Sensitivity of Personal Account Accumulated Value of New Rural Social Pension Insurance to Variation of Uncertainties

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Abstract　The personal account of new rural social pension insurance raises funds in the form of individual premium-paying, collectively pooled subsidy and government subsidy. The personal account accumulated value has a decisive influence on the payment level of personal account pension. The personal account accumulated value has a direct or indirect relationship with the income level of farmers, premium-paying level, the insured period, investment return rate of funds and other factors. Analysing the impact of infinitesimal variation of these factors on accumulated value of personal account pension, is of great significance to improving and consolidating personal account, and achieving sustainable development of new rural social pension insurance.

Key words　New rural social pension insurance，Uncertainties，Personal accumulation account value，Sensitivity

At present, China is in the critical period of perfection and development of social security system. In October 2009, the pilot work of new rural social pension insurance was launched in whole country. According to deployment of the central government, the new rural social pension insurance will be set up in rural areas comprehensively and universally at the end of 2012. The new rural social pension insurance practises "basic pension +personal account pension" model, raising pension funds in the form of individual premium-paying, collectively pooled subsidy and government subsidy. The government finance fully funds the establishment of basic pension system universally benefiting farmers, and as for the people aged older than 60, appropriate basic pension subsidy is carried out. The state establishes the personal account of pension insurance with lifelong record for each insured person. Individual premium-paying, collectively pooled subsidy, subsidy of social organization and individual for the insured, and subsidy of local government for premium-paying of the insured, are all recorded into personal account, and the interests are worked out in accordance with the relevant interest rate of tally. After the insured person reaches retirement age and retires, the monthly standard of granting pension is the total deposit volume of personal account divided by 139. Therefore, the personal account accumulated value has a decisive influence on the pension payment level of personal account. The personal account accumulated value has a direct or indirect relationship with the income level of farmers, premium-paying level, the insured period, investment return rate of fund and other factors. Therefore, I explore the

impact of little change of relevant factors on personal account accumulated value by building related model, in order to conduct thinking on how to consolidate and improve personal account, and achieve the sustainable development of new rural social pension insurance at level of policy.

1　The research model

The estimate of accumulated value of personal account pension of new rural social pension insurance is established on the basis of premium-paying standard, the insured period, growth rate of per capita net income, return rate of funds and other assumptions. In order to explain the impact of variation of each factor on accumulated value of personal account pension, now we assume that other factors are invariable, and take these factors as independent variables to calculate the partial derivatives respectively, so as to calculate the impact of slight variation of independent variable on accumulated value of personal account pension, namely calculate the sensitivity of this varied factor[1].

First, we determine accumulated value function of personal account pension. We assume that the insured farmers participate in pension insurance at age of a; the insured period is n; the insured farmers pay pension insurance at beginning of each year taking farmers' per capita net income in the previous year as premium-paying base, according to a certain percentage of income; the premium-paying rate of personal account of the insured farmers is λ; the retirement age is b; the investment return rate of pension is r; per capita net income of farmers in the base year is W_0; the growth rate of annual per capita net income of farmers is g; the annual premium-paying subsidy of government is T, and it is constant in the period of premium-paying. By discussing the case of $r \neq g$, we can get the accumulated value function of personal account pension of when the

insured farmers retire as follows：

$$M = \left\{ \frac{\lambda W_0 [(1+r)^{n+1} - (1+g)^n (1+r)]}{r-g} + \frac{T[(1+r)^{n+1} - (1+r)]}{r} \right\} (1+r)^{b-a-n}, \; r \neq g \tag{1}$$

Second，we solve the impact of variation of each factor on M. Keep other factors constant，calculate the partial derivative of M to independent variable signifying each influencing factor，and get the impact of slight variation of each independent varia-

ble on M[2].

Through calculating the partial derivative of function M in expression（1）to each independent variable，we get the following expressions：

$$\frac{\partial M}{\partial \lambda} = \frac{W_0}{r-g} [(1+r)^{b-a+1} - (1+g)^n (1+r)^{b-a-n+1}] \tag{2}$$

$$\frac{\partial M}{\partial r} = \frac{\lambda W_0}{(r-g)^2} [(r-g)(b-a+1)(1+r)^{b-a} - (1+r)^{b-a+1} - (r-g)(b-a-n+1)(1+g)^n (1+r)^{b-a-n} + (1+g)^n (1-r)^{b-a-n+1}] + \frac{T}{r^2} [r(b-a+1)(1+r)^{b-a} - (1+r)^{b-a+1} - r(b-a-n+1)(1+r)^{b-a-n} + (1+r)^{b-a-n+1}] \tag{3}$$

$$\frac{\partial M}{\partial g} = \frac{\lambda W_0}{(r-g)^2} [(1+r)^{b-a+1} + (1+g)^n (1+r)^{b-a-n+1} - n(r-g)(1+g)^{n-1}(1+r)^{b-a-n+1}] \tag{4}$$

$$\frac{\partial M}{\partial n} = -\frac{\lambda W_0 (1+g)^n (1+r)^{b-a-n+1}}{r-g} [\ln(1+g) - \ln(1+r)] - \frac{T(1+r)^{b-a-n+1} \ln(1+r)}{r} \tag{5}$$

2 Empirical analysis

2.1 Parameter setting

2.11 Standard of individual premium-paying and premium-paying subsidies of the government. In accordance with the instruction opinion of implementation of new rural social pension insurance，at present，five grades are set as the premium-paying standard：100 yuan，200 yuan，300 yuan，400 yuan，500 yuan. The insured can choose premium-paying grade independently. Assuming that the premium-paying grade for all farmers is 100 yuan，and the year 2008 is the first premium-paying year（Although the pilot work of new rural social pension insurance was carried out in October 2009，this assumption does not affect the empirical results.），and in 2007，farmers' per capita net income $W_0 = 4\,140$ yuan. When paying premium according to constant proportion of farmers' income，there is premium-paying grade $\lambda W_0 = 100$ yuan，and the proportion of annual premium paid to farmers' per capita net income in the previous year is 2.42%；the government subsidy T for premium-paying is determined as the minimum value of 30 yuan stipulated in the instruction opinion of implementation of new rural social pension insurance，and it is kept unchanged.

2.12 The growth rate of per capita net income of farmers（g）. The growth rate of farmers' per capita net income is set in accordance with the following principle. The domestic and foreign economists agree that China's demographic dividend will last about 15 years，and in the next 15 years，China's economy will benefit from the demographic dividend and grow rapidly，per capita net income will also maintain a high growth rate. From the stage of economic development，China's level of economic development is tending to be close to the world's middle level of economic development. In accordance with national economic and social development planning，by the middle of the 21st Century，China's level of economic development will reach the level of moderately developed countries[3]. Therefore，according to the relevant data from *China Statistical Yearbook*，after deliberately consideration，this article assumes that the annual average growth rate of farmers' per capita net income is 0.5%.

2.13 The age of the insured（a），retirement age（b）and the insured period（n）. We set the age of the insured（a）as 25，and retirement age（b）as 60. Since the new rural social pension insurance provides that the pension can not be drawn until the insured period reaches 15 years，so the insured period（n）is assumed as 15 years.

2.14 Return rate of funds. Given that at present China strictly limits the investment operation of basic pension insurance fund，for a fairly long period of time，the personal account funds of new rural social pension insurance mainly take long-term government bonds and interest rate of agreement deposit in the same period as reference. In the mean time，after referring to relevant researches in subject of " Pension Insurance Fund Calculation and Management in China" conducted by the Legal Division，Department of Labor and Social Security in 2001[4]，this research sets the return rate of fund as 4%.

2.2 Estimate conclusions After substituting the relevant parameter values into the above partial derivative function，we get results shown in Table 1.

Table 1 The analysis result of sensitivity of individual account accumulated value to variation of uncertainties

Uncertain factors x	Variation degree of M	
	Partial derived function（ǀ）of M to x	ΔM（ǁ）
λ	$\frac{\partial M}{\partial \lambda} = 63.2\ W_0$	$\Delta M(\Delta \lambda = 1\%) = 0.632\ W_0$
r	$\frac{\partial M}{\partial r} = 49.47\ W_0$	$\Delta M(\Delta r = 1\%) = 0.494\,7\ W_0$
g	$\frac{\partial M}{\partial g} = 2\,298.79\ W_0$	$\Delta M(\Delta G = 1\%) = 22.987\,9\ W_0$
n	$\frac{\partial M}{\partial n} = 0.99\ W_0$	$\Delta M(\Delta N = 1) = 0.99\ W_0$

Note：$\Delta M \approx \frac{\partial M}{\partial x} \Delta x$；as for the first three，ǀ = ǀ/100；as for the last one，ǀ = ǁ；x is uncertain factors；$W_0 = 4\,140$ yuan.

From the results in Table 1，we can find that on the premise that the starting age of participating in insurance is 25，the year 2008 is the early year of premium-paying，and the premium-paying grade is =100 yuan，there are the following results.

First, when $\Delta\lambda = 1\%$, $\Delta M = 0.632\ W_0$, indicating that when the premium-paying rate of personal account pension insurance increases by one percentage point, the accumulated value of personal account pension will increase by 0.63 times of the farmers' per capita net income in the previous year when the farmers begin to be insured.

Second, when $\Delta\lambda = 1\%$, $\Delta M = 0.494\ 7\ W_0$, indicating that when the the return rate of funds increases by one percentage point, the accumulated value of personal account pension will increase by $0.494\ 7$ times of the farmers' per capita net income in the previous year when the farmers begin to be insured.

Third, when $\Delta g = 1\%$, $\Delta M = 22.987\ 9\ W_0$, indicating that when the growth rate of farmers' per capita net income increases by one percentage point, the accumulated value of personal account pension will increase by $22.987\ 9$ times of the farmers' per capita net income in the previous year when the farmers begin to be insured.

Fourth, when $\Delta n = 1\%$, $\Delta M = = 0.99\ W_0$, indicating that when the premium-paying period increases by one year, the accumulated value of personal account pension will increase by 0.99 times of the farmers' per capita net income in the previous year when the farmers begin to be insured.

It can be seen that λ, r, g and n have positive varied relationship with M, and in the first three percentage factors, the sensitivity of g is the strongest, followed by λ and r.

3   Conclusion

Based on the above analysis, the variation of g has the greatest influence on accumulated value of personal account pension, therefore, although g is the exogenous variable of the model, impacted by many political and economic factors, it is difficult to control g to meet the needs of establishment of pension insurance system. However, from the perspective of big system of balanced socio-economic development, as the capital source for farmers' individual premium-paying of social pension insurance in rural areas, the level of per capita net income of farmers is related to the insured farmers' affordability in participating in pension insurance, which has a direct impact on the establishment of new rural social pension insurance and sustainable development, therefore, we should promote the development of rural economy, enhance farmers' income-generating capacity and pay attention to enhancement in the insured farmers' affordability. Thus, as the actual income level of farmers is promoted, it will lay solid foundation for enhancing premium-paying rate, elongating the premium-paying period, and increasing salary adjustment reserve, which will ultimately redound to improving the balance of payment of pension, and promoting the substituting rate of the pension.

In addition, through the scientific design of the system, we should implement effective control over three variables (λ, r and n), in order to achieve full raising of personal account pension funds, inflation-proofing and appreciation of funds.

First, within the affordability of farmers, we should promote the premium-paying rate timely and moderately. Second, through the government premium-paying subsidy, basic pension payment standard and other measures related to the individual premium-paying period, we should encourage farmers to increase the insured period. Third, we should further promote the pension fund management system, improve relevant laws and regulations, and establish the relevant regulatory bodies, to provide effective supervision for the flow of pension and operation of pension in the capital market, prevent and control operational risk of pension, and achieve inflation-proofing and appreciation of pension fund.

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