

# **The impact of increased life expectancy on the level pension**

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### **Abstract**

This paper proposes an overlapping generation model along the lines of the papers by Fanti and Gori (2008). Its objective is to study the effect of demographic shocks on the level pension respectively in the PAYG and funded system within the context of increased life expectancy at long-run.

### **Resumen**

En este trabajo se propone un modelo de generación de superposición en la línea de los trabajos de Fanti y Gori ( 2008 ) . Su objetivo es estudiar el efecto de los shocks demográficos sobre la pensión nivel , respectivamente, en el reparto y sistema de capitalización en el contexto del aumento de la esperanza de vida al largo plazo.

*Key words:* life expectancy, pension system, overlapping generation model

*JEL Classification:* H55, J13

## 1. Introduction

The question of retirement has been the subject for some time, an important and special attention from economists. Thus, the recent changes in demographics and pensions technical lead different economists to focus on debate PAYG/ funded. This debate focuses mainly on three points which are respectively differences in returns and risk, impact on savings and economic growth and sensitivities demographic shocks. The latter will be the interest of our . Blanchet (1999) distinguished two types of demographic shock. The first shock focuses on the population growth rate. The second shock is related to the increase in life expectancy. More specifically, we are interested in the effect of this second type of demographic shocks on the level pension. The increase in individual life expectancy at all ages is a recent population event in human history. Indeed, during the first half of the 20th century, it was obtained as a result of a sharp decrease in infant mortality rates, which helped make steady gains in life expectancy at birth. After the Second World War, the main contribution came from the decrease in mortality after 60, lengthening life expectancy in old age period. These gains in life expectancy at older ages have brought people into the era of longevity.

There is ample statistical evidence that indicated the trend of increased life expectancy will influence asset returns in funded system and therefore the level of pension received by the pensioner will reduce in the coming decades according Abel (2003). In fact, Zhang and Lee (2001), Miyazato (2010) and Beetsma et al. (2011) noted that this type of demographic shocks in the funded pension system results in regression of returns on annuities. Similarly, Altiparmakov (2013) showed that funded pension systems are far from immune to this phenomenon of increased life expectancy. In other words, this phenomenon leads contributors to receive over time lower pension levels for the same amount of accumulated retirement savings. In the same, Thomas et al. (2014) indicate that the level pension in the case of funded will decrease in the next two decades because of the arrival at the retirement of the baby-boom generation. On the other hand, Devolder (2007) have noticed that the increase of life expectancy affects an equivalent manner the level pension in the two types of pension system since each type of retirement system constitutes a transfer of income from assets to the pensioners. But, in our paper, we study this problem through an approach of overlapping generation along the lines of the papers by Fanti and Gori (2008).

The rest of the paper is organised as follows. Section 2 describes the model. Section 3 analyses how the increased of life expectancy affects the level pension in the PAYG system. Section 4 studied this impact in the case of funded pension system. Section 5 concludes.

## 2. The model

Our model is inspired by the paper of Fanti and Gori (2008) in which agents live two periods. Each individual born in  $t$  consume successively  $c_t$  and  $c_{t+1}$ . In this model, it assumes that the old individuals survive to the second period with a probability  $\pi$ . Thus, the function of intertemporal utility of the representative agent is given by the following expression:

$$U_t = \ln(c_{1,t}) + \pi\gamma \ln(c_{2,t+1}) \quad (1)$$

Where  $\gamma$  is the subjective discount factor

Each worker receives wage income at the competitive rate  $w_t$  and pays a proportional tax on income from work, which is used to finance the pension system. Thus, the budget constraint of the individual in the first period is written as follows:

$$c_t + s_t = w_t(1 - \theta) \quad (2)$$

where  $s_t$  is the level of saving in the first period and  $\theta$  is the contribution rate.

In the second period, individuals retire and their consumption is ensured by their savings from the previous period plus the accrued interest at rate  $r_{t+1}$  on the one hand, on the other hand the pension benefits  $P_{t+1}$ . Hence, the following equation of the budget constraint in the second period:

$$c_{t+1} = \frac{1 + r_{t+1}}{\pi} s_t + P_{t+1} \quad (3)$$

The objective of the individual is to maximize its intertemporal utility and to choose the equilibrium distribution of net income between the savings that serve for consumption during retirement and consumer spending in the first period. The resolution of the programme of the representative agent allows us then to write the expression of the saving as follows:

$$s_t = \frac{\pi\gamma w_t(1 - \theta)}{1 + \pi\gamma} - \frac{\pi P_{t+1}}{(1 + \pi\gamma)(1 + r_{t+1})} \quad (4)$$

This model supposes the existence of infinity of firms having the same production function and producing a homogeneous unique product. The production is assured by means of the labor ( $L_t$ ) and physical capital ( $K_t$ ) according on the technology production of Cobb-Douglas following:

$$Y_t = AK_t^\alpha L_t^{1-\alpha} \quad (5)$$

$A$  is a parameter of productivity

$\alpha$  is a elasticity of physical capital

$1 - \alpha$  is a elasticity of labor

In this model, there is a total depreciation of capital at the end of each period and that the production is sold at unit price. This brings us to the following conditions of maximization profit:

$$r_t = \alpha Ak_t^{\alpha-1} - 1 \quad (6)$$

$$w_t = (1 - \alpha)Ak_t^\alpha \quad (7)$$

With  $k_t = \frac{K_t}{L_t}$

### 3. The impact of the increase of life expectancy on pension level in the PAYG pension system

In a PAYG system, the contributions of the workers transmitted to the retirees during the same period. Therefore, the pension spending at  $t$  is limited by the total contributions. Then, the balance of PAYG pension in each period according is the following formula:

$$\pi P_t = \theta w_t (1 + n) \quad (8)$$

Using the balance of PAYG pension in equation 4 allows us to obtain the following expression:

$$s_t = \frac{\pi \gamma w_t (1 - \theta)}{1 + \pi \gamma} - \frac{(1 + n) \theta w_{t+1}}{(1 + \pi \gamma)(1 + r_{t+1})} \quad (9)$$

At equilibrium in the market for goods and services, the saving is equal to the investment on the one hand; on the other hand, even the investment of period is equal to the capital stock of the next period. These two conditions that brings us to:

$$(1 + n)k_{t+1} = s_t \quad (10)$$

Inserting equation 10 into equation 9 and use equations 5 and 6 determine the dynamic equilibrium sequence of capital:

$$k_{t+1} = \frac{\pi\gamma(1-\theta)\alpha(1-\alpha)A}{(1+n)[\alpha(1+\pi\gamma) + \theta(1-\alpha)]} k_t^\alpha \quad (11)$$

Steady-state occurs when  $k$  remains constant over time. We therefore find that the steady state value of  $k$  is given by:

$$k^* = \left\{ \frac{\pi\gamma(1-\theta)\alpha(1-\alpha)A}{(1+n)[\alpha(1+\pi\gamma) + \theta(1-\alpha)]} \right\}^{\frac{1}{1-\alpha}} \quad (12)$$

After the determination of the steady state of the stock of capital, we focalize in the determination of the level pension at long-run. For this, we combine equations 6, 7 and 12 to obtain:

$$P_{PAYG} = \frac{\theta}{\pi}(1+n)(1-\alpha)A \left\{ \frac{\pi\gamma(1-\theta)\alpha(1-\alpha)A}{(1+n)[\alpha(1+\pi\gamma) + \theta(1-\alpha)]} \right\}^{\frac{\alpha}{1-\alpha}} \quad (13)$$

From equation 13, we visualize that the increased life expectancy can cause two different effects on the level pension at long-run. The first effect is the decrease of the level pension because the higher number of pensioners in the future. The second effect is positive of the pension level by a rise wage rate due an increased stock of capital per-capita. The second effect is most important that the first effect because the positive relationship between PAYG pension and wages.

#### 4. The impact of the increase of life expectancy on level pension in the funded system

We consider another type of pension system which is the funded pension system that consists for an individual to contribute today for his future retirement. In the period of retirement, each pensioner receives the mass of the contributions paid during the period of activity which is raised by the interest rate. In fact, the balance of funded pension can then be written as:

$$P_t = \theta w_{t-1} (1 + r_t) \quad (14)$$

Integrating equation 14 into equation 7, we obtain therefore:

$$s_t = \frac{\pi\gamma w_t(1-\theta) - \theta w_t}{1 + \pi\gamma} \quad (15)$$

Under the funded pension system, the equation of capital accumulation is expressed as follows  $(1+n)k_{t+1} = s_t + \theta w_t$ . Thus, the exploitation of the capital accumulation equation and the two equations of wage and saving leads us to obtain the dynamics of the capital stock:

$$k_{t+1} = \frac{\pi\gamma(1-\alpha)A}{(1+\pi\gamma)(1+n)} k_t^\alpha \quad (16)$$

Therefore, the steady-state of capital stock in the long term is of the following form:

$$k^* = \left\{ \frac{\pi\gamma(1-\alpha)A}{(1+n)(1+\pi\gamma)} \right\}^{\frac{1}{1-\alpha}}$$

(17)

Subsequently, combining equations 6, 7 and 17 in order to determine the level of pension at long-run:

$$P_{funded} = \frac{\theta}{\pi}(1-\alpha)A^2 \left( \frac{\pi\gamma(1-\alpha)A}{(1+n)(1+\pi\gamma)} \right)^{\frac{2\alpha-1}{1-\alpha}} \quad (18)$$

From equation 18, in the funded pension system, the cost resulting from the increase in life expectancy is supported by retirees through a reduction in pensions. Thus, when a person affiliated to a funded pension, the accumulated capital through the sum of contributions and their returns in stock market is converted regular pension, known as rent. The calculation of the pension will be based on the expected lifespan for affiliates at the time of retirement, so that the level pension will automatically decrease as contributors live longer.

## 5. Conclusion

This paper presents a simple overlapping generation model with an increase of life expectancy. Almost all theoretical models existing in the literature attempt to show that the increase in life expectancy affects an equivalent manner the level of pension in the PAYG and funded system.

However, this paper reaches a different result, based on the work of Fanti and Gori (2008) but maintaining a generational approach to compare the effect of the increasing life expectancy on the pension level in both types of pension system.

We show that the funded pension system is more affected than the PAYG system by the risk of increasing life expectancy. The result is mainly due to the sharp decline of yield funded yield because the number of retirees growing more rapidly than the number of contributors. Thus, our contribution leads to a result different from the work of Devolder (2007), in which the increase of life expectancy in fertility leads to more reduce the level of pension in the case of funded pension than the PAYG system .

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