

Analysis on the Actuarial Balance of China's Basic Pension Benefits

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Abstract

Financial sustainability of public pension system is of great concern in recent years. In this paper, actuarial models for both the PAYG national account and the funded individual account are built. Instead of evaluating the actuarial balance of China's basic pension system of a particular year (as most of the papers do), the incomes and expenditures of insurance funds are analyzed based on the whole life span of a typical worker. The rationale is that, a successful pension system should be able to reach a balance when considering the whole life span of typical worker. Data from China's National Bureau of Statistics is used to calculate the present values of pension contributions and benefits of a typical worker. Experimental results suggest that China's current basic pension system is not sustainable. By varying the affecting factors of the pension system, we find that raising the retirement age, increasing the wage growth rate, and increasing the growth rate of pension funds will improve the deficit problem of China's current basic pension system. Increasing pension benefit growth rate, however, will worsen the financial situation of the pension funds significantly.

Keywords: Public Pension System; PAYG National Account; Funded Individual Account; Actuarial Balance

1. Introduction

China's pension system undertook a major reform in 1997 (Dorfman et al., 2013). The implementation of China's State Council No. 26 document and No. 38 document has unified China's different piloted pension schemes into one basic pension system (Wang and Beland, 2014). At present, China's pension system can be divided into three layers: basic pension system, enterprise pension system and pension insurances bought with personal savings. As the major part of China's pension system, the basic pension system consists of the Pay-As-You-Go (PAYG) National Account and the Funded Individual Account.

Pay-As-You-Go systems require a balance between the benefits paid and to be paid and the contributions collected and to be collected. Financial sustainability is a core principle of social security (Billig and Ménard, 2013)(Grech, 2013). However, the observed decline in fertility rates and increase in longevity will inevitably damage the sustainability of China's PAYG pension system (Dorfman et al., 2013)(DeSA, 2013). This problem is not only faced by China. Many developed countries have already taken ways to solve it (Horioka et al., 2007). Raising the retirement age is one of such ways (Bielecki et al., 2016)

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Raising the retirement age will increase the working population and thus increase the contributions collected. On the other hand, raising the retirement age will decrease the number of annuitants and hence decrease the amount of pension benefits. Many researches have been conducted by Chinese scholars on China's aging population and pension deficits. Liu CaiYun (2016) introduced Pension Adjustment Index and used actuarial model to estimate the paying scale of pool fund for the retired workers every year under the flexible delay retirement perspective. His results suggested that the implementation of flexible retirement policy is able to maintain the sustainability of the social pension system. Yuan (2013) estimated the pension replacement rate under different retirement age and return on investment, analyzed and evaluated the adjustment of system parameters and relevant reform measures. These researchers all believe that China should raise the retirement age to alleviate the pension deficits.

Actuarial models are also built to analyze the sustainability of China's pension system. Wang and Beland(2014) focused their researches on the financial sustainability of China's rural pension system. Wang (2011) studies and evaluates quantitatively sustainable development methods for Shanghai pension system. Wang's study suggests that postponing retirement age can reduce the pension deficit but cannot reaches fiscal balance in the long run. These actuarial models, however, are built for the PAYG system only. The benefits from the funded individual account are not included in their research works. In our paper, however, both the PAYG national account and the funded individual account are considered. In addition, instead of evaluating the actuarial balance of China's basic pension system of a particular year (as most of the papers do), the incomes and expenditures of insurance funds are analyzed based on the whole life span of a typical worker. The rationale is that, the pension funds may be unbalance for a particular year due to risks such as interests and mortalities. However, a successful pension system should be able to reach a balance when considering the whole life span of the people involved.

Section 1 of the paper gives the introduction. Section 2 builds the actuarial models of China's basic pension system (both the PAYG national account and the funded individual account). Section 3 studies the affecting factors of China's current basic pension system. The impact of raising retirement age as well as other factors are analyzed in Section 3. Conclusions are given in Section 4.

2. Actuarial models of China's basic pension system

China's basic pension system consists of the Pay-As-You-Go (PAYG) National Account and the Funded Individual Account. The Pay-As-You-Go account collects contributions from working population and distributes pension benefits to the retirees every year. Ideally, the contributions collected should be enough to cover the benefits distributed every year. Unfortunately, due to unfavorable investment experience, mortalities, or interest rate movements, benefits distributed by the PAYG national account may be more than the contributions collected and that will cause a deficit. The funded individual account is set up for each individual. Each individual will contribute to his/her own individual account. Such contributions will be accumulated and can be used when the individual is retired. Actuarial models for the PAYG account and the individual account will be built in the following paragraphs.

Before building the model, the following assumptions are made. First of all, we assume a worker joins the basic pension system are age n and retires at age N . Each year, the worker contributes a certain proportion of his/her wage, λ , to the PAYG national account, and contributes another proportion of his/her wage, γ , to his/her individual account. The annual growth rate of wages is g on average. The annual growth rate of pension benefits is f , and the annual growth rate of pension funds is i . As the contributions will be collected as long as the

worker is working and the pension benefits will be distributed after his/her retirement, the present values of all contributions and pension benefits will be calculated. Let P^λ be the present value of all contributions to the PAYG account of the worker and P^γ be the present value of all contributions to the individual account of the worker. Similarly, B^λ is the present value of all pension benefits paid from the PAYG account and B^γ be the present value of all pension benefits paid from the individual account. A sustainable pension system will require the sum of P^λ and P^γ be greater than the sum of B^λ and B^γ on average. Otherwise, a deficit will be caused. Note, China's mortality table 2010-2013 is used in our calculation.

In China's basic pension system, a retiree's pension benefits are determined by the amounts he/she previously contributed. A contribution index $\beta = \frac{1}{(N-n)} \sum_{t=n}^N \frac{w_t}{\bar{w}_t}$ is calculated

for each worker, where w_t is worker's wage in year t and \bar{w}_t is the average wage for all workers in the same year. When the worker retires, the basic pension benefits that he/she can received will be $\frac{1}{2}(\overline{w_{N-1}} + \beta \overline{w_{N-1}})$ times 1% for each year of contribution. Note $(N-n)$ is the total number of years of contribution for a worker.

(1) Model for the PAYG national account

present value of a worker's contributions to the PAYG account is:

$$P^\lambda = \sum_{t=n}^N \frac{\lambda w_t}{(1+i)^{t-n}} {}_tP_x \quad w_t = w_1(1+g)^{t-n}$$

where ${}_tP_x$ is the probability of a person aged x survives to age $x+t$.

Assuming a worker retires at age N , the amount of pension benefits he/she can receive from the PAYG account at age M ($M \geq N$) is b_M^λ :

$$b_M^\lambda = (\overline{w_{N-1}} + \beta \overline{w_{N-1}}) \cdot \frac{1}{2} \cdot 1\% \cdot (N-n) \cdot (1+f)^{M-N}$$

$$\overline{w_{N-1}} = \overline{w_n} \cdot (1+G)^{N-n-1}$$

The present value of the pension benefits he/she can collect from the PAYG account is B^λ :

$$B^\lambda = \sum_{t=N}^T \frac{b_M^\lambda}{(1+i)^{t-N}} {}_tP_n \quad (T \text{ is the limiting age})$$

(2) Model for the individual account

The present value of contributions made to the individual account is:

$$P^\gamma = \sum_{t=n}^N \frac{\gamma w_t}{(1+i)^{t-n}} {}_tP_n$$

When the worker retires, the accumulated value in his/her individual account is b^γ :

$$b^\gamma = \sum_{t=n}^N \gamma w_t (1+i)^{N-t}$$

The basic amount the worker can received from his/her individual account is $b_N^\gamma = b^\gamma/x$, where x is number of years of pension benefits. Note the pension benefit is not fixed, it will increase at rate f . At age t , the amount the worker can receive from his/her individual account is

$$b_t^\gamma = b_N^\gamma \cdot (1+f)^{t-N}$$

Thus, the present value of all pension benefits from the individual account is:

$$B^\gamma = \sum_{t=N}^T \frac{b_t^\gamma}{(1+i)^{t-n}} P_n$$

For China's basic pension system, we thus have the following present values:

contributions: $P = P^\lambda + P^\gamma$

pension benefits: $B = B^\lambda + B^\gamma$

and we need to study whether the contributions are enough for the pension benefits:

$$V = V^\lambda + V^\gamma = (P^\lambda - B^\lambda) + (P^\gamma - B^\gamma) = (P^\lambda + P^\gamma) - (B^\lambda + B^\gamma)$$

In the following paragraphs, data from China's National Bureau of Statistics (<http://www.stats.gov.cn/tjsj/ndsj/>) is used to calculate the above present values of typical worker.

The normal age of a university graduate is 22 and we will set n (the age of joining China's basic pension system) equal to 22. At present, the statutory retirement age in China is 60 for male and 55 years for female. For simplicity, we will only consider male workers and will set the retirement age N to 60. The long-term growth rate of pension funds is set to $i=5\%$. The growth rate of the wages is also set to 5% in our model. \bar{w} is the average annual wage. In 2016, the average annual wage of the employees in cities and towns in China was 68993. The starting wage for a new worker is 15000 RMB. According to the relevant regulations of China's pension system, the contribution rates of the PAYG national account and individual account are 20% and 8% respectively. That is, $\lambda = 20\%$ $\gamma = 8\%$.

According to Chinese Statistical Yearbook in 2017, the average life expectancy of a Chinese people is 76.34 years. Considering that this number contains all kinds of people in the country and the urban workers' life expectancy should be more than 76.34 because of the superior economic conditions and medical conditions. Thus we assume $T=90$ (Dorfman et al., 2013).

3. Affecting factors of China's current basic pension system

Using the actuarial model and assumptions in Section 2, we have the following results (as shown in Table 1). Note the calculations are in Chinese Yuan.

Table 1. Actuarial valuation results of China's basic pension system for a typical worker

P^λ	116856.6552
P^γ	46742.66206
B^λ	118217.0677
B^γ	94652.52359
V^λ	-1360.412551
V^γ	-47909.86153
V	-49270.27408

From the table, it is obvious that China's current basic pension system is not sustainable. The present value of contributions is less than the present value of pension benefits for a typical worker who retires at age 60. By varying the parameter of China's basic pension system, we have the following findings.

(1) The impact of raising retirement age

We increase the retirement age from 60 to 65 and 70, and the results are given in Table 2. It can be seen from Table 2 that when the retirement age is raised to 65 years old, the contributions to the pension system is able to cover the pension benefits distributed. There will be a surplus of 106995 yuan. When the retirement age is 70 years old, there will be a

higher surplus of 136156 yuan. Obviously, raising the retirement age will be a solution to solve the deficit of China's current basic pension system. However, it must be noted that the effect of raising the retirement age on pension fund balance is not a simple linear relationship.

Table 2. Actuarial valuation results for a typical worker by increasing the retirement age

	T=60	T=65	T=70
P^λ	116856.6552	131771.1896	146637.9154
P^γ	46742.66206	52709.46521	58655.16616
B^λ	118217.0677	60691.03064	47541.76955
B^γ	94652.52359	16794.31875	21594.33955
V^λ	-1360.412551	71080.15895	99096.14586
V^γ	-47909.86153	35915.14646	37060.82661
V	-49270.27408	106995.3054	136156.9725

(2) The influence of adjusting the wage growth rate

The wage growth rate g is set to 5% in previous calculations. By adjusting it to 10%, the following results are given in Table 3.

Table 3. Actuarial valuation results for a typical worker by increasing the wage growth rate to 10%

	T=60	T=65	T=70
P^λ	323005.2519	423667.84	550280.5181
P^γ	129202.1008	169467.136	220112.2072
B^λ	118217.0677	60691.03064	47541.76955
B^γ	72406.8656	116866.1474	115051.6483
V^λ	204788.1842	362976.8093	502738.7486
V^γ	56795.23517	52600.98863	105060.559
V	261583.4194	415577.798	607799.3075

When the wage growth rate is 10%, the pension funds will be much more healthy than those of 5%. Even for a retirement age of 60, the present value of contributions to the pension funds is greater than the present value of pension benefits. The payment ability of pension funds has been significantly improved, and the surplus has risen sharply. This result is obvious as the worker will contribute more as the wage growth rate becomes higher.

However, it must be noted that the growth of China's economy is slowing. The wage growth rate is actually very difficult to reach 10%. Therefore, although increasing the wage growth rate of workers is a good way to solve the deficit of China's basic pension system, it is impractical under the current situation.

(3) The impact of increasing the growth rate of pension benefits

The growth rate of pension benefits is set to 5%. By increasing it to 10%, the present values of pension funds are shown in Table 4.

Table 4. Actuarial valuation results for a typical worker by increasing the pension benefit growth rate to 10%

	T=60	T=65	T=70
P^λ	116856.6552	131771.1896	146637.9154

P^r	46742.66206	52709.46521	58655.16616
B^{λ}	9695391.801	8815690.036	7709207.492
B^r	1687731.444	1534596.804	1341985.158
V^{λ}	-9578535.146	-8683918.846	-7562569.577
V^r	-1640988.782	-1481887.339	-1283329.991
V	-11219523.93	-10165806.19	-8845899.568

By increasing pension benefit growth rate to 10%, the financial situation of the pension funds is worsened significantly. Even for a retirement age of 70, a deficit of 8845899 will be observed. These results suggest we must be very cautious when we adjust the pension benefits. Retirees always want more benefits. However, a small increase in pension benefit growth rate may cause big deficit to pension funds.

(4) The influence of the growth rate of pension funds

In previous calculation, the growth rate of pension funds is set to 5%. By increasing it to 10%, the results are given in Table 5. From Table 5, it can be seen that increasing the growth rate of pension funds has a positive effect on the financial health of the pension funds. By increasing it to 10%, a surplus of 6727 can be reached even for a retirement age of 60. However, as the growth rate is the long-term growth rate of the pension funds, 10% is unrealistic under the current situations.

Table 5. Actuarial valuation results for a typical worker by increasing the pension fund growth rate to 10%

	T=60	T=65	T=70
P^{λ}	55206.89321	57426.26512	59179.46799
P^r	22082.75728	22970.50605	23671.7872
B^{λ}	68776.5827	55879.79975	43023.98176
B^r	1785.671386	2038.109822	2306.925034
V^{λ}	-13569.68949	1546.465367	16155.48623
V^r	20297.0859	20932.39623	21364.86216
V	6727.396406	22478.86159	37520.34839

4. Conclusion

China's basic pension system consists of the Pay-As-You-Go (PAYG) National Account and the Funded Individual Account. The Pay-As-You-Go account collects contributions from working population and distributes pension benefits to the retirees every year. Ideally, the contributions collected should be enough to cover the benefits distributed every year. Unfortunately, due to unfavorable investment experience, mortalities, or interest rate movements, benefits distributed by the PAYG national account may be more than the contributions collected and that will cause a deficit. In addition, the observed decline in fertility rates and increase in longevity will further damage the sustainability of PAYG pension systems. This problem is not only faced by China. Many researches have been conducted to address this problem.

In this paper, actuarial models for both the PAYG national account and the funded individual account are built. Instead of evaluating the actuarial balance of China's basic pension system of a particular year as most of the papers do, the incomes and expenditures of insurance funds are analyzed based on the whole life span of a typical worker. The rationale is that, the pension funds may be unbalance for a particular year due to risks such as interests and mortalities. However, a successful pension system should be able to reach a balance when considering the whole life span of the people involved.

Data from China's National Bureau of Statistics is used to calculate the present values of pension contributions and benefits of a typical worker. Experimental results suggest that China's current basic pension system is not sustainable. The present value of contributions is less than the present value of pension benefits for a typical worker who retires at age 60.

By varying the affecting factors of the pension system, we find that raising the retirement age is a solution to solve the deficit of China's current basic pension system. By increasing the retirement age from 60 to 65, the balance of the pension funds is improved from a deficit of 49270 to a surplus of 106995. It must be noted the effect of increasing the retirement age is not linear. Increasing the wage growth rate will also improve the payment ability of pension funds. However, as the growth of China's economy is slowing, increasing the wage growth rate may be impractical under the current situation. Increasing pension benefit growth rate will worsen the financial situation of the pension funds significantly. This suggests we must be very cautious when adjusting the pension benefits. A small increase in pension benefit growth rate may cause big deficit to pension funds. Finally, increasing the growth rate of pension funds has a positive effect on the financial health of the pension funds. However, as the growth rate is the long-term growth rate of the pension funds, it might be difficult to increase the pension fund growth rate under the current situations.

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