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Partially Funded Pension, Fertility and Endogenous Growth

Zaigui Yang*

Abstract: Within a framework of an overlapping generations endogenous growth model, this paper examines the effects of China's partially funded public pension on the fertility, the economic growth and the family old-age security. Chinese are assumed to satisfy for both having children and getting old-age material support from children. It is shown that raising the firm contribution rate reduces the rates of fertility and intergenerational transfer, and increases the economic growth rate. The individual contribution has no effect on the above rates. This paper also finds the proper firm contribution rate interval to promote economic growth, control population rationally and maintain some family old-age security.

Keywords: Partially Funded Public Pension; Endogenous Growth; Fertility Rate; Family Old-Age Security

JEL classification: H55; J13; D64; O40

1. Introduction

China is confronted with low per capita GDP and over-population. It is argued that public pension system impacts economic growth and fertility rates (e.g. Nishimura and Zhang, 1992, 1995; Zhang et al, 2001; Zhang and Zhang, 2003; among others).

The World Bank (1997), Feldstein (1999) and Wang et al. (2004) analyze China's partially funded public pension system combining social pool with individual accounts[1]. China reforms its public pension system again in December of 2005. The system is different from a pay-as-you-go (PAYG) system and a fully funded one as follows: The government establishes an individual account for each employee and a social pool for all employees and retirees. Each firm contributes a percent of its payroll to the social pool, while each worker contributes another percent of her wage to her individual account. The social pool fund is used to pay the current retirees as pay-as-you-go pension benefits,

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[1] The World Bank (1997) simulates several options for China and recommends a three-pillar system based on an actuarial model. Feldstein (1999) analyzes the economics of a mixed pension system, and considers several options to reform the pension system in China. Wang et al. (2004) use a computable general equilibrium model to compare various options for financing China's implicit pension debt and to estimate the effects of pension reform on the sustainability of the system and on economic growth.

whereas the accumulation in the individual account is used to pay the individual herself when she retires as fully funded pension benefits. Each retiree receives funded pension benefits from his individual account and PAYG pension benefits from the social pool.

Most of theoretical literature regarding pension study PAYG public pension and/or fully funded public pension systems (e.g., Blanchard and Fischer, 1989; Zhang and Zhang, 1995; Zhang et al, 2001; Groezen et al., 2003; among others). Zhang and Zhang (1998) analyze the effects of social security in a model with alternative motives of having children. They show that social security increases per capita income growth when the social security tax is not too high. Wigger (1999) employs a model in which parents derive utility from having children and expect support from children to study the interrelation between growth, fertility and PAYG-public pension size. It is shown that small sized public pensions stimulate per capita income growth, but further increases in public pensions reduce it. A rise in public pensions reduces fertility if they are either small or large, and stimulates fertility if they are medium sized.

Chinese people generally satisfy for both having children and getting old-age material support from children, which is called family old-age security below for simplicity. This phenomenon is decided by economic development level. In this paper, we confine our attention to the stage at which the government is only able to provide a basic subsistence to the retired and it is necessary for each retiree to get some family old-age security to be better off. Individuals rear children for two basic motives: enjoying having children when young and obtaining some family old-age security when old. It is also a behavior habit that the young during the working period appreciate their parents. This behavior criterion can be called a self-evident or tacit agreement between parents and children in China. Another reason for intergenerational transfer running from children to parents is that the working-generation's incomes are much more than those of the retired-generation.

Employing an overlapping generations model with endogenous growth, this paper examines the effects of the partially funded public pension on the fertility, the economic growth and the family old-age security in China. It introduces the habit of material support from children to parents into the model, and the altruism is always operative because it is a behavior habit and a tacit agreement. It is shown that a rise in the firm contribution rate reduces the rates of fertility and intergenerational transfer from children to parents, and raises the growth rate of output per worker. The individual contribution has no effect on the rates of intergenerational transfer, fertility and output per worker growth. At last, this paper finds the proper firm contribution rate interval to promote economic growth, control population rationally and maintain some family old-age security. China should choose an optimal firm contribution rate in the proper firm contribution rate interval.

The rest of this paper is organized as follows: Section 2 presents the model. Section 3 examines the balanced growth equilibrium. Section 4 analyzes the proper firm contribution rate. Section 5 concludes the paper.

2. The model

This model extends those of Zhang and Zhang (1998) and Wigger (1999) by introducing operative transfers from children to parents and replacing the PAYG or fully funded pension systems with the partially funded pension system. There exists a closed

economy composed of numerous individuals, firms and a government. The generation born at the beginning of period *t* is called generation *t* with population N_t. Individuals in the same generation are identical. The fertility rate for each of generation *t* is n_t.

2.1 Individuals

Individuals live for two periods: working period and retirement period. Each individual earns wage by supplying inelastically one unit of labor, makes pension contribution, consumes part of her incomes, rears her children, makes gifts to her parent, and saves the rest of the incomes in her working period. In her retirement period, she consumes the fruits of her savings, gifts from her children, funded pension benefits (or individual account pension benefits) and social pool pension benefits.

Each individual of generation *t* derives utility from her working-period consumption C_{1t}, retirement-period consumption C_{2t+1}, the number of children $1+n_t$, and the retirement-period consumption of her parent C_{2t}. Each individual maximizes her utility by choosing the number of children, and the rates of saving and gift:

$$\max_{\{s_t,q_t,n_t\}} U_t = \ln C_{1t} + \theta \ln C_{2t+1} + \rho \ln(1+n_t) + \beta \ln C_{2t}, \tag{1}$$

$$s.t. \qquad C_{1t} = (1-\tau-h_t-q_t-s_t)W_t, \tag{2}$$

$$C_{2t+1} = (1+r_{t+1})s_t W_t + (1+n_t)q_{t+1}W_{t+1} + (1+r_{t+1})I_t + P_{t+1}, \tag{3}$$

where $\theta \in (0,1)$ denotes the discount rate, and ρ, β the weights for the number of children and the retirement-period consumption of her parent. $0 < \beta < \rho < \theta$ since individuals are assumed to care themselves more than their parents. W_t is the wage, τ the individual contribution rate, q_t the gift rate to her parent, s_t the saving rate, r_{t+1} the interest rate, I_t the individual account principal per worker, P_{t+1} the PAYG pension benefits. The child-rearing cost rate is assumed to be

$$h_t = \delta(1+n_t)^d, \tag{4}$$

where $\delta > 0, d \geq 1$, such that the costs of rearing children are either linear or convex[2]. $1+n_t > 0$ is the condition for population to last forever. $q_t > 0$ for all *t* because the young appreciate their parents according to the tacit agreement.

Substituting equations (2)-(4) into equation (1), and differentiating with respect to

[2] Zhang and Zhang (1995) and Wigger (1999) use the same type of child-rearing cost rate function.

$s_t, q_t, 1+n_t$ gives the first-order conditions:

$$1/C_{1t} = \theta(1+r)/C_{2t+1}, \tag{5}$$

$$1/C_{1t} = \beta(1+n_{t-1})/C_{2t}, \tag{6}$$

$$(dh_t/(1+n_t))(W_t/C_{1t}) = \theta q_{t+1} W_{t+1}/C_{2t+1} + \rho/(1+n_t), \tag{7}$$

Equation (5) states the tradeoff between the marginal utility of working-period consumption and that of retirement-period consumption through savings. Equation (6) states the tradeoff between the marginal utility of the representative individual's working-period consumption and that of her parent's retirement-period consumption through gifts. Equation (7) states the tradeoff between the marginal utility of child-rearing costs and the marginal utilities of gifts from children to parent and number of children.

2.2 Firms

Firms produce a single commodity in competitive markets. The production function $F(K_t, A_t N_t) = A_t N_t f(k_t)$ is homogeneous of degree one, where K_t denotes capital stock in period *t*, A_t labor productivity, $k_t = K_t/(A_t N_t)$ capital per unit of effective labor. Firms make pension contributions at rate $\eta \in (0,1)$ on their payroll. According to the product distribution, one can get that $F(K_t, A_t N_t) = r_t K_t + (1+\eta) w_t A_t N_t$. Euler's theorem gives

$$r_t = f'(k_t), \tag{8}$$

$$w_t = W_t/A_t = [f(k_t) - k_t f'(k_t)]/(1+\eta), \tag{9}$$

where w_t is the wage rate per unit of effective labor.

Following Saint-Paul (1992), Zhang and Zhang (1995, 1998, 2001), Wigger (1999), among others, this paper adopts the endogenous growth model with Romer's (1986) type of capital externality. In order to ensure the existence of a balanced growth path for the economy, the following particular form of A_t is adopted:

$$A_t = K_t/(aN_t), \tag{10}$$

where a is a positive technological parameter. Therefore $k_t = a$, and

$$r_t = r = f'(a), \tag{11}$$

$$w_t = w = W_t/A_t = [f(a) - af'(a)]/(1+\eta) \text{ for all } t. \tag{12}$$

2.3 The government

The government credits the individual contributions $\tau W_t N_t$ into each individual account, and the firm contributions $\eta W_t N_t$ into the social pool. The individual account balance is paid to the individual as funded pension benefits when she retires in the next period:

$$I_t = \tau W_t, \tag{13}$$

The social pool is paid to the retirees in the current period as PAYG pension benefits:

$$P_t = \eta(1 + n_{t-1})W_t, \tag{14}$$

2.4 The goods market

The savings and the individual account principal of the young in period t generate the capital stock in period $t+1$,

$$(s_t + \tau)W_t N_t = K_{t+1}. \tag{15}$$

3. Equilibrium analysis

Combining equations (10), (12), (15) and the labor force $N_{t+1} = (1 + n_t)N_t$ yields the growth rate of capital per worker:

$$1 + g_t = \frac{K_{t+1} / N_{t+1}}{K_t / N_t} = \frac{w(s_t + \tau)}{a(1 + n_t)}. \tag{16}$$

Analogously, the growth rates of wage and output per worker are also $1 + g_t$.

A balanced growth equilibrium is a competitive equilibrium in which intensive variables such as the gift rate, the fertility rate and so on are constant, while extensive variables such as the wage, the retirement-period consumption and so on grow at the same endogenously determined and constant growth rate of capital per worker. The following analysis focuses on the balanced growth equilibrium.

3.1 Effect on fertility

Equating equations (5) and (6), and using the wage growth rate gives

$$(1 + n)(1 + g) = \frac{\theta}{\beta}(1 + r). \tag{17}$$

This familiar equation is in fact the modified golden rule. Substituting equations (17) and (12) into equation (16), arranging yields

$$s + \tau = \frac{\theta}{\beta} z(1 + \eta), \tag{18}$$

where $z = \dfrac{a(1 + r)}{f(a) - af'(a)}$.

Some manipulation gives

$$h = \frac{-\theta\eta + \beta(\theta + \rho + \rho\eta) - z(1+\eta)(\theta + \theta^2 - \beta\rho + \theta\rho)}{\beta(d + \rho + \theta + \beta d)}, \tag{19}$$

$$q = -\frac{d[\eta - \beta + z(1+\eta)(1+\theta)] + \rho(z + \eta + z\eta)}{d + \rho + \theta + \beta d}. \tag{20}$$

Differentiating h with respect to η gives

$$\partial h/\partial \eta < 0. \tag{21}$$

Using equation (4) yields

$$\partial n/\partial \eta < 0. \tag{22}$$

Raising the firm contribution rate reduces the fertility rate. It is because that a rise in the firm contribution rate decreases the wage income. Thus, workers decrease the child-rearing costs by reducing the fertility rate. Moreover, an increase in the firm contribution rate means higher PAYG pension benefits, which renders children as a means of securing old age income less important and tends to reduce the fertility rate.

3.2 Effect on growth rate

Applying equation (17) and the effect on the fertility rate gives

$$\partial g/\partial \eta > 0. \tag{23}$$

Raising the firm contribution rate increases the growth rate of output per worker. This is because there exists a negative relationship between the growth rate of output per worker and the fertility rate, and raising the firm contribution rate reduces the fertility rate. It can also be interpreted by equations (16) and (18): Raising the firm contribution rate induces a fall in the denominator of the right-hand side, thereby the growth rate of output per worker increases.

3.3 Effect on gift rate

Differentiating q in equation (20) with respect to η yields

$$\partial q/\partial \eta < 0. \tag{26}$$

Raising the firm contribution rate reduces the gift rate. There are two reasons: On the one hand, a rise in the firm contribution rate induces the decrease in the wage, which leads to the young makes fewer gifts to their parents. On the other hand, raising the firm contribution rate induces the increase in the PAYG pension benefits, which renders the gifts less important for the old.

Individual contribution has no effect on the rates of fertility, output per worker growth and gift because mandatory savings (individual contributions) crowd out private savings by one-for-one. Summarizing the above results yields the following proposition.

Proposition 1: Raising the firm contribution rate decreases the rates of fertility and gift, and increases the growth rate of output per worker. The individual contribution has no effect on the three rates.

4. Proper firm contribution rate

4.1 Economic goals

The proper firm contribution rate depends on economic goals. First, China as a developing country with low per capita GDP and over-population needs high economic growth. Second, it is necessary for China to rationally control population size. Third, some family old-age security is necessary because the government cannot bear too heavy pension burden.

On the one hand, the population should be reduced or maintained at the original level, namely, $1+n \le 1$. Substituting it into equation (19) and arranging gives

$$\eta \ge \frac{\beta(\theta+\rho)-\left(\theta+\theta^2+\theta\rho-\rho\beta\right)z-\delta\beta(d+\rho+\theta+\beta d)}{\theta-\rho\beta+\left(\theta+\theta^2+\theta\rho-\rho\beta\right)z}=\underline{\eta}. \tag{27}$$

On the other hand, the population cannot be reduced unboundedly. Substituting the condition for population to last forever, $1+n>0$ into equation (19) and arranging yields

$$\eta < \frac{\beta(\theta+\rho)-\left(\theta+\theta^2+\theta\rho-\rho\beta\right)z}{\theta-\rho\beta+\left(\theta+\theta^2+\theta\rho-\rho\beta\right)z}=\bar{\eta}. \tag{28}$$

The correspondence relation between the intervals of η and n is $\underline{\eta} \le \eta < \bar{\eta}$ for $-1 < n \le 0$.

The family old-age security means that $q>0$, namely, workers certainly provide some material support to their retired parents. Substituting $q>0$ into equation (20) and arranging gives

$$\eta < \frac{d\beta-(1+\theta)dz-\rho z}{d+(1+\theta)dz+\rho(1+z)}=\hat{\eta}. \tag{29}$$

4.2 Economic goals and η

Comparing $\bar{\eta}$ with $\hat{\eta}$ gives $\bar{\eta}>\hat{\eta}$. Comparing $\underline{\eta}$ with $\hat{\eta}$ gives $\underline{\eta}<\hat{\eta}$ if $\delta > \frac{\rho}{(1+z)(d+\rho)+d\theta z}$. Consequently, if the firm contribution rate is $\underline{\eta}$, the population and the economic growth maintain their original levels. If the firm contribution rate is in the interval, $(\underline{\eta},\bar{\eta})$, then the population decreases and the economic growth increases. If the firm contribution rate is in the interval, $(\underline{\eta},\hat{\eta})$, then the population falls in a rational extent, the economy grows rationally, and some family old-age security is maintained.

The relationship between 1+*n*, *g*, *q* and η is shown as Figure 1. In Region Ⅰ, $\eta<\underline{\eta}$, the population continues to increase, and the economic growth rate is very low,. If $\eta=\underline{\eta}$,

the population maintains at the original level and the output per worker growth rate is $(1+r)\theta/\beta-1$. In Region Ⅱ, $\underline{\eta}<\eta<\hat{\eta}$, the population is reduced in medium size, the economic growth rate is high but not too high, and the intergenerational transfers from children to parents are positive. If $\eta=\hat{\eta}$, the intergenerational transfers vanish. In Region Ⅲ, $\hat{\eta}<\eta<\bar{\eta}$, the population is reduced largely, and the economic growth rate is very high. Obviously, Region Ⅱ is desirable because it satisfies the three economic goals.

Proposition 2: The proper firm contribution rate interval to promote economic growth, control population rationally and encourage some family old-age security is $(\underline{\eta},\hat{\eta})$ *if the parameters satisfy certain condition.*

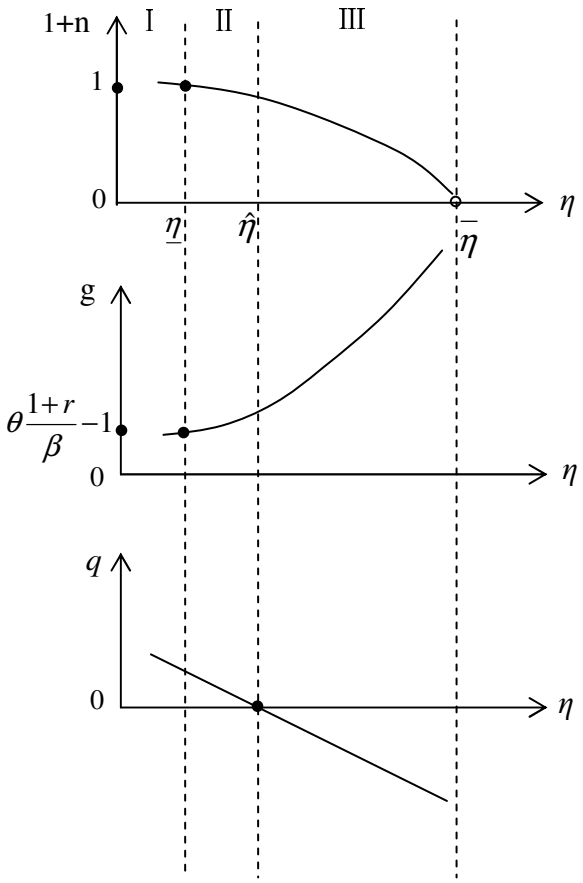

Figure 1. The relationship between 1+*n*, *g*, *q* and η

5. Conclusions

Under an overlapping generations model with endogenous growth, this paper examines the effects of China's partially funded public pension on the fertility rate, the economic growth and the family old-age security. In such a pension system, individual

contribution is accumulated in the individual's account, while firm contributions are collected into the social pool. This paper introduces the habit of material support from children to parents into the model, and the altruism is always operative because it is a behavior habit and a tacit agreement in China. Individuals and firms make pension contributions in this model instead of individuals only make in the literature.

This paper shows that a rise in the firm contribution rate reduces the rates of fertility and intergenerational transfer from children to parents, and raises the growth rate of output per worker. This result is different from those of Zhang and Zhang (1998) and Wigger (1999). In this model, the individual contribution crowds out the private savings by one-for-one; it has no effect on the rates of intergenerational transfer, fertility and output per worker growth. This paper also finds the proper firm contribution rate interval corresponding to the three economic goals.

China's population size is too large and the per capita GDP is low, in the meantime, the government bears too heavy burden of pension payments. It is necessary for China to choose an optimal firm contribution rate in the interval shown in Proposition 2. By virtue of that, China can not only promote economic growth and control its population rationally, but also encourage some family old-age security to reduce the government's heavy pension burden. As for the individual contribution, its rate should be set on the level at which workers can bear, and when they retire, the sum of the accumulation in individual accounts and the social pool benefits can maintain a basic subsistence.

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