Economics Bulletin

Volume 35, Issue 2

Growth, PAYG pension systems crisis and mandatory age of retirement

Luciano Fanti
Department of Economics and Management, University of Pisa

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 may be harmful for growth and, more interestingly, for pension payments. Therefore this result suggests that the positive effects of lengthening mandatory retirement ages for sustaining PAYG pension budgets might not be warranted.

I am grateful to an anonymous referee and to the Editor Ping Wang for useful cooments and suggestions. The usual disclaimers apply.
Citation: Luciano Fanti, (2015) "Growth, PAYG pension systems crisis and mandatory age of retirement", *Economics Bulletin*, Volume 35, Issue 2, pages 1160-1167
Contact: Luciano Fanti - luciano.fanti@unipi.it.
Submitted: September 02, 2014. **Published:** May 14, 2015.

1. Introduction

As is known, in many developed countries, old-age pensions are financed on a Pay-as-you-go (PAYG)-basis. 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, many countries have raised in the recent years the mandatory age of retirement in a very significant way and are debating on further increases.

Although on the basis of the basic accounting implicit in the PAYG pension budget a postponement of retirement ages seems to be indisputably effective for facing, for example, a decreased fertility, in a general equilibrium dynamic setting (such as the 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] Therefore the following question may deserve more attention: are the recent reforms introducing later starting ages for paying benefits really justified from a theoretical point of view?[2]

While much literature has been so far devoted to a "normative" analysis of the retirement age (e.g. Hu 1979, Marchand et al. 1996, Michel and Pestieau 1999, Crettez and Le Maitre 2002, Momota 2003, Lacomba and Lagos 2006), and to models of voting on the age of retirement (e.g. Conde-Ruiz and Galasso, 2004, and 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 sustained economic growth.[3] Very recently Fanti (2014) showed that, in the neoclassical OLG growth model context, a postponement of the retirement age may be harmful for long-run income and even for pensions. It is natural to ask which effects arise in an endogenous growth context, which has not been, at the best of our knowledge, so far explored. This paper aims to fill this gap.

To do so in the simplest way, we use the standard model of an OLG growing economy with log-linear life-cycle utility function and Cobb-Douglas production function, by assuming an Arrow-Romer approach, in which labour productivity is determined by cumulated aggregate investment per worker.

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, by reducing pension payments in the long and short run.[4]

---

[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] Moreover, 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. 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 more informed individuals are more likely to support pension reforms and then advised a more operative "advertising campaign" for popularising such reforms.

[3] An early analysis of the mandatory retirement age – endogenous economic growth nexus is in Fanti (2012), which is a working paper version of this article.

[4] We note that in this paper the driving force of endogenous growth is the level of capital per worker as in the standard Arrow-Romer tradition. A recent work (Kunze, 2014) showed that, when the endogenous growth is driven by the human capital investing instead of the learning-by investing, there exists an inverted U-shaped relationship between growth and mandatory retirement age. Therefore this result shows that even when the human capital is the sole engine of growth our result still holds true at least in countries in which the retirement age is already sufficiently high.

The rather paradoxical policy implication is that there would be room for a reduction, rather than the often implemented increase, 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 the balanced growth path. Section 4 concludes.

2. The model

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

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

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 employed 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 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 $L_t = N_t \frac{2+n-\lambda}{1+n}$), 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 $l = \frac{L_t}{N_t} = \frac{2+n-\lambda}{1+n}$ 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 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 $\lambda=1$ each person is retired for the whole second-period of life, as in 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).[5]
Thus, the representative individual born at time t faces 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

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

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[6]:

$$z_t = \tau\, w_t \mu \qquad (9),$$

where $\mu = \frac{2+n-\lambda}{\lambda}$.
Inserting (9) into (7) to eliminate z_{t+1}, the savings function chosen optimally by individuals modifies to become:

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

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, the reduced wage income in the oldness. [7]

3. Balanced growth analysis

[5] We may interpret $T\lambda$ as the length of retirement, where T is the length of one period. 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.

[6] 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.

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 that individuals have perfect foresight, the dynamic equilibrium sequence of capital is determined by:

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

3.1 Rate of economic growth and mandatory age of retirement

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):

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

where $F = \frac{\gamma(1-\tau)\alpha(1-\alpha)B}{\alpha[(2-\lambda+n)\gamma+(1-\tau)(1+n)]+1+\tau(1+n)-\lambda}$ is the factor growth.[8]

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 $\frac{\partial g}{\partial \lambda} > 0$.

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

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

---

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

[8] Note that the rate of growth $g_{t+1} = \frac{k_{t+1}}{k_t} - 1$ displays no transition and is always equal to g_t as follows from solving for 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.[9] In particular an increase 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 of the wage induced by the reduced capital accumulation due to the increased retirement age. [10]

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 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 the 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.

After having established that along the balanced growth path, in sharp contrast with the common belief, the sustainability of PAYG systems is menaced 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 increase 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.

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 (see also footnote 9), as stated by the following remark.

Remark 1: In the short run the relationship between pension benefits and mandatory retirement ages is a priori ambiguous and ultimately is an empirical matter.

In order to better qualify Remark 1 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, $\gamma = 0.30$ (e.g. 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), $n=0$ (i.e. stationary population). Furthermore, the scale parameter in the production function has been calibrated to replicate, in the case of fully retired old-age, a rate of economic growth around *2.35%* per year, that is $A= 18.8$, and it has been 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, we compare the level of the pension payment for the generation t when the mandatory age of retirement is 60 and 67.5 years, respectively.[11] The result is that the pension paid to the generation t is $z_{t+1}=0.3778$ *(resp. 0.3316)* when the mandatory age of retirement is 60 (resp. 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

[9] It is easy to see that H (F) is increasing (decreasing) with the mandatory retirement age.

[10] For the sake of precision, as regards the negative change of 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 larger number of contributors), on the total contributions, so that in Eq. (13) both effects do not explicitly appear.

[11] It is assumed a conventional period of thirty years, as discussed in footnote 5.

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 increase of the mandatory retirement age would reduce importantly pension payments around *25%*.
This means that in the case in which the boost of the mandatory retirement age occurs when there is a below-replacement fertility rate, as it seems to be 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 at 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.

4. Conclusions

In this paper we investigated, by using a standard OLG endogenous growth model, whether the recent widespread increase 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 may be always harmful for the rate of economic growth and for PAYG pensions systems. As a consequence, a reform increasing the mandatory retirement age may achieve the undesired result to reduce pension payments not only for all future generations but even for the current young generation. In particular this undesired result is, rather paradoxically, magnified when population is declining (which is precisely one of the main motives often invoked for the postponement).
This also shows that the agents' intertemporal behaviours in general equilibrium contexts may cause unexpected effects of pension reforms due to the interplay of these reforms with other branches of the economy (e.g. capital and labour markets).[12]
As future directions of research, it would be interesting to see how robust are the results when some simplifying assumptions are changed: e.g. assuming CES production and utility functions, endogenous age of retirement, aging resulting not only from declining fertility but also from increasing longevity.

References

Blinder, A. S. and A. B. Krueger (2004) "What does the public know about economic policy, and how does it know it?" *Brookings Papers on Economic Activity* 1, 327–387.

Boeri, T., Boersch-Supan, A. and G. Tabellini (2001) "Would you like to shrink the welfare state? A survey of European citizens" *Economic Policy* 16 (32), 7–50.

Boeri, T., Boersch-Supan, A. and G. Tabellini (2002) "Pension reforms and the opinions of European citizens" *American Economic Review* 92 (2), 396–401.

[12] 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".

Casamatta, G., Cremer H., and P. Pestieau (2005) "Voting on pensions with endogenous retirement age" *International Tax and Public Finance* 12(1), 7-28.

Conde-Ruiz, J.I., and V. Galasso (2004) "The macroeconomics of early retirement" *Journal of Public Economics* 88, 1849-1869.

Crettez, B., and P. Le Maitre (2002) "Optimal age of retirement and population growth" *Journal of Population Economics* 15, 737-755.

de la Croix, D. and P. Michel (2002) *A theory of economic growth. Dynamics and policy in overlapping generations*, Cambridge University Press, Cambridge (UK).

Diamond, P. (1965) "National debt in a neoclassical growth model" *American Economic Review* 55 (5), 1126-1150.

Fanti, L., and L. Gori (2008) "Longevity and PAYG pension systems sustainability" *Economics Bulletin* 10(2), 1-8.

Fanti, L., and L. Gori (2010) "Increasing PAYG pension benefits and reducing contribution rates" *Economics Letters* 107(2), 81-84.

Fanti, L. and L. Spataro (2008) "Poverty traps and intergenerational transfers" *International Tax and Public Finance* 15(6), 693-711;

Fanti, L. (2012) "Growth, PAYG pension systems crisis and mandatory age of retirement" Discussion Papers, Department of Economics and Management, University of Pisa, n. 153. http://www.ec.unipi.it/ricerca/discussion-papers.html

Fanti, L. (2014) "Raising the Mandatory Retirement Age and its Effect on Long run Income and Pay-as-you-go (PAYG) Pensions" *Metroeconomica*, 65 (4), 619-654.

Kunze, L. (2014) "Mandatory retirement and economic growth: An inverted U-shaped relationship" *Economics Bulletin*, 34(2), 885-891.

Grossman, G. M. and N. Yanagawa (1993) "Asset bubbles and endogenous growth" *Journal of Monetary Economics* 31, 3-19.

Hu, S.C. (1979) "Social Security, the Supply of Labor, and Capital Accumulation" *American Economic Review* 69(3), 274–283.

Lacomba, J. and F. Lagos (2006) "Population aging and legal retirement age" *Journal of Population Economics* 19(3), 507-519.

Liikanen, E. (2007) "Population ageing, pension savings and the financial markets" *BIS Review* 53, 1–6.

Marchand, M., Michel P., and P. Pestieau (1996) "Optimal Intergenerational Transfers in an Endogenous Growth Model with Fertility Change" *European Journal of Political Economy* 12, 33-48.

Michel, P., and P. Pestieau (1999) “Social Security and Early Retirement in an Overlapping-Generations Growth Model” C.O.R.E. Discussion Paper, 9951.

Momota, A. (2003) “A retirement decision in the presence of a social security system” *Journal of Macroeconomics* 25(1), 73-86.

Sala-i-Martin, X. (1992) “Transfers” N.B.E.R. Working Paper 4186.