system has then mainly focused on the age of retirement and the time spent in retirement. Subsequently, during this debate, the retirement system has appeared as particularly regressive. However, one should have also noted that, like in most retirement systems throughout the world, and especially in Anglo-Saxon countries where pensions are weakly related to earnings, the pension benefit formula is highly progressive (see OECD, 2007). Therefore, when both taking into account the progressivity in the calculation of pension benefits and the regressivity linked to differential mortality by income, studies[1] stress that most retirement systems are in fact close to actuarial fairness[2]. Delaying the retirement age for most workers except for unskilled ones is then maybe not so fair, at least from the actuarial perspective. In addition, a large increase in the social security progressivity is not necessarily to the advantage of low-income earners. Indeed, by increasing progressivity, this policy could reduce the incentives to invest in education to become skilled worker. Considering that education can generate strong knowledge spillovers which have positive influence on productivity through the sharing of ideas (see Rauch, 1993; Moretti, 2004), reducing the private investment in education through an increase in the social security progressivity can then turn out harmfull even for low-income earners. Investigating social security reforms must then cope with

[1] See Burkhauser and Walick (1981), Stahlberg (1990), Garrett (1995), Coronado et al. (1999, 2000), Gustman and Steinmeier (2001), Brown et al. (2006), Goda et al. (2011).

[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).

traditional dimensions like life expectancy, savings, progressivity and actuarial fairness, but also with heavy work and differential mortality, investment in human capital and productivity. To that extent, the construction of a framework, which accurately adresses the link between earnings and human capital and the main features of work history, is particularly crucial.

As well documented in the literature (e.g. Mincer, 1997; Neal and Rosen, 2000), earnings are strongly related to human capital. As learning activities and human capital formation are concentrated at young ages, a work history can be summarized by two different periods. During the first period, people invest time to be trained, including higher education and job training. This first period is characterized by relatively low earnings. In the second period, they benefit from their human capital investment and then earn more. Age-earnings profiles are thus increased, except for high-school dropouts whose age-earnings profiles are almost flat (e.g. Andolfatto et al., 2000). Lilliard (1977) then highlighted that the age-earnings profile of a worker is increased with his learning ability and the time he has spent in training. In order to replicate these facts, the Ben-Porath (1967) human capital model has been widely used (e.g. Mincer, 1997, Neal and Rosen, 2000). In this model, individuals maximize the present value of their lifetime earnings by allocating their time between training activities and work. It predicts accurately that individuals with higher abilities will invest more in human capital and therefore will have steeper age-earnings profiles than their counterparts with lower abilities. The model we develop is an extended version of the Ben-Porath model (1967) introducing heterogeneity in learning ability in the spirit of Cahuc and Michel (1996) and Le Garrec (2012) allowing for an endogenous unskilled/skilled workers structure. Following Rauch (1993) and Moretti (2004) who have pointed out that productivity was positively impacted by the proportion of skilled workers through the sharing of ideas, we can then study the impact of delaying the retirement age whether educational spillovers matter or not[3]. Our work extends then other studies analysing social security reforms with fixed skill structures (e.g. Hairault et al., 2004).

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 so that all the adjustment corresponds to an increase of the social security size. Theoretical results are first presented in a simplified version of the model. We then propose a baseline based on the full model calibrated on the French economy. In section 4, compared to the baseline characterized by a legal retirement age of 60, we analyse the consequences of delaying the legal age of retirement of 2 years, with or without a "long career" exception so that unskilled workers may still continue to retire at age 60. In the last section, we briefly conclude.

2 The Model

In order to study conjointly social security, investment in education and aging, we develop an OLG version of the Ben-Porath model (1967) introducing heterogeneity in learning ability, in the spirit of Cahuc and Michel (1996) and Le Garrec (2012), allowing for an endogenous unskilled/skilled workers structure. Individuals live for two periods of length normalized to one: they are respectively young and old. They work in both periods. Potentially the

[3]Challenging findings of Rauch (1994) and Moretti (2004), Acemoglu and Angrist (2000) found no significant effect of the proportion of skilled workers on productivity

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. Aging in the model is then characterized by rising longevity, i.e. by the lengthening of ρ.

Low-skilled individuals have only access to less-paid jobs which are also heavier and potentially health-damaging jobs involving losses in life expectancy. Investment in education in the model will then respond as traditional to earnings incentives but also to longer live incentives. Indeed, investing in education to become skilled worker allow first to increase earnings but also to expand longevity by avoiding hard work conditions[4].

A unique good, which can be either consumed or invested, is produced by competitive firms through a constant return to scale technology using physical capital and labor (skilled and unskilled). We will then assume either that education generates knowledge spillovers so that a higher proportion of skilled workers yields higher productivity as highlighted by Rauch (1993) and Moretti (2004), or not as supported by Acemoglu and Angrist (2000). Before analyzing the impact of rising longevity, we present in what follows the optimizing behaviors of individuals and firms, the functioning of the retirement system and the characteristics of the equilibrium.

[4] Even if the correlation between socioeconomic status and life expectancy is clear, assuming that the main reason is due to low economic conditions and hard work conditions is not straightforward. Indeed, the socioeconomically disavantaged are also associated with riskier behaviors such as cigarette smoking. However, one standard explanation in the literature is that people may smoke (or drink) as a response of stress induced by poor material and bad work conditions (see Laaksonen et al., 2005, for an overview). In addition, better material ressources may provide easier access to alternative ways of coping with stress than smoking. In either case, investing in education may expand longevity as sustained in our framework.

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 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 so that $h_{it}^t(e_{it} = 1) = \lambda_y^H h_{it}^t$, where $\lambda_y^H > 1$. In addition, we 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:

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

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. $e_t = 0$. $\ln (\rho_i - l_i)$ represents utility from retirement years as in Michel and Pestieau (2000). Everything being equal, it characterizes both utility from leisure when old and preferences for longer life.

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[5]. Accordingly, we then assume that ε_i is distributed over the population according to a Pareto distribution $\mathcal{P}\left(\varepsilon_{\min}, \sigma\right)$ 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 so that:

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

where s_{it} denotes savings, w_t the wage rate by unit of effective labor, 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:

[5]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.

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

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

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

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

where $\Omega_{it} = (1-\tau_t)(1-ze_{it})\, h^t_{it}(e_{it})\, w_{it} + (1-\tau_{t+1})\, l_i \frac{h^t_{it+1}(e_{it}) w_{t+1}}{R_{t+1}} + (\rho_i - l_i)\frac{p_{it+1}}{R_{t+1}}$ denotes the lifetime income. By reducing simultaneously the disposable income and the need for future income, a retirement system reduces private savings.

An individual will choose to make the effort for complementary schooling if it entails a utility benefit I_t higher than the utility cost ε_i associated with effort, $I_t \geq \varepsilon_i$. Following eq. (1), I_t can be decomposed into two components $I^{\mathcal{C}}_t$ and $I^{\mathcal{R}}_t$ such as:

$$I_t = I^{\mathcal{C}}_t + I^{\mathcal{R}}_t \tag{5}$$

where $I^{\mathcal{C}}_t$ and $I^{\mathcal{R}}_t$ denote inequality indexes between skilled and unskilled workers borned at date t respectively of consumption over the life cycle, $I^{\mathcal{C}}_t = \ln\left[\frac{c^H_t}{c^L_t}\left(\frac{d^H_{t+1}}{d^L_{t+1}}\right)^{\beta\rho^L}\left(d^H_{t+1}\right)^{\beta\left(\rho^H-\rho^L\right)}\right]$ where $\frac{\partial I^{\mathcal{C}}_t}{\partial \frac{c^H_t}{c^L_t}} > 0$ and $\frac{\partial I^{\mathcal{C}}_t}{\partial \frac{d^H_{t+1}}{d^L_{t+1}}} > 0$, and of retirement years, $I^{\mathcal{R}}_t = \beta \ln \frac{\rho^H - l^H}{\rho^L - l^L}$, $\frac{\partial I^{\mathcal{R}}_t}{\partial \frac{\rho^H - l^H}{\rho^L - l^L}} > 0$. Note that an increase in the longevity inequality results also, everything else being equal, in an increase in the consumption inequality index only if $d^H_{t+1} \geq 1$: $\frac{\partial I^{\mathcal{C}}_t}{\partial \rho^H - \rho^L} \geq 0$ if $d^H_{t+1} \geq 1$. Note also that if there are no differences neither in longevity, $\rho^H = \rho^L = \rho$, nor in the age of retirement, $l^H - l^L$, it yields $I^{\mathcal{R}}_t = 0$ and the consumption inequality index is rewritten following eqs. (2)-(4) as $I_t^{\mathcal{C}} = (1+\beta\rho)\ln\frac{\Omega_t^H}{\Omega_t^L}$, where Ω_t^H denotes the lifetime income of a skilled worker and Ω_t^L the lifetime income of an unskilled worker. In that case, I_t is only characterized by the lifetime income inequality $\frac{\Omega_t^H}{\Omega_t^L}$.

In its general expression, I_t represents then the life cycle welfare inequality between skilled and unskilled workers. 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:

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

where $\frac{d\bar{e}_t}{dI_t} > 0$, and σ is the elasticity of the effort decision with respect to the life cycle welfare inequality: $\sigma = -\frac{d\ln(1-\bar{e}_t)}{d\ln I_t}$. 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, pension benefits 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[6], 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.

[6] See Casamatta et al. (2000), Docquier and Paddison (2003), Sommacal (2006), Cremer et al. (2007), Hachon (2010), Le Garrec (2012).

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[7], 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 most existing retirement systems, the pension benefit formula (8) is progressive. Indeed, when considering an unskilled worker, $e_{it-1} = 0$, the gross replacement rate[8] 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, $e_{it-1} = 1$. However, 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 amount of pension benefits received by an individual and the (actualized) amount of his contributions, this means that:

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

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

[8]Defined following the United Nations (2007) as the pension benefit divided by gross pre-retirement earnings.

Note that in our setting the existence of an actuarially fair retirement system is not straightforward. Indeed, if we consider that educated workers contribute less long (they enter the job market later) and benefit from a 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 (2012), is sufficient to assert that a pure earnings-related system based on best or last years is regressive (see Aubert and Bachelet, 2012, for empirical evidence on the French retirement system). An actuarially fair retirement system can then exist in our setting only if a pure flat-rate system is progressive and if a pure earnings-related system is regressive, i.e. if $\frac{(1-z)\frac{\lambda_y^H}{\lambda_o^H} + \frac{l^H}{R}}{1+\frac{l^L}{R}} \leq \frac{\rho^H - l^H}{\rho^L - l^L} \leq \frac{(1-z)\lambda_y^H + \frac{l^H \lambda_o^H}{R}}{1+\frac{l^L}{R}}$.

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:

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

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 profit maximization 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. Following Rauch (1993) and Moretti (2004), we therefore assume that the productivity (and earnings) is positively linked to the proportion of (young) educated individuals in the economy so that:

$$A_t = \tilde{A}\bar{e}_t^{\gamma},\ \tilde{A} > 0, \tag{13}$$

where γ denotes the elasticity of earnings with respect to the proportion of educated workers and characterizes the size of human capital spillovers: $\frac{d\ln A_t}{d\ln \bar{e}_t} = \gamma \geq 0$. At steady state, earnings of a worker i is equal to $h_i(e_i)\tilde{A}\bar{e}^{\gamma}\left(1-\alpha\right)k^{\alpha}$. Contrasting with Acemoglu and Angrist (2000) who found no significant human capital spillovers ($\gamma \approx 0$), Moretti (2004) has estimated that the elasticity of earnings γ with respect to the proportion of educated workers is robustly 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 eqs. (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) does not depend on longevity ρ. With an unchanged pension benefit calculation, a retirement system which was actuarially fair stays actuarially fair when considering rising longevity[9].

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

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

where $I = (1+\beta\rho)\ln\left[(1-z)\,\lambda_y^H\right]$. From eq. (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 eq. (20), it also yields:

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

[9] 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.

workers. Besides, if education generates knowledge spillovers (Rauch, 1993, Moretti, 2004), a progressive system can reduce the global productivity in the economy. By contrast, a regressive system could enhance productivity and be profitable 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[10]. 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 $\beta\rho$ 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 retirement system size.

Considering eq. (20), the balanced budget of the pension system, obtained with eqs. (7), (8) and (14)-(17), is defined as:

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

[10] 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.

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 $k_0 > 0$[11], 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 eq. (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 stays unchanged with productivity variations.

Proposition 3 *If $l^H = l^L = 0$ and $\rho^H = \rho^L = \rho$, an increase in the size of an actuarially 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 $\theta + \nu > \frac{\sqrt{(2+\beta\rho)^2+4\frac{1-\alpha}{\alpha}}-(2+\beta\rho)}{2\rho\frac{1-\alpha}{\alpha}}$.*

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

The effect of 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 for current 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 in the contribution rate to fulfill balanced budget. If pension benefits are sufficiently high, 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 rising longevity in 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$^{\text{ies}}$. First, for this period high-school dropouts represent 30% of the French population (Eurostat). Assimilating high-school dropouts to subsequent unskilled workers, we set the proportion of skilled workers to 70%, i.e. $\bar{e} = 0.7$. We then consider that high-school dropouts enter the labor force at age 17 and leave it at the legal age of retirement 60. Assuming that a period of life represents 36 years in the model, it follows that high-school dropouts work a proportion $l^L = \frac{7}{36}$ of their second life period. Stating that the average retirement age (in the private sector) is equal to 61.3, we set $l^H = \frac{8.9}{36}$ as the proportion of the second life period that educated individuals work. 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, p. 5), having the life expectancy of the total population at 20.8 years yields a difference of longevity between skilled and unskilled workers of 2.5 years. Getting the demographic dependency ratio of 36% in 2005 in France (United Nations, 2009, see Figure 1, p. 4) corresponds then to the following longevities: $\rho^H = \frac{23.2}{36}$ 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 the length of education for those who make the effort at $z = \frac{7.3}{36}$ in proportion of the first life period. 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 French public 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 approximate the progressivity of the pension formula by the following ratio: $\frac{\theta+\nu}{\theta+\frac{\nu}{\lambda_o^H}} \approx \frac{63.8}{46.9} = 1.36$.

Finally, as usual, we set the capital's share of income α at 0.3, and we calibrate the model in order to get an initial annual interest rate equal to 2.8%[12] which corresponds to the long term average over the period 1971-2004 in Europe (Banque de France; see Mésonnier, 2005). In addition, we normalize $A = 1$. Following eq. (13), as $A = \tilde{A}\bar{e}^{\gamma}$, 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.

[12] Considering a period of 36 years, an annual interest rate of 2.8% corresponds to an interest factor of $R = (1.028)^{36} = 2.7$ for the period.

Target	data (2005)	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	$z = \frac{7.3}{36}$
Unskilled workers' proportion	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 of income	0.3	0.3	$\alpha = 0.3$
Annual interest rate	2.8%	2.81%	$\beta = 0.55$

Table 2. Calibrated values for the French economy.

3.3 A baseline scenario

Regarding the initial equilibrium, consider rising longevity (in $t = 0$) so that $\rho^H = 1$ and $\rho^L = \frac{33.5}{36}$, i.e. with an unchanged mortality differential corresponding to 2.5 years[13]. 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, p. 4). 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,

[13] Dynamic simulations have been performed through Dynare (see Juillard, 1996).

i.e. $\theta = 22.9\%$ and $\nu = 36.4\%$, the rising longevity leads to an increase in the social security size from 13.2% to 25.2% of 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 in 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 productivity A_t. However, as longevity rises, the return to investment in human capital increases and the average schooling time increases to a maximum of 8 months if the social return to education is at its maximum[14], 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 in the proportion of skilled workers between 7.5% and 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 case an increase of the proportion of skilled workers generates a productivity boost and then an increase in the demand for capital. The interest rate first increases then decreases towards its stationary level. By contrast, if the

[14]We have also calibrated $\varepsilon_{\min}$ and σ so that the average school years increases to 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.

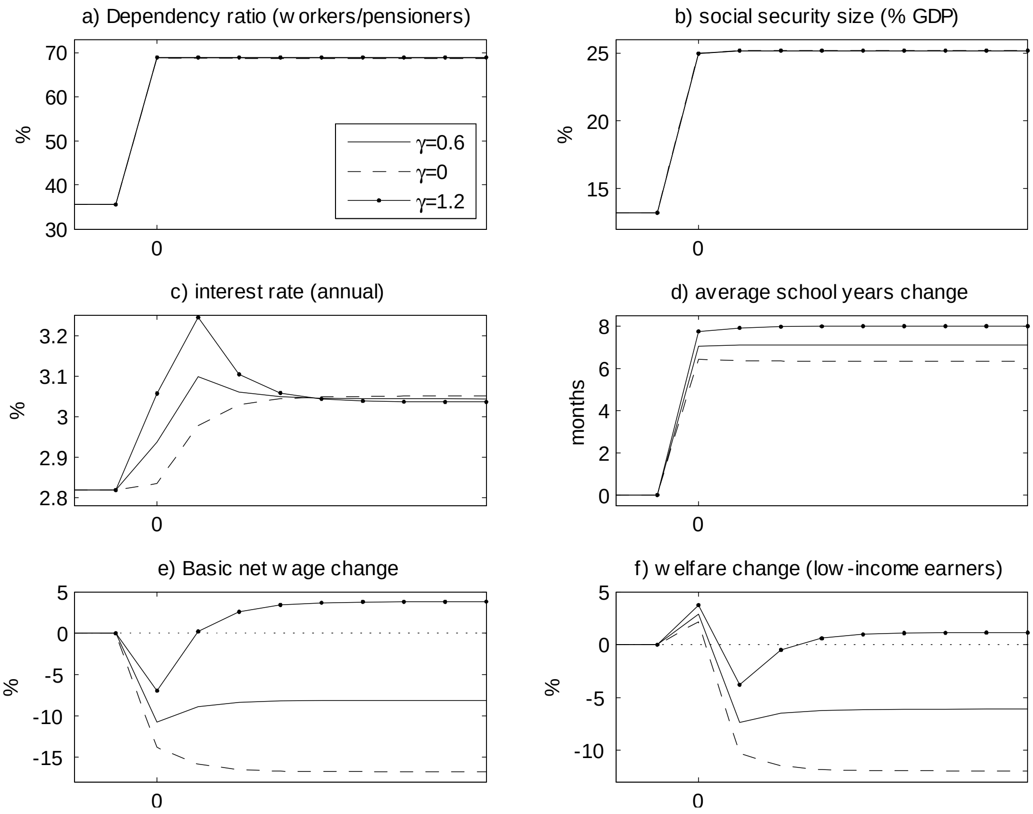

Figure 2: Rising longevity with unchanged gross replacement rates

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 rising longevity, the impact is similar to a free lunch. They have to contribute more during a very limited period of time (equal to l^L) to enjoy a longer retired life with unchanged flows of 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 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, 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 rising longevity.

In the baseline scenario, we consider the impact of 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 postponement 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, since 1981 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 contribute 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. That is why in 2012 the newly elected French government (left wing) has introduced an exception to the new legal age of retirement by allowing workers who have entered precociously the labor market, and then have "long career", to continue to retire at age 60. In the following, we then investigate both a uniform delay of the retirement age, and a delay supported 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 in 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 in 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

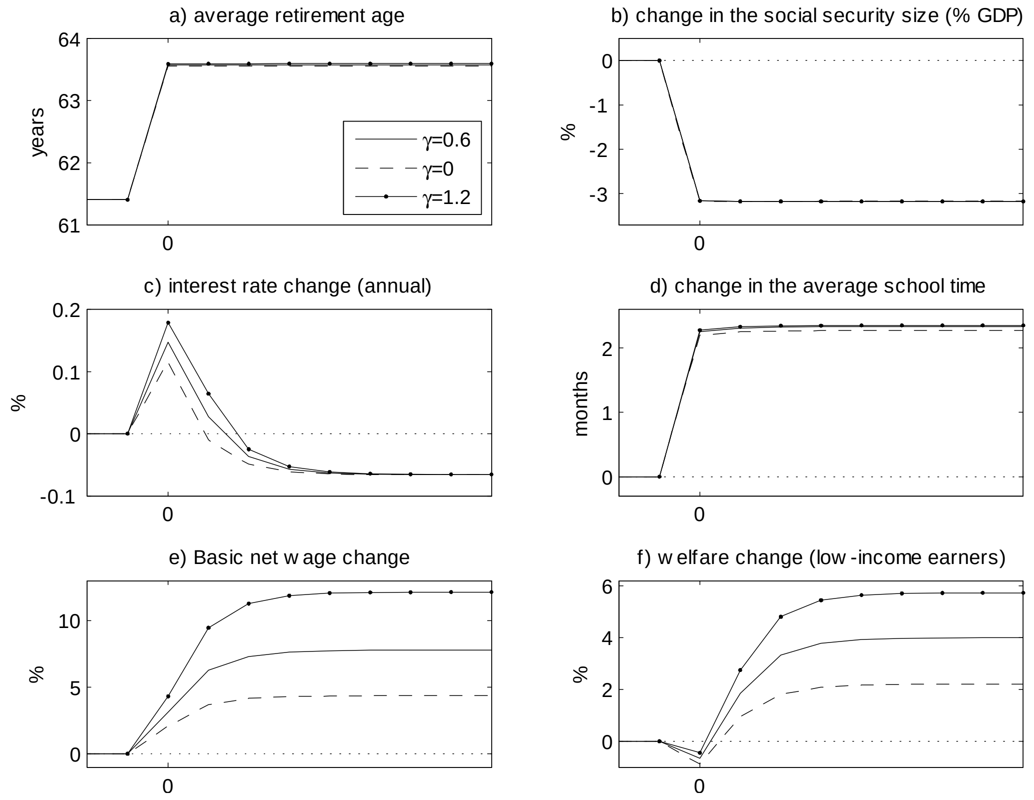

Figure 3: Increasing the legal age of retirement of 2 years (w.r.t. the baseline)

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 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 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, allowing them to retire at age 60 while skilled workers should contribute two years more compared to the baseline can appear at first glance fairly justified. Such a result can first be achieved by delaying the legal age of retirement of two years and by introducing in the law an exception for "long career" so that workers who entered precociously the job market can continue to retire at age 60. Such a reform can also be achieved by increasing the length of contribution necessary to obtain the full rate, at least if assuming sufficiently high penalties. In our framework, considering an increase of two years of the length necessary to obtain the full rate has no impact on the retirement decision of unskilled workers. Assuming then that this lengthening results in the delay of two years of the retirement of skilled workers is consistent with findings of Bozio (2004). Indeed, he shows that, in average, one additional quarter of necessary contribution leads to an increase of two months in retirement age in France, corresponding to an elasticity of 0.7 in average. In our framework, it fits with an elasticity of 0 for the unskilled workers (representing 30% of the workers), and an elasticity of 1 for the skilled workers. 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 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 productiv-

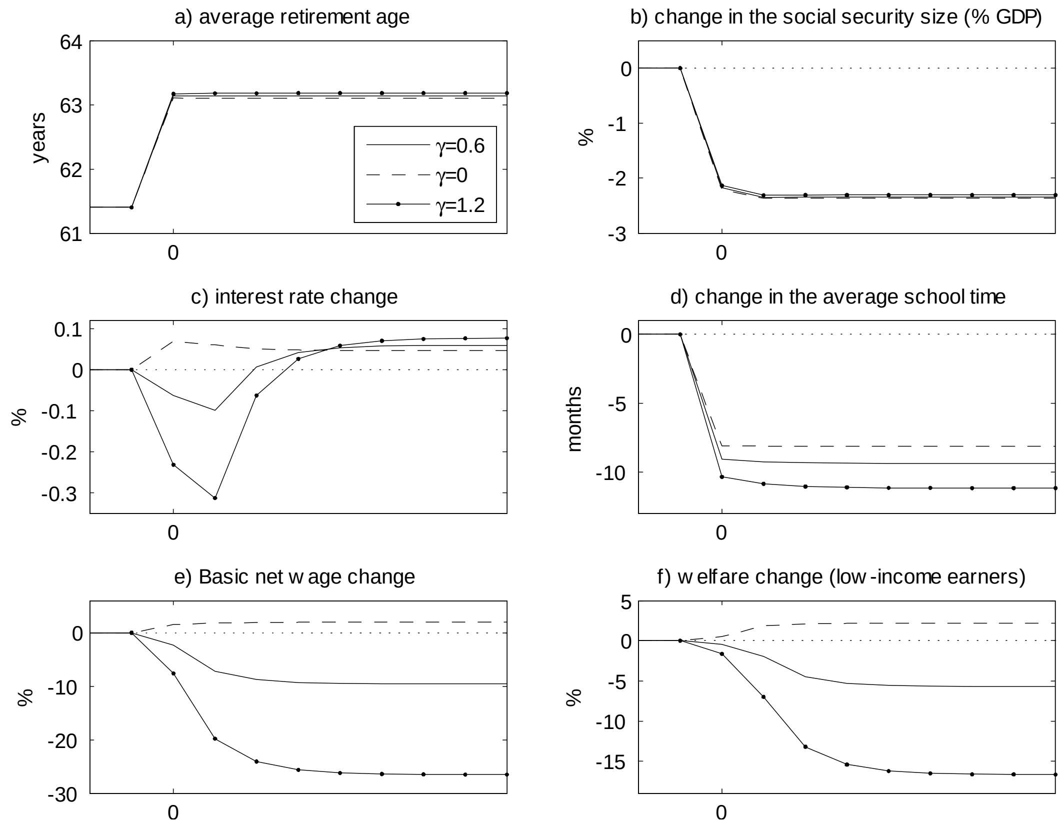

Figure 4: Increasing the skilled workers' contribution length of 2 years (w.r.t. the baseline)

ity 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, from a Rawlsian perspective, the superiority of this reform over both the baseline and the uniform postponement of the legal age of retirement. However, this result is valid only if education yields no spillover effects. Considering that the social return to education is between 0.6 and 1.2 gives indeed 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 uniform postponement of the legal age of retirement of two years clearly performs better than allowing unskilled workers to retire still at age 60, even from the unskilled workers perspective.

5 Conclusion

As a fact, population in the industrialized countries is aging. The threat associated with which 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 precociously, 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 contribute longer to enjoy a less long retirement. That is why in 2012 the newly elected French government (left wing) has introduced an exception to the new legal age of retirement by allowing workers who have entered precociously the labor market, and then have a "long career", to continue to retire at age 60. In this article, we then analyse the consequences of these two alternative reforms: delaying the legal age of retirement of 2 years either for all workers or 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 (from the low-skilled worker perspective) corresponds to introduce an exception to the postponement of the legal age of retirement so that unskilled workers may still continue to retire at age 60. By contrast, if the social return to education is significantly higher than the private return as estimated by Moretti (2004), the most socially preferable reform corresponds to a delay of the legal age of retirement for all workers, with no exception.

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 (p. 4), 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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