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The effects of the raising-the-official-pension-age policy in an overlapping generations economy[☆]

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HIGHLIGHTS

- The effects of raising-the-official-pension-age policy in an OLG model are studied.
- Such a policy does not always increase output in an economy.
- Working longer increases labor input, while it decreases capital through savings.
- The social security benefit per unit of time can decrease.

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ABSTRACT

This paper studies how economic variables are affected by raising the official pension age. Although it is said that such a policy increases output, this paper shows that such a statement is not necessarily true. Moreover, the paper finds that the social security benefit can decrease, which implies that it might be impossible to sustain the same level of benefit only by such a policy.

1. Introduction

As is well known, many developed countries are facing the problem of the sustainability of social security as the fertility rate has dropped and longevity has risen. To sustain the current social security system, several countries have chosen to slightly change the current social security system rather than change the system drastically. One common way of achieving this is to reduce the social security benefits of retired people by reducing the amount of the benefits or through raising the official pension age.[1] For instance, Japan will raise the official pension age from 60 to 65 over next ten years without reducing the amount of the retirement benefits or raising the payroll tax rate.[2] This paper theoretically studies how the raising-official-pension-age policy affects the economic variables such as the output and the social security benefit.

This paper extends an overlapping generations model of Diamond (1965) by assuming that an old agent must work for a certain amount of time before retirement to receive the full amount

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1 Another common way is the increase in the payroll tax rate levied on workers. The effect of an increase in the payroll tax rate is studied by Fanti and Gori (2010).

2 There are quite a few countries that have extended or will extend the official pension age gradually. For other examples, see, for instance, Fenge and Pestieau (2007).

of social security pension.[3] The model shows that output per efficiency unit of labor decreases, aggregate output can decrease, and the per unit of time retirement benefit can decrease given the same payroll tax rate. The intuition underlying this result is as follows: since a young worker knows that s/he has to work longer, s/he has less incentive to save when s/he is young. In addition to this, since more old agents work, the per capita capital stock decreases, and hence, the output per worker decreases. Notice that this result does not necessarily imply that the aggregate output also decreases, because even though the aggregate capital stock declines, the aggregate labor input increases. However, the economy illustrated in this paper, which is commonly used in this area, shows that the extent of the decrease in the aggregate capital stock can be larger than the extent of the increase in the aggregate labor input. Therefore, the aggregate output also decreases. Even though more workers support retired agents, since the income per worker decreases, the per unit of time social security benefit can decrease given a payroll tax rate.

The contribution of this paper is as follows: first, although raising the official pension age is a policy option in practice, there has so far not been any analysis of the policy. Although the model is simple, this paper first studies the effect of the policy on the economy. Second, the findings in this paper can correct the misunderstanding that people might have about the effect of the policy. For example, The Economist reports current issues of social security in 2011 and points out:

> "Working longer has two obvious economic benefits: it boosts output and reduces the length of time for which pensions need to be paid".

The former argument of this quote considers only an increase in the labor input for production and does not consider the effect of such a policy on the savings behavior of agent and the labor wage. The latter argument suggests that since the length of time for the pension payment is reduced, the resource for the total payment will decrease even if the same amount of benefit is paid to retired people. This is the hope of sustaining the current pay-as-you-go social security without reducing the benefit. The result of this paper shows the case in which the resources might not be enough to cover the total benefits because the tax base itself shrinks.

Some papers also investigate the effects of retirement age on economic growth. For example, Sala-i-Martin (1996) considers a growth model where the average stock of human capital matters. Since human capital depreciates over time, old workers are less productive than young workers. Sala-i-Martin (1996) assumes that old workers have to retire if pensions exist. Since pensions buy less productive old workers out of the labor force, the average stock of human capital is improved, and the economy produces more. Therefore, the economy with pensions or retirement can experience higher GDP than the economy without pensions or retirement. This paper provides the same positive implication of early retirement, although the channels are different. For another example, Zhang and Zhang (2009) considers a growth model where human capital investment in children is conducted by parents. The paper shows if the mandatory retirement age becomes lower, the saving rate increases because old workers work less, and the human capital investment in children decreases because the rate of return to the human capital is reduced. In the long run, since the growth rate is determined by the growth rate of human capital stock, the lower mandatory retirement age lowers the growth rate. Zhang and Zhang (2009) focuses on the long-run growth rate, while this paper focuses on the long-run GDP level. Both papers, however, show a negative effect of early retirement on growth through different channels.

The remainder of this paper is organized as follows. Section 2 describes the model in full, and Section 3 analyzes the equilibrium. Section 4 concludes.

2. The model

Time is discrete and continues forever, $t = 1, 2, \ldots$.

2.1. Agents

An agent lives for two periods: young and old. A young agent is endowed with one unit of time and supplies labor inelastically. After production occurs, a young agent receives the labor income, w_t. A young agent also has to pay the payroll tax, which is denoted by $\tau \in [0, 1)$. With disposable income, $(1-\tau)w_t$, a young agent decides how much to consume, c_t^y and how much to save, s_t. Thus, a young agent's budget constraint is

$$c_t^y + s_t = (1-\tau)w_t. \tag{1}$$

A young agent's saving at date t, s_t, is used for production at $t+1$ as a capital good without any transformation cost from one unit of a consumption good to a capital good. When a young agent at date t saves s_t and s/he becomes old at $t+1$, s/he receives the interest income, $r_{t+1}s_t$, where r_{t+1} is the interest rate. An old agent is also endowed with one unit of time. Before an old agent receives the social security pension, s/he has to work for a fraction of his/her time, which is denoted by $x \in [0, 1)$. For the rest of his/her time, $1-x$, s/he is retired. Here, x is a policy variable determined by the government. Therefore, an old agent's budget constraint in period $t+1$ is

$$c_{t+1}^o = r_{t+1}s_t + (1-\tau)x\theta w_{t+1} + (1-x)P_{t+1}, \tag{2}$$

where $\theta \in (0, 1]$ is the productivity of an old agent and P_{t+1} is the per unit of time social security benefit. An initial old agent has saved $s_0 > 0$ at date 0. We assume that the population is constant over time and is normalized to be one. An agent's utility function is represented by

$$U(c_t^y, c_{t+1}^o) := \ln(c_t^y) + \beta \ln(c_{t+1}^o),$$

where $\beta \in (0, 1)$ is a discount factor. Hence, an agent's problem is to maximize U subject to (1) and (2). The first-order condition for an interior solution to an agent's problem is

$$s_t = \frac{\beta(1-\tau)r_{t+1}w_t - (1-\tau)x\theta w_{t+1} - (1-x)P_{t+1}}{(1-\beta)r_{t+1}}. \tag{3}$$

2.2. Firm

At each date, the representative firm produces a single output by using labor and capital. Let L_t and K_t be the aggregate labor and capital, respectively. A production function is $F(K, L) = K^\alpha L^{1-\alpha}$, where $\alpha \in (0, 1)$. At each date t, a firm maximizes its profit,

$$F(K_t, L_t) - w_t L_t - r_t K_t,$$

where r_t is the rental rate of capital. I assume that factor markets are perfectly competitive. I assume further that capital is fully depreciated once production occurs. Let k_t be capital per worker at date t, i.e., $k_t = K_t/L_t$. Let $f(k) := k^\alpha$. In equilibrium,

$$r_t = f'(k_t) = \alpha k_t^{\alpha-1} \tag{4}$$

[3] Feldstein (1974) and Hu (1979) consider an endogenous old agent's retirement decision making and claim that the expansion of social security lowers the retirement age. Conde-Ruiz and Galasso (2004) consider an early retirement benefit and discuss the effect of this policy on the economy. In this paper, an old agent works until the official retirement age. Hence, as the retirement age becomes longer, an old agent works longer. This assumption may not be so strange, because Staubli and Zweimüller (2013) find that as the (early) retirement age increases, an old agent will work longer.

and

$$w_t = f(k_t) - k_t f'(k_t) = (1-\alpha)k_t^{\alpha}. \tag{5}$$

2.3. Government

The government in every period balances the pay-as-you-go social security budget according to the following formula:

$$(1-x)P_{t+1} = \tau w_{t+1}(1+x\theta) \tag{6}$$

which holds for all $t \geq 0$.

2.4. Equilibrium and steady state

An equilibrium concept is a standard *perfect foresight competitive equilibrium*.

Since $k_{t+1} = \frac{s_t}{1+x\theta}$, by using (3)–(6), we have

$$k_{t+1} = \frac{\beta(1-\tau)(1-\alpha)}{(1+x\theta)(1-\beta)}k_t^{\alpha} - \frac{(1-\tau)x\theta(1-\alpha)}{(1+x\theta)(1-\beta)\alpha}k_{t+1} - \frac{\tau(1-\alpha)}{(1-\beta)\alpha}k_{t+1}.$$

From this,

$$k_{t+1} = \frac{\alpha\beta(1-\tau)(1-\alpha)}{(1+x\theta)(1-\beta)\alpha + (1-\tau)x\theta(1-\alpha) + \tau(1+x\theta)(1-\alpha)}k_t^{\alpha}.$$

Therefore, given that $K_1 > 0$, there is a unique, globally stable steady state k^* for any $x \in [0, 1)$. The steady state is

$$k^* = \left[\frac{\alpha\beta(1-\tau)(1-\alpha)}{(1+x\theta)(1-\beta)\alpha + (1-\tau)x\theta(1-\alpha) + \tau(1+x\theta)(1-\alpha)}\right]^{\frac{1}{1-\alpha}}.$$

It is easy to show that

$$\frac{\partial k^*}{\partial x} < 0.$$

3. Results

3.1. Output

Proposition 3.1. *In the steady state, the output per efficiency unit of labor decreases in x. As for the aggregate output, there exists a unique* $\overline{\alpha} \in (0, 1/2)$ *such that* (i) *for all* $\alpha < \overline{\alpha}$, *aggregate output increases in x for every* $\tau \in [0, 1)$, (ii) *for all* $\alpha \in (\overline{\alpha}, 1/2)$, *for some unique* $\overline{\tau} \in (0, 1)$, *aggregate output decreases in x for every* $\tau \in [0, \overline{\tau})$ *and increases in x for every* $\tau \in (\overline{\tau}, 1)$, *and* (iii) *for all* $\alpha > 1/2$, *aggregate output decreases in x for every* τ.

Proof. See Appendix A. □

If the retirement age is raised, there are two effects on aggregate output. One is that more labor is input, and the other is that the capital stock decreases because of less savings. If the former effect dominates the latter effect, then aggregate output will increase as the retirement age increases. When the output elasticity of capital, i.e., $\alpha = \frac{dY^*/Y^*}{dK/K}$, is sufficiently small, the former effect dominates the latter effect; hence, aggregate output increases. It follows that as α is high enough, the latter effect becomes stronger. When α takes some medium value, how aggregate output changes depend on τ too. High τ reduces young agent's savings, and capital stock becomes small. Therefore, when α is some medium value, aggregate output increases for sufficiently high τ as x increases.

3.2. Social security benefit

Next, consider how raising the official pension age affects the social security benefit. Consider the per unit of time social security benefit, P^*.

Proposition 3.2. 1. *If* $x > 1-(1+\theta)(1-\beta)$, *then* P^* *increases in x for every* $\tau \in [0, 1)$.

2. *If* $x \in \left(1-\frac{(1+\theta)(1-\beta)}{\theta}, 1-(1+\theta)(1-\beta)\right]$, *then there exists a unique* $\widetilde{\alpha} \in (0, 1)$ *such that for every* $\alpha < \widetilde{\alpha}$, P^* *increases in x for every* $\tau \in [0, 1)$ *and for every* $\alpha > \widetilde{\alpha}$, *for some unique* $\widetilde{\tau} \in (0, 1)$, P^* *decreases in x for* $\tau < \widetilde{\tau}$ *and* P^* *increases in x for* $\tau > \widetilde{\tau}$.
3. *If* $x \leq 1-\frac{(1+\theta)(1-\beta)}{\theta}$, *then there exists a unique* $\widehat{\alpha} \in (0, 1)$ *such that for every* $\alpha < \widehat{\alpha}$, P^* *decreases in x for every* $\tau \in [0, 1)$ *and for every* $\alpha > \widehat{\alpha}$, *for some unique* $\widehat{\tau} \in (0, 1)$, P^* *decreases in x for* $\tau < \widehat{\tau}$ *and* P^* *increases in x for* $\tau > \widehat{\tau}$.

Proof. See Appendix B. □

Raising the official pension age has two effects on per unit of time social security benefit P^*. One is that more workers support fewer retired people, and the other is that a reduction of per efficiency unit of capital lowers the real wage. For example, when x is sufficiently high, the first effect dominates the second effect and P^* increases. However, when x is sufficiently low and the labor share, $1-\alpha$, is large enough, the second effect dominates the first effect, and thus, P^* decreases. This result suggests the following policy implication: some country will try to reduce the burden of the government budget without reducing the per unit time of the social security benefit or raising the payroll tax rate. To achieve this goal, one possible way is to raise the official pension age. However, the result shows the possibility that the per unit of time retirement benefits will be lowered, and such a hope may not be achievable. In this case, if the government wishes to maintain the same level of social security benefit, it has to issue the government bond to borrow the source of the benefits and/or raise the payroll tax rate. This contradicts the government's original goal.

4. Conclusion

This paper uses a simple Diamond-type overlapping generations model and investigates how raising the official pension age affects the economy in the long run. One policy implication is that even though the labor input increases by raising the official pension age, the aggregate output does not necessarily increase. Another policy implication is that raising the official pension age can help the current social security crisis in the short run, but it cannot effectively help in the long run, because the tax base itself can shrink. In this case, the government needs to increase the tax rate as well as decrease the social security benefit in order to sustain the current social security system.

Appendix A. Proof of Proposition 3.1

Proof. Because $dk^*/dx < 0$, the output per efficiency unit of labor, $y^* = (k^*)^{\alpha}$, is decreasing in x. However, it does not necessarily imply that the aggregate output, $Y^* = (1+x\theta)(k^*)^{\alpha}$, decreases in x. Taking the derivative of Y^* with respect to x,

$$\frac{dY^*}{dx} = (k^*)^{\alpha-1}\Omega^{\frac{\alpha}{1-\alpha}}\left[\underbrace{\theta\Omega + \frac{(1+x\theta)\alpha}{1-\alpha}\frac{\partial\Omega}{\partial x}}_{A}\right],$$

where $\Omega := \frac{\alpha\beta(1-\tau)(1-\alpha)}{(1+x\theta)(1-\beta)\alpha+(1-\tau)x\theta(1-\alpha)+\tau(1+x\theta)(1-\alpha)} > 0$. The sign of $\frac{dY^*}{dx}$ is determined by the sign of A. Thus,

$$A = \frac{\theta\alpha\beta(1-\tau)}{B^2}\big[(1-\alpha)^2\tau + (1+x\theta)(1-\beta)\alpha(1-2\alpha) + x\theta(1-\alpha)(1-2\alpha) - \alpha(1-\alpha)\big],$$

where $B := (1+x\theta)(1-\beta)\alpha+(1-\tau)x\theta(1-\alpha)+\tau(1+x\theta)(1-\alpha) > 0$. Therefore, the sign of dY^*/dx is determined by

$$G(\tau;\alpha) := (1-\alpha)^2\tau + (1+x\theta)(1-\beta)\alpha(1-2\alpha) + x\theta(1-\alpha)(1-2\alpha) - \alpha(1-\alpha). \quad (7)$$

If $G(0;\alpha) \geq 0$, then since $G(\cdot;\alpha)$ is strictly increasing in τ on $[0,1)$, $F(\tau;\alpha) > 0$ for all $\tau \in (0,1)$. Notice that

$$G(0;\alpha) = [-1+2\beta(1+x\theta)]\alpha^2 - [2x\theta+\beta(1+x\theta)]\alpha + x\theta.$$

Thus, $G(0;0) = x\theta > 0$, and

$$G(0,1) = (-1+\beta)(1+x\theta) < 0.$$

This implies that there is a unique $\overline{\alpha} \in (0,1)$ such that for all $\alpha < \overline{\alpha}$, $G(0;\alpha) > 0$ and for all $\alpha > \overline{\alpha}$, $G(0;\alpha) < 0$. Therefore, for all $\alpha < \overline{\alpha}$, $dY^*/dx > 0$ for every $\tau \in [0,1)$. When $G(0;\alpha) < 0$, the sign of dY^*/dx depends on the value of $G(1;\alpha)$. If $G(1;\alpha) > 0$, there is a unique $\overline{\tau} \in (0,1)$ such that $G(\tau;\alpha) < 0$ for every $\tau \in [0,\overline{\tau})$ and $G(\tau;\alpha) > 0$ for every $\tau \in (\overline{\tau},1)$. Note that

$$G(1;\alpha) = (1+x\theta)[2\beta\alpha^2 - (2+\beta)\alpha + 1].$$

It is not difficult to check that $G(1;\alpha) = 0$ at $\alpha = 1/2$, and $G(1;\alpha) > 0$ for all $\alpha < 1/2$ and $G(1;\alpha) < 0$ for all $\alpha > 1/2$. Therefore, for $\alpha < 1/2$, there is a unique $\overline{\tau} \in (0,1)$ such that $dY^*/dx < 0$ for $\tau < \overline{\tau}$ and $dY^*/dx > 0$ for $\tau > \overline{\tau}$. If $\alpha > 1/2$, then $dY^*/dx < 0$ for all $\tau \in [0,1)$. Notice that $\widehat{\alpha} < 1/2$, because

$$G(0;1/2) = -\frac{1}{4} < 0. \quad \square$$

Appendix B. Proof of Proposition 3.2

Proof. Taking the derivative of P^* with respect to x,

$$\frac{dP^*}{dx} = \frac{\tau(1-\alpha)}{1-x}(k^*)^{\alpha-1}\left[\underbrace{\frac{1+\theta}{1-x}k^* + (1+x\theta)\alpha\frac{\partial k^*}{\partial x}}_{C}\right].$$

The sign of $\frac{dP^*}{dx}$ is determined by C. Thus,

$$C = \frac{\Omega^{\frac{\alpha}{1-\alpha}}\alpha\beta(1-\tau)(1-\alpha)}{B}\left[\underbrace{\frac{1+\theta}{1-x} - \frac{(1+x\theta)\alpha\theta}{B}}_{D}\right].$$

The term, D, decides the sign of C. After some rearrangement, D becomes

$$\frac{1}{(1-x)B}\left[(1+\theta)(1-\alpha)\tau + (1+\theta)(1+x\theta)(1-\beta)\alpha + (1+\theta)\theta(1-\alpha)x - (1-x)\alpha\theta(1+x\theta)\right].$$

Let

$$H(\tau;\alpha) := (1+\theta)(1-\alpha)\tau + (1+\theta)(1+x\theta)(1-\beta)\alpha + (1+\theta)\theta(1-\alpha)x - (1-x)\alpha\theta(1+x\theta).$$

Since $(1+\theta)(1-\alpha) > 0$, $H(\tau;\alpha)$ is strictly increasing in τ. Consider

$$H(0;\alpha) = \alpha[(1+x\theta)(1+\theta)(1-\beta) - (1+x\theta)(1-x)\theta - (1+\theta)\theta x] + (1+\theta)\theta x.$$

When $\alpha = 0$, $H(0;0) = (1+\theta)\theta x \geq 0$. Since $H(0;\alpha)$ is linear in α, $H(0;\alpha) > 0$ for every $\alpha \in (0,1)$ if and only if $H(0;1) > 0$. Thus, $H(0;1) > 0$ if and only if

$$x > 1-(1+\theta)(1-\beta).$$

In this case, for all $\tau \in [0,1)$ and all $\alpha \in (0,1)$, $dP^*/dx > 0$. If $x \leq 1-(1+\theta)(1-\beta)$, there exists a unique $\widetilde{\alpha} \in (0,1)$ such that for all $\alpha < \widetilde{\alpha}$, $H(0;\alpha) > 0$ and for all $\alpha > \widetilde{\alpha}$, $H(0;\alpha) < 0$. Hence, if $\alpha < \widetilde{\alpha}$, for all $\tau \in [0,1)$, $dP^*/dx > 0$.

Consider

$$H(1;\alpha) = (1+x\theta)\left[1+\theta-\alpha\{\beta(1+\theta)+(1-x)\theta\}\right].$$

Since $H(1;0) = (1+x\theta)(1+\theta) > 0$ and $H(1;\alpha)$ is linear in α, $H(1;\alpha) > 0$ for all α if and only if $H(1;1) > 0$. $H(1;1) > 0$ if and only if

$$x > 1 - \frac{(1+\theta)(1-\beta)}{\theta}.$$

Therefore, if $1-\frac{(1+\theta)(1-\beta)}{\theta} < x \leq 1-(1+\theta)(1-\beta)$ and for $\alpha > \widetilde{\alpha}$, there exists a unique $\widetilde{\tau} \in (0,1)$ such that for $\tau < \widetilde{\tau}$, $dP^*/dx < 0$ and for $\tau > \widetilde{\tau}$, $dP^*/dx > 0$.

If $x < 1-\frac{(1+\theta)(1-\beta)}{\theta}$, then there exists a unique $\widehat{\alpha} \in (0,1)$ such that $H(1;\alpha) > 0$ for $\alpha < \widehat{\alpha}$ and $H(1;\alpha) < 0$ for $\alpha > \widehat{\alpha}$. Then, for $\alpha < \widehat{\alpha}$, there exists a unique $\widehat{\tau} \in (0,1)$ such that $dP^*/dx < 0$ for $\tau < \widehat{\tau}$ and $dP^*/dx > 0$ for $\tau > \widehat{\tau}$. For $\alpha > \widehat{\alpha}$, $dP^*/dx < 0$ for every $\tau \in [0,1)$. $\square$

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