Insurance: Mathematics and Economics 45 (2009) 230–235

Contents lists available at ScienceDirect

Insurance: Mathematics and Economics

journal homepage: www.elsevier.com/locate/ime

Urban public pension, replacement rates and population growth rate in China

Zaigui Yang *

School of Insurance, Central University of Finance and Economics, Beijing, 100081, PR China

ARTICLE INFO

Article history:
Received August 2008
Received in revised form June 2009
Accepted 18 June 2009

Insurance Branch Category:
IB80

JEL classification:
H55
D91

Subject Category:
IE25

Keywords:
Urban public pension
Replacement rate
Population growth rate

ABSTRACT

This paper uses an overlapping generations model to investigate the urban public pension in China. It examines the effects of the replacement rates and population growth rate on the capital–labor ratio, pension benefits, consumption and utility, and finds the optimal replacement rate. It is shown that raising the individual account benefit replacement rate only induces the increase in the individual account benefits. Raising the social pool benefit replacement rate induces the increase in the social pool benefits and retirement-period consumption, while the decrease in the capital–labor ratio, individual account benefits, working-period consumption and utility. The fall in the population growth rate leads to the increase in the capital–labor ratio, social pool benefits, individual account benefits, working-period consumption and utility, and leads to a decrease in the retirement-period consumption. The optimal social pool benefit replacement rate depends on the individual discount factor, social discount factor, capital share of income and population growth rate, and it decreases in the case of falling population growth rates. It will do more good than harm to raise the individual account benefit replacement rate, reduce the social pool benefit replacement rate and strictly implement China's population policy.

1. Introduction

The publication of "The Chinese State Council Decision on Improving the Basic Pension System for Enterprise Employees" in December 2005 implies a new round of reform of the urban public pension system in China. The government discloses the target replacement rate of pension benefits via the People's Daily as follows: "The target replacement rate before the reform was 58.5%, where the social pool benefit replacement rate was 20% and the individual account benefit replacement rate 38.5%. The target replacement rate after the reform is 59.2%, where the social pool benefit replacement rate is 35% and the individual account benefit replacement rate 24.2%".[1] The government has increased the pension benefits in recent years, and has pledged to continue increasing it. Hence, it is valuable to answer the following questions: what level should be the optimal replacement rate, what is the criterion to determine the optimal replacement rate, what are the determinant elements, and how should the optimal replacement rate be calculated?

Some of the literature on public pension with overlapping generations (OLG) model study pay-as-you-go (PAYG) pension system (e.g., Pecchenino and Pollard (2002) and Groezen et al. (2003)). Several studies analyze fully funded pension system (e.g., Abel (1987)). Some investigate both PAYG and fully funded pension systems (e.g., Altig and Davis (1993) and Zhang et al. (2001)). This paper will explore China's partially funded public pension system combining social pool and individual accounts. Samuelson (1975) studies the optimum social security in a life-cycle growth model. He adjusts the capital–labor ratio to the modified golden rule level to maximize the social welfare by controlling social security taxes. The approach to find the optimal social security taxes is to equate the rate of interest to the growth rate of economy in a decentralized economy. Blanchard and Fischer (1989) elaborate the principle of social optimum, which is the Pareto Optimum. A social planner maximizes social welfare by rationally allocating the social resources.

In the above literature, pensions are financed only by wage taxes. However, in most of the countries that have public pension systems, the governments levy pension taxes on each employee's wage and on each enterprise's payroll using a proportional taxation schedule. Thus in this model, as real life, the government levies pension taxes on each worker's wage and on each firm's payroll; and the pension taxes are proportional taxes.

The population growth rate in China is also taken into account in this model since it has been falling in the last three decades. This is mainly because of China's special population policy. In

* Tel.: +86 10 6228 8628; fax: +86 10 6228 9350.
E-mail address: yangzaigui@hotmail.com.

1 See Bai (2005) for details.

0167-6687/$ – see front matter © 2009 Elsevier B.V. All rights reserved.
doi:10.1016/j.insmatheco.2009.06.003

general, the government requires a couple to have not more than one child. In some special cases, e.g., both wife and husband are one child in their respective families before they get married, a couple of peasants with no child but a daughter, a couple from the minority nationalities with population below one million persons, and so on, the couples are eligible to have two or more children. There are some ways for rural residents to become urban residents. For example, graduated college students get jobs in urban area; military officers transfer to civilian works in an urban area; urbanization makes corresponding rural residents become urban residents; and so on.

Employing an OLG model within general equilibrium framework, this paper investigates China's urban public pension system. It examines the effects of the individual account benefit replacement rate, social pool benefit replacement rate and population growth rate on the capital–labor ratio, social pool benefits, individual account benefits, working-period consumption, retirement-period consumption and utility. This paper also seeks the optimal replacement rate. Under the specializations of logarithmic utility function and Cobb–Douglas production function, we use the data such as urban population, capital share of income and the like in China to simulate the effects of the exogenous variables on the endogenous variables and that of the population growth rate on the optimal social pool benefit replacement rate.

The rest of this paper is organized as follows: Section 2 presents the model in decentralized economy. Section 3 examines the effects of the exogenous variables. Section 4 simulates the effects in the last section. Section 5 derives the optimal social pool benefit replacement rate and simulates the effect of the population growth rate on it. Section 6 gives the conclusions.

2. The model

A closed economy is composed of numerous individuals and firms and a government. The generation born at the beginning of period t is called generation t. The population grows at the rate of $n = N_t/N_{t-1} - 1$, where N_t is the population size of generation t.

2.1. Individuals

Individuals live for two periods: working period and retirement period. In the working period, each individual earns a wage by supplying inelastically one unit of labor, makes pension contributions, consumes part of her/his income and saves the rest. In the retirement period, she/he consumes the savings with accrued interest, individual account benefits and social pool benefits.

Each individual derives utility from her/his working-period consumption c_{1t} and retirement-period consumption c_{2t+1}. The utility is described by an additively separable logarithmic function. Each individual maximizes her/his utility by choosing lifetime consumption and savings, thus solves the following maximization problem:

$$\max_{\{c_{1t}, c_{2t+1}, s_t\}} U_t = \ln c_{1t} + \theta \ln c_{2t+1}, \tag{1}$$

$$s.t. \quad c_{1t} = (1-\tau)\, w_t - s_t, \tag{2}$$

$$c_{2t+1} = (1 + r_{t+1})\, s_t + B_{t+1} + P_{t+1}, \tag{3}$$

where $\theta \in (0, 1)$ denotes the individual discount factor, τ the individual contribution rate, w_t the wage, s_t the savings, r_{t+1} the interest rate, B_{t+1} the individual account benefits, and P_{t+1} the social pool benefits.

The first-order condition for the utility maximization is

$$-c_{2t+1} + \theta\,(1 + r_{t+1})\, c_{1t} = 0. \tag{4}$$

This familiar expression implies that the utility loss from reducing one unit of working-period consumption is equal to the utility gain from increasing $(1 + r_{t+1})$ units of retirement-period consumption discounted by θ.

2.2. Firms

Firms produce homogeneous commodities in competitive markets. The production is described by Cobb–Douglas function $Y_t = AK_t^\alpha N_t^{1-\alpha}$ or $y_t = Ak_t^\alpha$, where Y_t is the output in period t, K_t the capital stock, $\alpha \in (0, 1)$ the capital share of income, A the productivity, $k_t = K_t/N_t$ the capital–labor ratio, and y_t the output-labor ratio.

Firms make pension contributions at the rate of $\eta \in (0, 1)$ on their payroll. According to the product distribution, one can get $AK_t^\alpha N_t^{1-\alpha} = r_t K_t + (1+\eta)\, w_t N_t$. Firms act competitively, renting capital to the point where the marginal product of capital is equal to its rental rate, and hiring labor to the point where the marginal product of labor is equal to $(1+\eta)\, w_t$:

$$r_t = \alpha A k_t^{\alpha-1}, \tag{5}$$

$$w_t = \frac{(1-\alpha)\, Ak_t^\alpha}{1+\eta}. \tag{6}$$

2.3. The government

The social pool fund is paid to the retirees in the current period as PAYG pension benefits: $P_t N_{t-1} = \eta w_t N_t$. Using the definition of social pool benefit replacement rate ξ gives

$$P_t = \xi w_t = (1+n)\, \eta w_t, \tag{7}$$

thus

$$\eta = \frac{\xi}{1+n}. \tag{8}$$

The accumulation in the individual account is used to pay the individual when she retires in the next period as funded pension benefits. Using the definition of individual account benefit replacement rate μ gives

$$B_{t+1} = \mu w_{t+1} = (1 + r_{t+1})\, \tau w_t, \tag{9}$$

thus

$$\tau = \frac{\mu}{1 + r_{t+1}} \cdot \frac{w_{t+1}}{w_t}. \tag{10}$$

2.4. Dynamic equilibrium

The savings and the individual pension contributions in period t generate the capital stock in period $t+1$ (see Blanchard and Fischer (1989) or Barro and Sala-I-Martin (2004)):

$$s_t + \tau w_t = (1+n)\, k_{t+1}. \tag{11}$$

A competitive equilibrium for the economy is a sequence as $\{c_{1t}, c_{2t+1}, s_t, w_t, r_{t+1}, B_{t+1}, P_{t+1}, k_{t+1}\}_{t=0}^{\infty}$ that satisfies Eqs. (1)–(11) for all t, given the initial condition k_0 and the values of parameters μ and ξ.

Substituting Eqs. (2), (3) and (5)–(11) into (4) gives a dynamic equilibrium system described by the following difference equation:

$$-\left(k_{t+1} + \alpha A k_{t+1}^\alpha\right) - \frac{\xi\,(1-\alpha)}{1+n+\xi} A k_{t+1}^\alpha + \theta\left(1 + \alpha A k_{t+1}^{\alpha-1}\right) \times \left(\frac{1-\alpha}{1+n+\xi} A k_t^\alpha - k_{t+1}\right) = 0. \tag{12}$$

Assume that there exists unique, stable and nonoscillatory equilibrium. In order to find the stability condition, we linearize Dynamic System (12) around the steady state (k). Some manipulation gives

$$a\,(k_{t+1} - k) + e\,(k_t - k) = 0, \tag{13}$$

where