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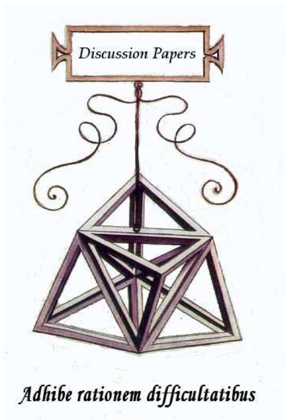

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Growth, PAYG pension systems crisis and mandatory age of retirement

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Discussion Paper
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Abstract

Since in many countries - plagued by low fertility - significant increases of the mandatory retirement age have been recently introduced with the declared objective to sustain PAYG pension budgets, then in this paper we investigate whether and how such boosts are effective. It is shown - in the basic two-period overlapping generations model of endogenous growth, which is maybe the toy-model most used for pension policy analyses - that the postponement of the retirement age is always harmful for growth and even for pension payments. Therefore this result suggests that the effects of boosts of mandatory retirement ages for sustaining PAYG pension budgets may not be warranted.

Keywords Retirement age; Pensions; OLG model

JEL Classification J26; O41

1. Introduction

As is known, in many developed countries, old-age pensions are financed on a Pay-as-you-go (PAYG)-basis. This may cause serious problems if the share of the old in total population is steadily rising due to both the extension of life expectancy and a sharp decrease in fertility rates. A vast consensus exists as regards the fact that: 1) PAYG social security schemes will face increasing difficulties in the years to come due to the ageing of the population; 2) to avoid the disruptions that the population ageing could bring about, pension reforms are obligatory.

In this respect, mainly four reform lines have been proposed: 1) a decrease in benefits; 2) an increase in contributions; 3) an increase in savings rates; 4) a raise of the retirement age, that is an obligatory longer working life.

Although social security reforms combine the four solutions, especially the compulsory increase of the working life seems to be a very practiced solution: many countries have raised in the recent years the mandatory age of retirement in a very significant way and are debating on further increases.

The reasons for these reforms rest on the assumption that the basic accounting implicit in the PAYG pension budget is cogent. In fact, according to this basic accounting, benefits, contribution rates, retirement ages and demographic patterns, must be mutually consistent. For instance, for facing with a decreased fertility, it would be indisputably necessary – following only the accounting rules - to increase contribution rates or decrease benefits or postponing retirement ages or a combination of them. However, in an economic growth setting, a change, for instance, in the mandatory age of retirement brings upon various important economic effects (for instance on labour supply, wages, savings and so on), which may influence the sustainability of PAYG pension systems more - and even in an opposite direction - than the basic accounting effects.[1] On the other hand, it is also noted that these pension reforms are perceived as painful by workers and seem to have low popularity, which in turn causes some concerns for policy-makers.[2] Therefore the following question may

[1] Indeed, for example, Fanti and Gori (2008, 2010) have shown that, in a conventional OLG neoclassical growth model, an increasing longevity may be useful as well as raising contribution rates may be harmful for the sustainability of pay-as-you-go pension systems. As regards the poverty traps problem, Fanti and Spataro (2008, p. 693) have shown that "policy programs such as pay-as-you-go pension schemes ….may help escaping from poverty".

[2] The documentation of whether the belief of the unavoidability of such pension reforms is also shared or not by citizens has been the object of a recent literature, which also has addressed the issue of how to have success – for instance through appropriate informational campaigns – in popularising such reforms. For instance, Boeri et al. (2001, 2002), drawing on surveys of European citizens, and Blinder and Krueger (2004) studying opinion polls in the US, noted that

deserve more attention: the recent reforms introducing later starting ages for paying benefits are, from a theoretical point of view, really justified?

While much literature has been so far devoted to a "normative" analysis of the retirement age (Hu, 1979, Marchand et al., 1996, Michel and Pestieau (1999), Crettez-Le Maitre (2002), Momota (2003), Lacomba and Lagos (2006), as well as to models of political games for voting on the age of retirement (Conde-Ruiz and Galasso, 2004; Casamatta et al., 2005), what seems to be also needed, however, is an analysis of the effects of the boost in the mandatory age of retirement on the pension systems itself in a context of economic growth. This paper aims to fill this gap.

To do so in the simplest way, we use the standard model of an OLG growing economy which is widely used in the literature especially for pension policies analyses, starting from the seminal Diamond (1965).[3] For simplicity, we mainly restrict ourselves to the case of log-linear life-cycle utility function and Cobb-Douglas production function.

The main results are that the rate of economic growth is always harmed by pension reforms boosting the mandatory age of retirement. As a consequence, such reforms ultimately also hurt the sustainability of the PAYG pension system. For instance it is shown that any boost in the mandatory age of retirement not only reduces pension payments (ceteris paribus) in the long run, but in realistic economies, especially if plagued by below replacement fertility rates – which is one of the motives causing such a boost – pension payments are reduced even in the short run (i.e. for the current young workers).

The rather paradoxical policy implication is that there would be room for a reduction, rather than the often implemented boost, in the mandatory retirement age for improving future pension payments.

The paper is organised as follows. In Section 2 the model is developed. Section 3 analyses the balanced growth of the economy and discusses the relationship between pensions and compulsory age of retirement along with the balanced growth path. Section 4 concludes.

2. The model

2.1. Firms

We assume the technology of production faced by each firm as:

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more informed individuals are more likely to support pension reforms and then advise a more operative "advertising campaign".

[3] For instance, we note that, again for what concerns pension reforms, such a model is used at a textbook level, as known, for showing that the rate of growth is higher with a Fully-Funded pension system than with a PAYG pension system.

$$Y_{i,t} = K_{i,t}{}^{\alpha}(A_{i,t}L_{i,t}{}^{1-\alpha}), \tag{1}$$

where the index i denotes the typical firm, Y_i is total output produced by firm i, $K_{i,t}$ and $L_{i,t}$ are the capital input and the labour input hired in that firm, respectively, A is the labour productivity and $0 < \alpha < 1$ is the capital's weight in technology. Labour input is provided by young population and by a fraction (1-λ), 0<λ<1, of the old population, as detailed below. As usual (e.g. Grossman and Yanagawa, 1993) it is assumed that labour productivity is the following function of the average capital per-worker in the whole economy K_t / L_t, which is taken as given by each single firm

$$A_{i,t} = \left(B \frac{K_t}{L_t} \right)^{1-\alpha} \tag{2}$$

where $B > 0$ represents a scale parameter. Then, by inserting Eq. (2) in (1), the production function thus implies an externality of capital investment and, setting $L_{i,t} = L_t$, $K_{i,t} = K_t$ and $Y_{i,t} = Y_t$, the aggregate time-t production function is given by:

$$Y_t = B(K_t / L_t)^{1-\alpha} K_t{}^{\alpha} L_t{}^{1-\alpha}, \tag{3}$$

where $L_t = N_t + (1-\lambda)N_{t-1}$ (which may be rewritten as $L_t = N_t \dfrac{2+n-\lambda}{1+n}$), N_t (N_{t-1}) is the young (old) population and young population N_t is assumed to grow at a constant rate n. Defining $k_t := K_t / N_t$, $y_t := Y_t / N_t$ and $l = \dfrac{L_t}{N_t} = \dfrac{2+n-\lambda}{1+n}$ as capital per-young, output per-young and the ratio between total (young and old) workers and the young workers, respectively, the aggregate intensive-form production function can be written as

$$y_t = B k_t \tag{4}$$

Assuming total depreciation of capital at the end of each period and knowing that final output is sold at unit price, profit maximisation implies that the inputs of production are paid their marginal product, i.e.:

$$r = \alpha B - 1, \tag{5}$$

$$w_t = (1-\alpha) B k_t l^{-1}. \tag{6}$$

Note that while the rate of interest is independent of the age of retirement, the latter affects wages: the lower is the mandatory age of retirement, the higher wages are (since the lengthening of the retirement period implies a reduction of the labour supply of old workers and thus of the total labour supply).

2.2. Individuals

Agents are assumed to belong to an overlapping generations structure with finite lifetimes. Adult life is separated among two periods: youth and old-age (Diamond, 1965). Individuals belonging to generation t have a conventional Cobb-Douglas utility function defined over young-aged and old-aged consumption, $c_{1,t}$ and $c_{2,t+1}$, respectively. Each person born at (the beginning of period) t lives for two periods and is capable of providing one unit of labour per period. In the first period t he works full time, earning a wage income of w_t while paying a Social Security tax according to the contribution rate τ. In the second period $t+1$, he works a fraction $(1-\lambda)$ of the time, and then retires (i.e. when λ=1 each person is retired for the whole second-period of life, which is the assumption of the conventional OLG model of Diamond (1965)). During old-age agents' earnings therefore consist of 1) the proceeds of their savings (s_t) plus the accrued interest at the rate r_{t+1}, 2) a net wage income of $(1-\lambda)(w_{t+1}(1-\tau))$ and 3) a pension of λz_{t+1}, which is publicly provided and financed at balanced budget by the government. The length of the retirement period λ is mandatory (e.g. fixed by government).[4]

Thus, the representative individual born at time t is faced with the following program:

$$\max_{\{s_t\}} U_t = \ln(c_{1,t}) + \gamma \ln(c_{2,t+1}), \tag{P}$$

subject to

$$c_{1,t} + s_t = w_t(1-\tau))$$
$$c_{2,t+1} = (1+r_{t+1})s_t + w_{t+1}(1-\tau)(1-\lambda) + \lambda z_{t+1}$$

where $0 < \gamma < 1$ is the subjective discount factor.

The maximisation of program (P) gives the following savings function:

$$s_t = \frac{1}{1+\gamma}\left[w_t(1-\tau)\gamma - \frac{w_{t+1}(1-\tau)(1-\lambda)}{(1+r_{t+1})} - \frac{\lambda z_{t+1}}{(1+r_{t+1})} \right]. \tag{7}$$

2.3 Government

The government balances the PAYG social security scheme in every period

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[4] We may interpret $1+\lambda$ as being the retirement age as well as the total time devoted to labour over the life-cycle, while, of course, the length of retirement is $1-\lambda$. This also means that, for instance, by assuming conventionally the length of one period equal to thirty years and an age of entry in the adult life (i.e. in the labour market) of thirty years, then the age of retirement would be 60 years when λ=1, 65 years when λ=0.84, 70 years when λ=0.667, and so on.

$$\lambda z_t N_{t-1} = \tau\, w_t N_t + \tau w_t N_{t-1}(1-\lambda)\,, \tag{8}$$

where the left-hand side represents the social security expenditure and the right-hand side the tax receipts. This scheme leads to the following formula for pension benefits[5]:

$$z_t = \tau\, w_t \mu \tag{9},$$

where $\mu = \dfrac{2+n-\lambda}{\lambda}$.

Inserting (9) into (7) to eliminate z_{t+1}, savings function chosen optimally by individuals modifies to become:

$$s_t = \frac{1}{1+\gamma}\left[w_t(1-\tau)\gamma - \frac{w_{t+1}[1+\tau(1+n)-\lambda]}{(1+r_{t+1})} \right] \tag{10}$$

It is of interest to note that when the old-age working period is reduced (which is combined with a lower wage income in the old-age period) young individuals choose a higher saving in order to better sustain the consumption because of, on the one hand, the longer retirement period and, on the other hand, to the reduced wage income in the oldness. [6]

3. Balanced growth analysis

Given the government budget (8) and knowing that population evolves according to $N_{t+1} = (1+n)N_t$, the market-clearing condition in goods as well as in capital markets is expressed by the equality $(1+n)k_{t+1} = s_t$. Substituting out for s according to Eq. (10), exploiting (5) and (6), and assuming individuals are perfect foresighted, the dynamic equilibrium sequence of capital is determined by:

$$k_{t+1}(1+n) = \frac{1}{(1+\gamma)}\left\{ k_t \frac{(1+n)\gamma(1-\tau)(1-\alpha)A}{2+n-\lambda} - k_{t+1}\frac{(1-\alpha)(1+n)[1+\tau(1+n)-\lambda]}{\alpha(2+n-\lambda)} \right\} \tag{11}$$

3.1 Rate of economic growth and mandatory age of retirement

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[5] This is the so-called defined contribution scheme where the contribution rate is constant and the pension benefit is residually obtained through the budget constraint. Otherwise, in the so-called defined pension scheme the contribution rate is residually determined to balance the budget and thus the pension benefit would be kept at a constant level.

[6] The proof that a lengthening of the working period (i.e. a mandatory increase of the retirement age) reduces savings follows straightforwardly from $\dfrac{\partial s_t}{\partial \lambda} > 0$.

From Eq. (11) we obtain the growth rate of the per young stock of capital, *g*, (which obviously coincides with the growth rate of per young output since the labour input is constant):

$$g=F-1, \qquad (12)$$

where $F=\dfrac{\gamma(1-\tau)\alpha(1-\alpha)B}{\alpha[(2-\lambda+n)\gamma+(1-\tau)(1+n)]+1+\tau(1+n)-\lambda}$ is the factor growth.[7]

Proposition 1: *A lengthening of the working period (i.e. a mandatory increase of the retirement age) always reduces the rate of economic growth.*

Proof: the proof follows straightforwardly from the derivative $\dfrac{\partial g}{\partial \lambda}>0$.

One important question concerns the channels through which the result of Prop.1 operates. The first channel is represented by a direct "saving" effect: the lengthening of the retirement period implies an increase in the need to save for supporting the consumption for a longer retirement period as well as to remedy to a reduced old-age wage income. The second channel is represented by a "wage" effect: the lengthening of the retirement period implies a reduction of the labour supply of old workers and thus of the total labour supply, which, in turn, implies an increase in wages (which indirectly raises savings). Both channels work for a negative (positive) effect of a boost (reduction) in the mandatory retirement age on growth.

3.2 Pension payments on the balanced growth path and mandatory age of retirement

By observing, from a basic accounting point of view, the pension formula in Eq. (9), it is easy to see, for instance, that an increase of the mandatory age of retirement brings upon an increase of pension benefits or that a fertility rate drop must be counterbalanced by an adequate increase of the mandatory age of retirement in order to keep in-altered pension benefits (ceteris paribus).

However, by analysing more in detail Eq. (9) also taking account of the wage growth context, we may write, solving *k (t)* in Eq. (11) and combining Eqs. (6) and (9), the following dynamic evolution of the pension benefit:

$$z(t)=HF^{t}k(0)\text{, where } H=\left[\frac{\tau(1-\alpha)B(1+n)}{\lambda}\right]. \qquad (13)$$

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[7] Note that the rate of growth $g_{t+1}=\dfrac{k_{t+1}}{k_t}-1$ displays no transition and is always equal to *g*, as follows from solving g_{t+1} in Eq. (11).

It is easy to see from Eq. (13) that the length of the retirement period plays a twofold role. In particular a boost of the mandatory age of retirement has a positive direct effect consisting in an increase of pension benefits because pensions must be paid for a shorter period and a negative indirect effect due to the negative change in the wage induced by the reduced capital accumulation due to the increased retirement age. [8]

As regards the latter point, we know that (i.e. Prop. 1) a reduced retirement period depresses the rate of economic growth and thus the rate of wage growth as well. Since the number of contributors (the labour supply) as well as the number of pensioners are constant along with the balanced growth path, then the fact that a reduced retirement period depresses the rate of wage growth implies that from some point of time onward it must necessarily hold the following result: the lower the age of retirement, the higher pension benefits will be for ever along with balanced growth path.

Therefore in the long run a boost of the mandatory age of retirement is always harmful for the sustainability of a PAYG pension system.

To sum up, the considerations above lead to the following lemma and remark.

Lemma 1: *H (F)* is increasing (decreasing) with the mandatory retirement age. This derives from the Prop.1 and the fact that the derivative of *H* with respect to λ is positive.

Remark 1: In the long run, the lower is the mandatory retirement age, the higher the pension benefits is. This follows from the fact that in the dynamic equation of the pension formula (13) the growth factor *F* is decreasing with the retirement age (as shown in Prop. 1).

After having established that along with balanced growth rate, in sharp contrast with the common belief, the sustainability of PAYG systems is menaced (favoured) by a lengthening of the retirement age, it is also of interest to investigate the short-run effect of such a lengthening. Indeed, as regards the pension payments which will be perceived in the old age by the current young generation (i.e. the generation in the young-age at the moment of the boost of the mandatory retirement age), the overall effect of an increased retirement age appears to be, a priori, ambiguous, since, on the one hand, the total contributions will be reduced due to reduced wages but, on the other hand, also the period for which pensions must be paid is reduced.

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[8] For the sake of precision, as regards the negative change in the wage, we note that a change of the retirement period affects wages in the long run through two channels: 1) the effects on the capital stock input, 2) the effects on the labour input. In particular, as regards the latter point we know that a reduced retirement period implies a higher labour supply, which, in turn, tends to lower wages. However, in our model, the negative effect of the higher labour supply on wages exactly compensates the positive effect of the higher labour supply, i.e. the higher number of contributors, on the total contributions, so that in Eq. (13) both effects do not explicitly appear.

Therefore, for determining the effect of an increased retirement age in the short run it needs to analyse ultimately which of the opposite forces dominates, as stated by the following remark.

Remark 2: In the short run the relationship between pension benefits and mandatory retirement age is a priori ambiguous and ultimately is an empirical matter. This follows from lemma 1.

In order to better qualify Remark 2 providing a quantitative assessment of the effect of an increased retirement age in the short run, we parameterize our simple model by using values which, although chosen only for illustrative purposes, are in accord with those of a conventional economy: α =0.33 (as in most studies), $\gamma = 0.30$ (a rather standard value as in De La Croix and Michel, 2002, p. 50), $\tau = 0.15$ (e.g., the level of pension contributions in Europe is currently around *16%* of aggregate wages (e.g. Liikanen, 2007, p. 4)), $n=0$ (stationary population). As regards the scale parameter in the Cobb-Douglas production function, we have calibrated its value such that, in the case of fully retired old-age, the rate of economic growth is around *2.35%* per year, that is $A= 18.8$. Furthermore, we assumed an initial value of the per young capital stock $k_0=0.1$.

Since many recent pension reforms increased the mandatory age of retirement up to 65 years, and proposals for further increases – for instance up to 67 and even 70 years - are on the political agenda, our numerical example compares the level of the pension payment for the generation *t* when the mandatory age of retirement is 60 and 67.5 years, respectively.[9] The result is that the pension paid to the generation *t* is $z_{t+1}=0.3778$ *(0.3316)* when the mandatory age of retirement is 60 (67.5) years: that is the boost of the mandatory retirement age would reduce pension payments more than *12%*. Finally we have chosen a value of the population growth rate corresponding to the current below-replacement fertility rate observed in many advanced economies, in particular about 1.35 children for each couple (i.e. $n= -0.333$). In this case, while the pension payment when the mandatory age of retirement is 60 years remains the same of the case of stationary population, the pension paid to the generation *t* when the mandatory age of retirement has been raised up to 67.5 years is $z_{t+1}=0.2838$: that is the boost of the mandatory retirement age would reduce pension payments around *25%*.

This means that in the case in which the boost of the mandatory retirement age occurs when there is below-replacement fertility rate, as it seems the case of the current advanced economies, the damage for the sustainability of the PAYG pension system is higher than in the case of increasing population. Therefore we remark the paradoxical result that a reform increasing the mandatory retirement age for remedying to a declining population, achieves the undesired result to reduce pension payments not only for all the future generations but even for the current young generation.

[9] It is assumed a conventional period of thirty years, as discussed in footnote 4.

4. Conclusions

In this paper we investigated, by using the conventional OLG growth model as it is usual for what concerns pension analyses, whether the recent widespread boost of the mandatory age of retirement is really effective for sustaining the PAYG pension system viability.

It is shown that the postponement of the retirement age is always harmful for both the rate of economic growth and PAYG pensions systems. In particular a reform increasing the mandatory retirement age achieves the undesired result to reduce pension payments not only for all future generations but even for the current young generation, especially, rather paradoxically, when population is declining.

In other words, this paper draws attention to the intertemporal agents' behaviours in general equilibrium contexts, as a mechanism through which changes in the elements of the social security system such the mandatory age of retirement - which if considered in isolation in the social security accounting formula would have univocal effects - may have unexpected economic effects due to the interplay with other branches of the economy (e.g. capital and labour markets).[10]

Therefore this result, although obtained under the assumption of a specific double Cobb-Douglas economy, suggests that the effects of boosts of mandatory retirement ages for sustaining PAYG pension budgets may not be warranted.

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[10] Note that we have deliberately abstracted from other channels which would have worked in the direction of strengthening our unconventional results, such as those implied in Sala-i-Martin (1992). The latter, for instance, argues that one implication of the work in old age is that the old workers, through the reduction of the average stock of human capital due to the fact that skills depreciate with age, have a negative effect on the productivity of the young, and shows that, under the circumstance of a sufficiently strong skill depreciation with age the aggregate output in an economy is higher if old workers retire. In Sala-i-Martin's own words (1992, p. 1): "Retirement in this case will be a good thing".

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