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Research on Replacement Rate from Occupational Pension in China and Influencing Factors

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Abstract

Under the background of the pension system reform in government departments and public institutions, occupational pension is an important supplement to basic endowment insurance, and provides retirement income in the form of a complete accumulation mechanism. By constructing an actuarial cash flow balance model, this study calculates the replacement rate from occupational pension for "new people" who begin to work in government departments and public institutions in 2015 onwards, and analyzes its influencing factors such as retirement age, rate of investment return, contribution rate, wage growth rate, etc. The results reveal that delaying retirement, increasing the rate of return and increasing the rate of contribution have significant positive effects on the growth of the replacement rate. Meanwhile, the increase in wage growth rate has a negative impact on replacement rate. When the influencing factors are the same, the replacement rate of men is about 5% higher than that of women. The main reason is that the average life expectancy of women is longer. The policy suggestions are as follows: appropriately delaying retirement to adapt to the changes in demographic structure; optimizing investment operations to ensure investment return; improving rate of individual contribution flexibly to accelerate the accumulation of funds.

Keywords

Occupational Pension, Replacement Rate, Influencing Factors, Government Departments and Public Institutions (GDPI), China

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1. Introduction

1.1. Research background and significance

According to the latest data of the National Bureau of Statistics (NBS) of China, the population aged 60 and over in China has reached 280.04 million, accounting for 19.8% of the national population; the population aged 65 and over has reached 209.78 million, accounting for 14.9% by the end of 2022. It can be observed that the population aging problem that China is facing is becoming increasingly serious. With the change in demographic structure, basic endowment insurance, as the first pillar, would face an increase in payment pressure. In order to cope with the impact of aging, there is an urgent need to build a multi-pillar pension system.

The research object for the present study is the replacement rate from occupational pension. The replacement rate in the text, unless otherwise specified, refers to the replacement rate from occupational pension (RROP). The emergence of occupational pension is closely correlated to the reform of the pension system in China's government departments and public institutions (GDPI). Before 2015, the problem of two-track pension scheme occurred. Compared to the employees of enterprises, the staff of GDPI did not need to contribute, but received higher retirement benefits. In order to establish a more equitable and sustainable pension system, China comprehensively promoted the reform of the pension system of GDPI in 2015. The new policy proposes the establishment of unified basic endowment insurance, and the establishment of an occupational pension for the staff of GDPI.

Occupational pension refers to the supplementary pension scheme, which is established for employees of GDPI, on the basis of participating in basic endowment insurance. According to China's policies, occupational pension is the second pillar of China's multi-pillar pension system, and is a mandatory supplementary pension mechanism. The contributions for occupational pension include the contributions by agency and individual. The contribution rate of an agency is 8%, while the individual contribution rate is 4%. These above contributions are integrated into occupational pension funds, which are invested by professional financial institutions. When the participants meet certain conditions, such as retirement, they can receive pension benefits. That is, China's occupational pension adopts the complete accumulation model of defined contribution.

Since the establishment of China's occupational pension, the number of participants has continuously increased, and the scale of funds has steadily increased. By the end of 2021, the investment scale of occupational pension funds has reached 1.79 trillion yuan. The investment return in whole year of 2021 has reached 93.2 billion yuan[1]. According to experience, only when the RROP reached 20%, occupational pension provided sufficient benefits for retirees.

By constructing an actuarial cash flow balance model, the present study aims

[1]Statistical Bulletin on the Development of Human Resources and Social Security in 2021, http://www.gov.cn/xinwen/2022-06/07/content_5694419.htm.

to calculate the RROP for "new people". The so-called "new people" refers to the staff who enter GDPI in 2015 onwards. Concretely, according to existing policies and the external environment, parameters are assigned to determine whether the RROP can achieve the expected goal. If the result of replacement rate is lower than the ideal level, this study would further analyze the reasons and adjust the parameters, for example, delaying retirement or increasing contribution rate. In addition, this study conducts a sensitivity analysis of the key factors that affect the replacement rate. These factors include retirement age, contribution rate, rate of investment return, etc. Based on the results of the empirical analysis, suggestions to improve China's occupational pension system are put forward.

1.2. Literature Review

Occupational pension started earlier in some OECD countries than in China. Relevant research and analysis had certain reference significance. Novy-Marx and Rauh (2014) analyzed some of the disadvantages of occupational pension for public officials. The research results revealed that the improper operation of occupational pension brought considerable burden on the US financial system. Occupational pension contribution required to recover the burden may be 2.5 times or more than the present one. Pavolini and Seeleib-Kaiser (2018) pointed out that a number of developed countries have changed from the defined benefit (DB) plan to the defined contribution (DC) plan. When taking the UK as an example, in 2019, a flexible contribution mechanism was introduced for occupational pension, and provisions were made for the minimum statutory contribution rate. Some scholars focused on the Thrift Savings Plan (TSP)[2] in the US. The role of the TSP in the United States is similar to that of the occupational pension plan in China, and both of which are supplementary pensions and defined contribution schemes in the public sector. Falk and Karamcheva (2018) explained that only when participants of the TSP worked more than the minimum working-time limit, the individual account obtained contributions from institution and related income automatically. In summary of TSP published by Federal Retirement Thrift Investment Board of the US[3] in 2023, the contribution methods of the participants were explained[4]. The TSP required that participants should be full-time or part-time employees of the federal government or members of the uniformed services. Regular employee contributions were payroll deductions that came out of basic pay before taxes were withheld (traditional contributions) or after taxes had been withheld (Roth contributions). Turner et al. (2016) pointed out that the TSP provided 4.6 million participants the same type of savings and tax benefits as 401 (k)[5] plans. At

[2]https://www.TSP.gov/.
[3]https://www.frtib.gov/.
[4]Federal Retirement Thrift Investment Board, Summary of the Thrift Savings Plan. https://www.tsp.gov/publications/tspbk08.pdf.
[5]https://www.irs.gov/retirement-plans/401k-plans.

the beginning of 2015, assets in TSP reached 440 billion US dollars, and employee participation rate was as high as 89%, significantly higher than the 401 (k) participation rate.

Zheng (2015) compared TSP of the United States and occupational pension of China, detailed the characteristics of the TSP, and summarized the enlightenment to China from the aspects of contribution mechanism, tax policy and investment choice. Lou (2020) conducted a comparative study of pension systems in several countries. However, the conclusion revealed that compared to Japan, Germany and other developed countries, China's three-pillar system was structurally unbalanced. China's pension treatment mainly depended on the first pillar, while the second and third pillars played limited roles. The article further pointed out that the development of compulsory occupational pension should be promoted on the basis of ensuring the source of funds and level of pension treatment.

The replacement rate and influencing factors of occupational pension have also become research hotspots. Scholars have chosen different models and variables for empirical analyses. Chen et al. (2019) focused on contribution rates, calculated that the overall moderate contribution rate range for occupational pension was from 9.75% to 12.91%, and the individual moderate contribution rate range was from 3.84% to 9.77%. The model built by Zhang and Xue (2019) indicated that when the rate of return increased from 4% to 10%, the average replacement rate from occupational pension increased from 23.7% to 63.9%. At the same time, sensitivity analysis revealed that the sensitivity coefficient, SAF, also increased with increase of rate of return. In addition to the impact of investment, the study also revealed that delaying retirement and flexibly raising the individual contribution rate improved the replacement rate. Zhang and Lu (2021) pointed out that in calculating the life RROP, it was necessary to consider the life expectancy when determining the bookkeeping interest rate. Pu and Wang (2021) considered the difference of gender and constructed an actuarial model to calculate and analyze the retirement pension benefits of GDPI after the completion of occupational pension claims. The research results revealed that male "new people" had longer contribution periods due to older retirement age. Comparing with female, longer contribution resulted in a higher accumulated amount of pension account. Thus, male "new people", with the same conditions of other factors, generally had a higher RROP than female.

In terms of policy support, Li et al. (2021) and Yang et al. (2021) called for more incentive policies, such as investment policies that gave consideration to risk control and value concepts, fiscal policies that reflected more tax preferences and contribution mechanisms that set up flexible models.

In summary, domestic and foreign research results revealed that reasonable policies and excellent external environment promoted the development of occupational pension, and made it an effective supplement for basic endowment insurance.

2. Concept and Theory

2.1. Replacement Rate from Occupational Pension (RROP)

The replacement rate from occupational pension (RROP) investigated in the present study refers to the target replacement rate, which is numerically equal to the ratio of the annual pension benefits received by the retirees of GDPI to the annual wage income for the one year before retirement (Xue et al., 2020). This reflects the support level that workers receive from occupational pension after retirement.

RROP is calculated based on the parameters of the policy currently being implemented. If the result of RROP is very high, although it can support the retirement life well, high contribution rate and heavy financial burden to the institutions and employees will be derived. On the contrary, if the RROP is very low, the income provided by occupational pension will be very limited and cause a psychological gap for retirees. The general view of the academic community, such as Zhang (2014), Jin and Yan (2018), Zhou et al. (2020), is that when the total replacement rate from basic endowment insurance and occupational pension reaches approximately 80% (basic endowment insurance approximately 60% and occupational pension approximately 20%), it can provide retirees with adequate benefits.

2.2. Actuarial Equivalence Principle

For a certain annuity insurance policy, actuarial equivalence principle is that the premium charged by an insurance company is equal to the sum of the actuarial present values of the annuity paid by the insurance company in the future. This equation is also called equation of value. For occupational pension, at the year of retirement, the accumulation value of contributions before retirement should be equal to the sum of actuarial present values of the annuity paid by occupational pension funds. Therefore, actuarial equivalence principle is also seen as cash flow balance model. For occupational pension funds, the money in is equal to the money out.

The RROP will be calculated using actuarial equivalence principle. From the perspective of occupational pension sources, occupational pension funds come from agency contributions and employee contributions. From the perspective of occupational pension payment, when the insured reaches retirement age specified by the policy or early retirement is caused by other reasons, the retirees will receive pension benefits in the form of annuity.

3. Modelling and Parameter Setting

3.1. Modelling the equation of value and Calculating the RROP

In this section, the RROP under different parameters is calculated, and the impact of each parameter is analyzed through empirical research. The cash flow balance model is a common method to measure the pension replacement rate,

such as Zhang and Xue (2019), Xue et al. (2020) and Liu et al. (2022). The equation of value in present study is

$$S = P \tag{3.1}$$

$$S = \sum_{t=\alpha}^{\beta-1} cw(1+g)^{t-\alpha}(1+r)^{\beta-1-t} \tag{3.2}$$

$$P = \sum_{t=\beta}^{\theta} bw(1+g)^{\beta-\alpha-1}\left(\frac{1}{1+i}\right)^{t-\beta} \cdot {}_{t-\beta}p_{\beta} \tag{3.3}$$

where S denotes the accumulated contribution value of the staff in the year of retirement, P denotes the actuarial present value of the occupational pension received after retirement, α denotes the age of starting work and participating occupational pension, β denotes the retirement age, g denotes the wage growth rate, i denotes the average annual interest rate, r denotes the rate of investment return, w denotes the initial wage, c denotes the contribution rate, b denotes the replacement rate from occupational pension, ${}_{t-\beta}p_{\beta}$ denotes the probability that a life aged β survives $t-\beta$ years, θ denotes the expected age of death of pensioners, that is, $\theta = \beta + e_{\beta}$, the sum of the retirement age and the average remaining life under the retirement age.

The replacement rate from occupational pension can be deduced from the equation of value.

$$b = \frac{c\sum_{t=\alpha}^{\beta-1}(1+g)^{t-\alpha}(1+r)^{\beta-1-t}}{(1+g)^{\beta-\alpha-1}\sum_{t=\beta}^{\theta}\left(\frac{1}{1+i}\right)^{t-\beta} \cdot {}_{t-\beta}p_{\beta}} \tag{3.4}$$

Replacement rate from occupational pension, b, is a function of α, β, θ, c, g, r, i, and ${}_{t-\beta}p_{\beta}$.

3.2. Setting Values of Parameters

3.2.1. Participation Age α and Retirement Age β

Due to the increase in education level, the age of starting to work of "new people" is increased. When undergraduates or junior college students take part in work after graduation, they are approximately 22 - 23 years old. Therefore, the participation ages for both male and female of "new people" in this model are setting at 25.

Statutory retirement age is 60 for men and 55 for women in China now. China's policy also stipulates that civil servants can retire early when they meet one of the following conditions: first, they have worked for 30 years; second, those who have worked more than 20 years, and are less than five years from the retirement age set by law. In addition, the government proposed "a gradual delaying retirement policy". Considering the above situations and the trend of male and female retirement at the same age in the future, the range of retirement age may be 55 - 65 for men and 50 - 65 for women.

3.2.2. The Expected Age of Death of Pensioners θ

The larger the average remaining life time after retirement is, the longer the pe-

riod of receiving pension is, and the lower replacement rate from occupational pension is. The report issued by the National Bureau of Statistics (NBS) of China in 2020 revealed that the average life expectancy for women was 80.88. According to the data of the World Health Organization in 2019, the average life expectancy for Chinese men was 74.6.

The average life expectancy is relative to new born babies, the lives aged 0. For those who have lived to the retirement age, the probability that they can live to the average life expectancy is greater than new born babies. Therefore, θ is appropriate to take the expected age of death of pensioners, that is, $\theta = \beta + e_\beta$, the sum of the retirement age and the average remaining life under the retirement age. The formula to calculate the mean residual life is

$$e_\beta = \sum_{k=0}^{\infty} k \cdot {}_k p_\beta \cdot q_{\beta+k}$$

where ${}_k p_\beta$ denotes the probability that a life aged β survives k years and $q_{\beta+k}$ denotes the probability that a life aged $\beta + k$ survives 1 year.

China Life Insurance Mortality Table (2010-2013)[6] was published at the end of 2016, but it is still the latest life table in China. Because pensioner with high death risk after retirement, when the probability of survival and the probability of death are calculated, this study needs to use "pension business table" of *China Life Insurance Mortality Table* (2010-2013), which is presented in **Table A1**. Then, different values of θ for men and women are derived. When the range of retirement for men is 55 - 65, the corresponding θ is 84.33 - 85.48. Thus, it is appropriate to take θ as 85 years old. When the range of retirement for woman is 50 - 65, the corresponding θ is 88.32 - 89.19. Thus, it is appropriate to take θ as 89.

3.2.3. Survival Probability after Retirement ${}_{t-\beta} p_\beta$

${}_{t-\beta} p_\beta$, the probability that a life aged β survives $t - \beta$ years, also can be calculated using the "pension business table" mentioned in previous section.

3.2.4. Wage Growth Rate g

The following factors affect the setting of wage growth rate. The first is the average wage growth rate of urban workers. According to the data published by the NBS of China, the average wage of urban workers and wage growth rate for each year between 2013 and 2021 are presented in **Table 1**. The average growth rate in these 9 years (2013-2021) was 9.62%.

Table 1. Wage growth rate of urban workers for each year between 2013 and 2021.

Year	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012
Average wage (yuan)	106837	97379	90501	82413	74318	67569	62029	56360	51483	46769
Growth rate	9.713%	7.600%	9.814%	10.892%	9.988%	8.931%	10.059%	9.473%	10.079%	-

Source: NBS of China, the average wage of urban workers[7].

[6] http://www.cbirc.gov.cn/cn/view/pages/ItemDetail.html?docId=372677&itemId=925&generaltype=0.
[7] https://data.stats.gov.cn/easyquery.htm?cn=C01.

The second factor is the GDP growth rate. Scholars have reported that wage growth rate is closely correlated to economic growth rate. Wang and Ren (2013) assumed that the economic growth rate was 1% lower than the growth rate of wages. According to the data published by the NBS of China, the GDP and GDP growth rate for each year between 2013 and 2021 are presented in Table 2. GDP growth rate for one year is equal to the GDP difference between this year and last year over GDP of last year. The average of growth rates in these 9 years (2013-2021) was 8.82%.

The third factor is the prediction of wage growth rate by scholars. Li et al. (2021) predicted that the average wage growth rate in 10 years of 2020-2031 was approximately 6%.

Due to the epidemic and other factors, China's economic growth rate slowed down, and the wage growth rate also decreased. This study sets a moderate wage growth rate of 6% per year.

3.2.5. Average Annual Interest Rate *i*

The average annual interest rate *i* is numerically equal to the one-year fixed deposit rate published by the People's Bank of China and updated on 24 Oct 2015. From Table 3, the interest rate of one-year fixed deposit fluctuated between 1.5%

Table 2. GDP and GDP growth rate for each year from 2013 to 2021.

Year	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012
GDP (trillion)	114.924	101.356	98.652	91.928	83.204	74.639	68.886	64.356	59.296	53.858
Growth rate	13.386%	2.741%	7.314%	10.485%	11.475%	8.351%	7.039%	8.533%	10.097%	-

Source: NBS of China, System of National Accounts[8].

Table 3. Interest rate published by the People's Bank of China from 2011 to 2015.

Adjustment date	Current deposit	Fixed deposit					
		3 months	6 months	1 year	2 years	3 years	5 years
2011.02.09	0.4	2.6	2.8	3	3.9	4.5	5
2011.04.06	0.5	2.85	3.05	3.25	4.15	4.75	5.25
2011.07.07	0.5	3.1	3.3	3.5	4.4	5	5.5
2012.06.08	0.4	2.85	3.05	3.25	4.1	4.65	5.1
2012.07.06	0.35	2.6	2.8	3	3.75	4.25	4.75
2014.11.22*	0.35	2.35	2.55	2.75	3.35	4	-
2015.03.01	0.35	2.1	2.3	2.5	3.1	3.75	-
2015.05.11	0.35	1.85	2.05	2.25	2.85	3.5	-
2015.06.28	0.35	1.6	1.8	2	2.6	3.25	-
2015.08.26	0.35	1.35	1.55	1.75	2.35	3	-
2015.10.24	0.35	1.1	1.3	1.5	2.1	2.75	-

Note: The benchmark interest rate for RMB deposits was not adjusted from October 2015 to the end of 2022. Source: The People's Bank of China[9].

[8]https://data.stats.gov.cn/easyquery.htm?cn=C01.
[9]http://www.pbc.gov.cn/zhengcehuobisi/125207/125213/125440/125838/125888/2968982/index.html.

and 3.5% during the period of 2011-2015. The benchmark interest rate for RMB deposits was not adjusted from October 2015 to the end of 2022. Thus, the interest rate in Section 4 is set as 2.5%.

3.2.6. Rate of Investment Return *r*

Rates of investment return of occupational pension funds determine the support level in claim period. According to China's policies, the assets accumulated in the individual accounts of occupational pension funds can be invested in the financial market. Reasonable asset allocation can not only help to meet the requirements of risk control, but also lead to higher returns than deposit in the bank.

The marketization of occupational pension funds in China has just started, and the historical data and empirical data on rate of return remain insufficient. It is known that both occupational pension and enterprise annuity comprise of the second pillar of China's multi-level pension system. Compared to occupational pension, the operation for enterprise annuity is longer. The Social Insurance Fund Supervision Bureau of the Ministry of Human Resources and Social Security of China announced the investment performance of enterprise annuity funds and listed the rate of return of each year over 2007-2021 in Table 4. The pension assets and investment portfolios of China's enterprise annuity funds

Table 4. Rates of investment return of enterprise annuity funds over 2007-2021.

Year	Number of Portfolio	Asset balance (billion yuan)	Weighted average rate of return of the year (%)
2007	212	15.463	41.00
2008	588	97.490	−1.83
2009	1049	159.102	7.78
2010	1504	245.298	3.41
2011	1882	332.548	−0.78
2012	2210	445.162	5.68
2013	2519	578.360	3.67
2014	2740	740.286	9.30
2015	2993	926.030	9.88
2016	3207	1075.622	3.03
2017	3568	1253.757	5.00
2018	3929	1450.221	3.01
2019	4327	1768.996	8.30
2020	4633	2214.957	10.31
2021	4965	2607.744	5.33
Annual average rate of return	-	-	7.17

Data source: Ministry of Human Resources and Social Security of China[10].

[10]http://www.mohrss.gov.cn/shbxjjjds/SHBXJDSzhengcewenjian/202203/W020220311694382790812.pdf.

increased steadily from 2007 to 2021. The annual rate of investment return of the enterprise annuity funds fluctuated greatly, ranging from −1.82% to 40.00%. From 2007 to 2021, the annual average rate of return of the enterprise annuity funds was 7.17%, which was the geometric average of the annual rate of return.

Many scholars considered that the investment return of enterprise annuity funds had an important reference role (Bai & Chen, 2020; Xu & Hao, 2020). The present study approves this standpoint. Yang et al. (2021) investigated the market-oriented investment operation of enterprise pension funds in Japan, Canada and Hong Kong Special Administrative Region of China. The research results revealed that the average investment return was 3.30%, 7.39% and 2.88%, respectively. It was concluded that a long-term average investment return of 4.5% - 8.5% would be more suitable for occupational pension. In the present study, with reference to the average value in the above range, 6.5% is set as the benchmark return on investment in Section 4.

3.2.7. Contribution Rates *c*

For China's occupational pension, the agency contribution rate is 8%, and the individual contribution rate is 4%, with a total of 12%. Thus, the contribution rate of occupational pension in China is the same for all insured individuals at present. As mentioned earlier, scholars discussed the feasibility of adjusting the contribution rate, or the feasibility of selecting an appropriate contribution rate range to ensure that different participants achieve the target replacement rate.

Combined with China's national conditions, the present study intends to test the level of replacement rate under the joint influence of different investment returns and contribution rates, and investigate the appropriate level of contribution rate for GDPI.

4. Calculation and Analysis of the Replacement Rate from Occupational Pension

If the RROP in China will be analyzed, each influencing factor according to the actual situation will be set as a value or a range. These influencing factors for male and female are participation age, retirement age, remaining life after retirement, annual wage growth rate during work, contribution rate, and probability of survival or death after retirement. Other influencing factors include interest rate and investment return rate of occupational pension fund. When the actual situations change, the settings of influencing factors and then RROP will be modified.

Two key questions of this paper are: first, how do these factors affect the replacement rate from occupational pension? Second, under what conditions can the replacement rate reach a satisfactory level of 20%? To answer these two questions, the impacts of one or several factors on the replacement rate will be observed when other factors are fixed.

In Section 4, the impact of retirement age on replacement rate will be focused on. In Section 5, the impact of investment return rate and the joint influence of

investment return rate and contribution rate will be analyzed. In Section 6, the impact of wage growth rate and the joint influence of wage growth rate and retirement age will be discussed. In Section 7, some policy suggestions based on the calculation results of previous three sections will be made.

4.1. Influence of Retirement Age on Replacement Rate from Occupational Pension

From Section 3, it is assumed that participation age for both sexes is 25, wage growth rate is 6% per year, interest rate is 2.5% per year, rate of return is 6.5% per year, and contribution rate is 12%. The RROP is calculated under these assumptions and listed in Table 5.

Table 5. RROP under different retirement ages for male and female.

Gender of pensioner	Retirement age, β	Expected age of death of pensioner, θ	Claim years	Replacement rate when retirement at age, $b(\beta)$	Increase of replacement rate under the two adjacent retirement ages, $b(\beta) - b(\beta-1)$
male	55	85	30	19.92%	-
	56		29	21.15%	1.23%
	57		28	22.47%	1.32%
	58		27	23.86%	1.39%
	59		26	25.36%	1.50%
	60		25	26.96%	1.60%
	61		24	28.68%	1.72%
	62		23	30.53%	1.85%
	63		22	32.54%	2.01%
	64		21	34.71%	2.17%
	65		20	37.09%	2.38%
female	50	89	39	13.50%	-
	51		38	14.32%	0.82%
	52		37	15.19%	0.87%
	53		36	16.10%	0.91%
	54		35	17.04%	0.94%
	55		34	18.04%	1.00%
	56		33	19.10%	1.06%
	57		32	20.21%	1.11%
	58		31	21.39%	1.18%
	59		30	22.64%	1.25%
	60		29	23.97%	1.33%
	61		28	25.39%	1.42%
	62		27	26.90%	1.51%
	63		26	28.52%	1.62%
	64		25	30.26%	1.74%
	65		24	32.13%	1.87%

As shown in Table 5, when the retirement age of male employees is within 55 - 65 years old, the replacement rate increases, with the lowest level at 19.92%, corresponding to retirement at the age 55 years old, and the highest level at 37.09%, corresponding to retirement at the age of 65 years old. In addition, when the retirement age of female employees is within 50 - 65 years old, the replacement rate increases, with the lowest level of 13.50%, corresponding to 50 years old, and the highest level of 32.13%, corresponding to 65 years old. The trend and difference of replacement rate under each retirement age have been also compared, respectively for male and female.

4.2. Results and Analysis of Replacement Rate Changes under Different Genders

It can be observed from Figure 1 that when men retire between 55 and 65 years old, and women retire between 50 and 65 years old, the RROP steadily increases with the increase in retirement age, and the cross-domain growth is relatively significant. This is because delaying retirement makes contribution period longer and benefit claim period shorter. The combined effect of these two causes the replacement rate to increase.

Through the comprehensive comparison of the replacement rate of men and women, and under the assumption of the same retirement age, the replacement rate of male is higher than that of female. The most direct reason is that the θ of male is four years younger than women. Therefore, compared to women, men expect less time to receive benefits, which leads to the increase in corresponding claim value each year. Thus, as the retirement age increases, the difference between replacement rates of male and female will become more obvious.

According to Figure 2, regarding the added value of replacement rate under the two adjacent retirement ages, men steadily increases from 1.23% at the age of 56 years old to 2.38% at the age of 65 years old. The value-added curve of women also exhibits an obvious upward trend during the period of 50 - 65 years old

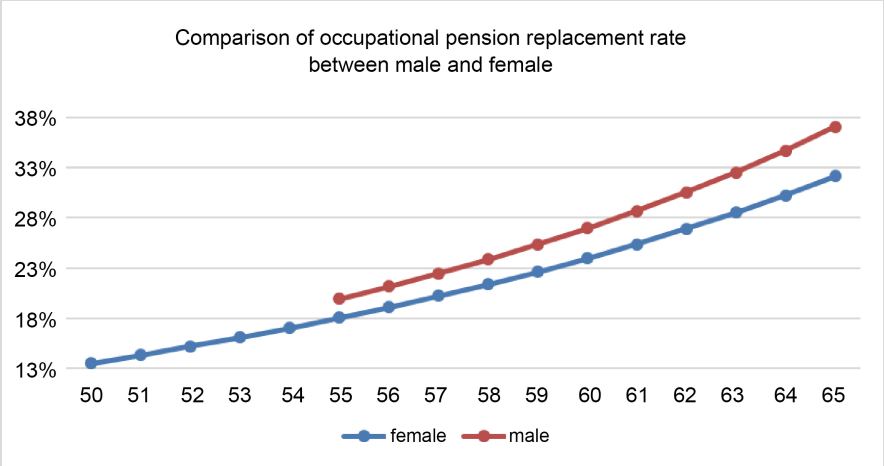

Figure 1. Replacement rates from occupational pension at different retirement ages for men and women.

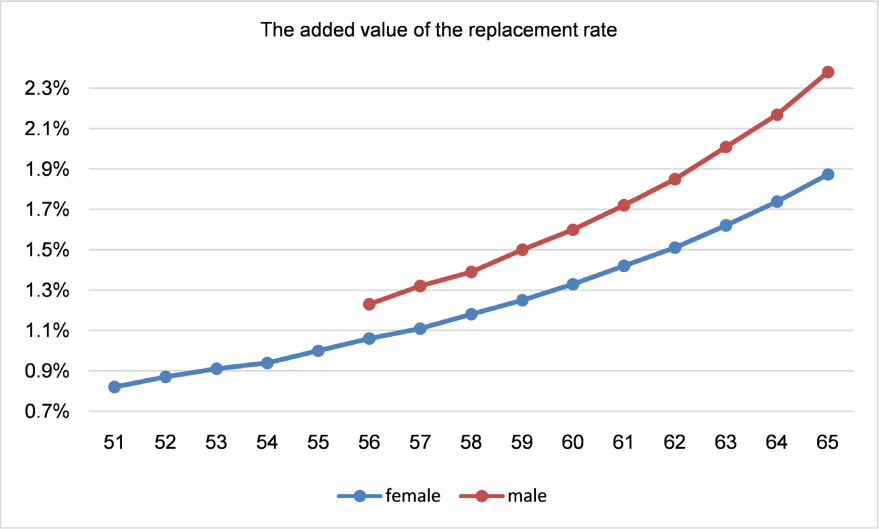

Figure 2. Increase of replacement rate under the two adjacent retirement ages for men and women.

(from 0.82%, which corresponds to 51 years old, to 1.87%, which corresponds to 65 years old). This upward trend has the same characteristics as the growth rate of the male replacement rate.

With the same retirement age, the increase of replacement rate between the adjacent retirement age of men and women is also different. From the age of 56 years old to 65 years old, the increase of replacement rate for men is higher than that of women, which increases with age. From the above analysis, the following conclusions can be drawn. As long as both sexes retire at the same age, with the increase of retirement age, the increase of replacement rate between the adjacent retirement ages for males is greater than that of females. It also explains why the difference between the replacement rates for both sexes is more obvious from a numerical point of view.

5. Impact Analysis of the Investment Return Rate and Contribution Rate

5.1. Influence of Rate of Investment Return on RROP

Except retirement age, changing the values of other influencing factors in Formula (3.4) also affects the RROP, e.g. rate of investment return and contribution rate. This section focuses on the changes of replacement rate under different levels of investment return and contribution rates.

In order to analyze RROP under different investment returns, some assumptions for other parameters are supposed. The assumptions include that participation age for both sexes is 25, retirement age for both sexes is 58, expected ages of death of male and female are 85 and 89, wage growth rate is 6% per year, interest rate is 2.5% per year and contribution rate is 12%.

Considering that investment return may be very low, even have a negative growth during an economic market downturn, such as the COVID-19 epidemic,

the lower limit of the conservative estimate is 3% per year. On the other hand, relatively aggressive investment plans increase investment return, 9% per year is set as the upper limit of investment return. Therefore, replacement rates with an investment return range of 3% - 9% are calculated.

The replacement rates for men and women are respectively displayed in Table 6 and Table 7.

As shown in Table 6 and Table 7, it can be concluded that when the investment return rate increases from 3% to 9%, the replacement rate gradually increases. The ranges of replacement rate for males and females are 14.50% - 35.79% and 13.00% - 32.08%, respectively. With the increase in investment return rate, the increment speed also increases. This indicates that the marginal impact of investment return is significant.

In addition, under the same investment return, the female replacement rate is lower than male. The principal reason is that the average life expectancy of women is 4 - 5 years higher than men, overall.

In Figure 3, the changes in replacement rate under different rates of return can be more intuitively observed.

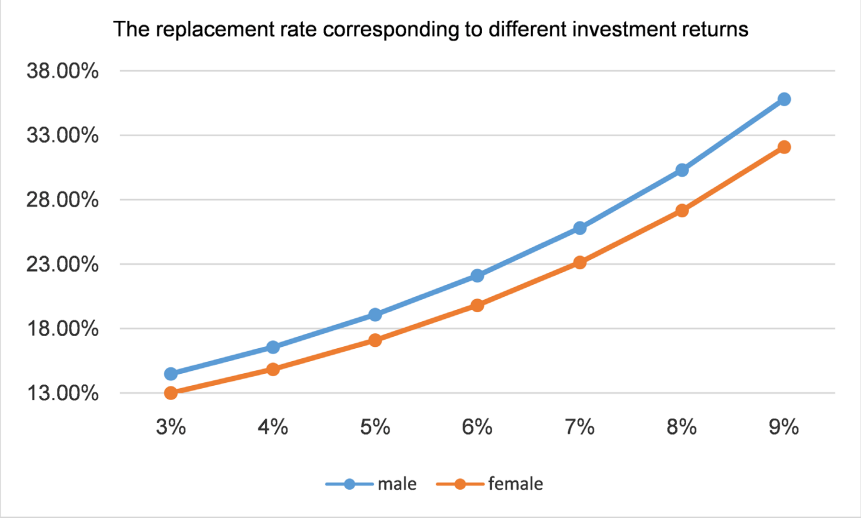

Figure 3. Influence of different investment returns on the replacement rate for male and female.

Table 6. Replacement rate under different investment returns (male).

Investment Return	3%	4%	5%	6%	7%	8%	9%
Replacement rate	14.50%	16.57%	19.08%	22.11%	25.80%	30.30%	35.79%
Increase of Replacement rate	-	2.07%	2.51%	3.03%	3.69%	4.50%	5.49%

Table 7. Replacement rate under different investment returns (female).

Investment Return	3%	4%	5%	6%	7%	8%	9%
Replacement rate	13.00%	14.86%	17.10%	19.82%	23.13%	27.16%	32.08%
Increase of Replacement rate	-	1.86%	2.24%	2.72%	3.31%	4.03%	4.92%

With the increase in investment return rate, the level of replacement rate gradually increases, and the added value of replacement rate gradually increases, indicating that the positive incentive effect of the investment return rate is becoming increasingly significant. It is feasible to use reasonable asset allocation to ensure the rate of return, and then ensure that the replacement rate reaches 20%.

5.2. Combined Influence of Investment Return and Contribution Rate

This section attempts to determine the corresponding contribution rates, in order to achieve the target level of replacement rate under different investment return environments, namely, 3%, 5% and 8%. In other words, when the investment market tends to be stable, neutral, and risk preference (three different circumstances), how can the contribution rate be properly set.

As shown in Table 8, with the same parameters, the replacement rate of women is lower than that of men. That is to say, if the female replacement rate is higher than 20%, then the male replacement rate must be higher than 20%. Therefore, the analysis is carried out by female pensioner. The 3% investment return represents the level of sound investment. Even when the contribution rate reaches 18%, the replacement rate merely reaches 19.49%. This shows that under the condition of economic market depression, the replacement rate can reach the target level merely by delaying retirement and increasing the contribution rate at the same time. Thus, the retirement age should not only be limited to 58 years old. If the investment return remains at 3%, the contribution rate needs to remain at 17%, and women would need to retire at the age 65-year-old to reach the higher replacement rate of 25%.

When the investment return is 5% in a conventional financial market, the contribution rate would have a significant impact under the established parameter of 58 years old. If the contribution rate flexibly increases, the replacement rate is expected to exceed 25%, thereby better supporting the basic endowment insurance.

Table 8. Replacement rate under the combined influence of rate of return and contribution rate.

Contribution rate / Investment rate	Gender	12%	14%	16%	18%
3%	Male	14.50%	16.91%	19.33%	21.74%
5%		19.08%	22.26%	25.43%	28.61%
8%		30.29%	35.34%	40.39%	45.44%
3%	Female	13.00%	15.16%	17.32%	19.49%
5%		17.10%	19.95%	22.80%	25.65%
8%		27.16%	31.68%	36.21%	40.73%

The investment return remains at 8%, which means that financial markets are performing well, a 12% contribution rate would still push the replacement rate to more than 27%.

6. Impact Analysis of Wage Growth Rate and Retirement Age

6.1. Influence of Wage Growth Rate on Replacement Rate from Occupational Pension

Based on the information from NBS of China mentioned in Section 4, wage growth rates in recent 10 years were higher than 6%. Therefore, in this section, the change level of the replacement rate is analyzed when the wage growth rate is in range of 6% - 10%.

Similarly, some assumptions need to be supposed, which include participation age for both sexes is 25, retirement age for both sexes is 58, expected ages of death of male and female are 85 and 89, interest rate is 2.5% per year, rate of return is 6.5% per year and contribution rate is 12%. The results of RROP are summarized in Table 9.

When the wage growth rate increases from 6% to 10%, the replacement rates of both men and women exhibit a gradual declining trend. The replacement rate of men decreases from 23.86% to 13.81%, while female decreases from 21.39% to 12.38%. At the same wage growth rate, the male replacement rate is higher than that of the female.

The level of replacement rate decreases with the increase of wage growth rate, which can be fully explained. In the fraction of Formula (3.4) for the replacement rate calculation, the numerator is the average annual claim received during the period after retirement, and the denominator is the annual salary of the one year before retirement. The increase in the growth rate of salary can increase the cumulative value of the total contribution period, thereby leading to an increase in average pension. However, the increase in the growth rate of salary is most directly reflected in the increase in salary over working years, resulting in the increase in salary at one year before retirement, which is much higher than that of the pension received after retirement. Although both the numerator and denominator increase, the increase of the denominator is larger than that of the numerator. Thus, the level of the replacement rate exhibits a decline.

When the wage growth rate is 10%, the replacement rates for both men and women are below 14%. Under this circumstance, support from occupational pension needs to be enhanced. In the next section, different combinations of wage growth rate and retirement age will be made to raise the replacement rate to 20%.

Table 9. RROP under different wage growth rates for male and female.

Wage growth rate	6%	7%	8%	9%	10%
Replacement rate (male)	23.86%	20.53%	17.83%	15.63%	13.81%
Replacement rate (female)	21.39%	18.41%	15.99%	14.01%	12.38%

6.2. The Level of Replacement Rate under the Combined Effect of Retirement Age and Wage Growth Rate

Next, in this section, authors attempt to calculate the replacement rate corresponding to different retirement ages under different wage growth rates, namely, 6%, 8% and 10%, in order to answer two questions. First, what is the impact of the joint effect of retirement age and wage growth rate on the replacement rate? Second, under what combination of retirement age and wage growth rate, can the replacement rate reach a satisfactory level of 20%?

The assumptions include that participation age for both sexes is 25, expected ages of death of male and female are 85 and 89, interest rate is 2.5% per year, rate of return is 6.5% per year and contribution rate is 12%. The replacement rates under different combinations are listed in Table 10.

From Table 10, the conclusion consistent with Section 4 can be obtained. First, delaying retirement improves the RROP for both sexes. Second, under the same conditions, the replacement rate of men is higher than that of women.

In addition, for male insured, when the wage growth rate is 6% and the retirement age is 55, the replacement rate reaches 19.92%, which is close to the target of 20%. When the wage growth rate is 8% and the retirement age is 61, the replacement rate can reach 20.87%. When the wage growth rate is 10% and the retirement age is 66 years old, the substitution rate has just reached 20%.

For female insured, when the wage growth rate is 6% and the retirement age is 55, the replacement rate reaches 18.04%, which is also close to the target of 20%. When the wage growth rate is 8% and the retirement age is 63, the replacement rate can reach 20.39%. When the wage growth rate is 10%, even when the retirement age is 66, the replacement rate is still less than 20%.

Table 10. The impact of the joint effect of retirement age and wage growth rate on the replacement rate.

Wage growth rate / Retirement age	Male			Female		
	6%	8%	10%	6%	8%	10%
55	19.92%	15.29%	12.09%	18.04%	13.85%	10.95%
56	21.15%	16.09%	12.64%	19.10%	14.53%	11.41%
57	22.47%	16.94%	13.21%	20.21%	15.24%	11.89%
58	23.86%	17.83%	13.81%	21.39%	15.99%	12.38%
59	25.36%	18.78%	14.45%	22.64%	16.77%	12.90%
60	26.96%	19.79%	15.12%	23.97%	17.60%	13.45%
61	28.68%	19.79%	15.84%	25.39%	18.48%	14.02%
62	30.53%	22.02%	16.60%	26.90%	19.41%	14.63%
63	32.54%	23.27%	17.42%	28.52%	20.39%	15.27%
64	34.71%	24..61%	18.31%	30.26%	21.45%	15.96%
65	37.09%	26.06%	19.26%	32.12%	22.58%	16.69%
66	39.69%	27.64%	20.31%	34.16%	23.79%	17.47%

Therefore, if the replacement rate is simply required to reach 20%, the higher the wage growth rate, the older the retirement age needs to rise. Obviously, this approach is unreasonable. Moreover, the wage growth rate is not controlled by pension related policies. It is advisable to increase the rate of return of occupational pension fund in combination with appropriate retirement age, and flexibly adjust the contribution rate to make the replacement rate of occupational pension close to 20%.

7. Conclusion and Relevant Policy Recommendations

7.1. Analysis Conclusion

By constructing an actuarial model, this study calculates the replacement rate from occupational pension received by "new people". Then, sensitivity analyses on the contribution rate, rate of investment return, retirement age and other factors that have significant impacts on replacement rate are discussed in order to analyze the impact of different variables on occupational pension. Four conclusions are summarized as following.

The first, when setting the parameters according to the situation of China in the past ten years (2012 to 2021), that is, given the assumptions that participation age for both sexes is 25 years old, contribution rate is 12%, rate of return is 6.5%, rate of interest is 2.5%, and wage growth rate is 6%, whether men or women, delaying retirement significantly increases the replacement rate from occupational pension for all "new people". For men, when the retirement age is 56, the replacement rate already reaches 20%. For women, when the retirement age is 57, the replacement rate also can reach 20%.

Second, when the retirement ages for male and female and other factors are same, the RROP of men is higher than that of women. In addition, the marginal effect of the increase of retirement age for male is greater than that for female.

Third, each rate of investment return and the contribution rate has a significant positive correlation with the RROP. Increasing the rate of return or the rate of contribution can increase the PPOR, and has a greater impact on the PPOR of men than women. When the rates of return are equal for both sexes, setting different contribution rates for male and female can narrow the gender difference.

The last, there is a significant negative correlation between the wage growth rate during the working period and the growth of RROP. The higher the wage growth rate, the lower the RROP. However, the wage growth rate is determined by the economic environment and industry, and is not a variable that can be controlled by pension policy or occupational pension policy.

7.2. Policy Suggestions

The level of pension benefit is an important indicator to measure the effect of the pension system reform. Occupational pension is a supplementary pension scheme for the staff of government departments and public institutions, and replacement rate from occupational pension has a significant impact on the re-

tirement income of the participant. Referring to the research experience of scholars, the present study has selected key variables, built a reasonable actuarial model, further measured the level of RROP, and analyzed the impact of key factors. On this basis, the present study intends to provide suggestions and references for optimizing system parameters, and improving policy details, which have a positive significance for upgrading China's pension system, and coping with the impact of aging.

7.2.1. Appropriate Increase in Retirement Age

Delaying retirement can prolong the accumulation period of contributions and shorten the pension receiving period, which plays a significant role in improving the RROP. Although it can improve the pension level, the retirement age is not the older the better. Delaying retirement can also cause some problems, for example, resistance due to the extended working period. The key is to implement differentiated and personalized delaying retirement policies for different groups of people, and give the staff of GDPI the right to choose their own retirement age. In other words, through certain incentives or welfare policies, staff is encouraged to choose a reasonable retirement age.

7.2.2. Optimization of Investment Operations

Optimizing the investment operation will help to improve the investment income, strengthen the fund accumulation, and improve the RROP. This paper proposes to improve the investment operation from the following two aspects. The first is to optimize the asset allocation, improve the return on investment, and achieve the goal of maintaining and increasing the value of fund assets. The second is to strengthen the supervision of financial institutions operating occupational pension funds and promote financial institutions to do a good job in risk management.

7.2.3. Flexible Adjustment of Contribution Rates

Under the same assumption, the RROP for women is significantly lower than that for men. Women can be encouraged to increase their personal contribution rate through policy preferences. For example, while increasing women's individual contributions, the awareness of reserving the money needed for the elderly in advance should be advocated, and health and longevity management services should be provided for free, in order to offset the risk of longevity.

For all employees, international experience should be acquired, mechanisms of flexible contribution should be explored, and "pay more and get more" should be encouraged (Guo, 2021). For staff that would have the ability and willingness to pay more, the government can give more matching contributions, such as the federal matching contributions in the TSP plan in the US.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

Bai, Z., & Chen, Y. (2020). Coordination, Innovation and Sharing: Research on Collaborative Optimization of Enterprise Annuity and Professional Annuity. *Northwest Population Journal, 41,* 115-124. (In Chinese) https://doi.org/10.15884/j.cnki.issn.1007-0672.2020.06.010

Chen, Y., Mu, H., & Bian, S. (2019). A Study of the Occupational Pension Payment Desirable Level about Public Institutions. *Journal of Quantitative & Technological Economics, 36,* 92-107. (In Chinese) https://doi.org/10.13653/j.cnki.jqte.2019.03.006

Falk, J., & Karamcheva, N. (2018). The Effect of Employer Matching and Defaults on Workers' TSP Savings Behavior: Presented at the National Tax Association's 111th Annual Conference on Taxation. In *Annual Conference on Taxation and Minutes of the Annual Meeting of the National Tax Association* (pp. 1-21). National Tax Association.

Guo, X. (2021). Comparison of Occupational Pension System for Civil Servants in Developed Countries. *Co-Operative Economy & Science, No. 1,* 116-117. (In Chinese) https://doi.org/10.13665/j.cnki.hzjjykj.2021.01.048

Jin, G., & Yan, T. (2018). Substitution Rate of Government and Public Institutions Employee Occupational Annuity. *Journal of Beijing University of Aeronautics and Astronautics (Social Sciences Edition), 31,* 36-43. (In Chinese) https://doi.org/10.13766/j.bhsk.1008-2204.2018.0112

Li, B., Li, H., & Qiao, D. (2021). Research on the Influence of Endowment Insurance Reform on Pension Treatment of Government and Public Institution: Analysis Based on Pension Replacement Rate. *Financial Theory & Practice, No. 7,* 111-118. (In Chinese)

Liu, M., Chen, Y., & Xu, Y. (2022). Calculation and Analysis of the Occupational Annuity Replacement Rate. *Financial Perspectives Journal, No. 9,* 44-48. (In Chinese)

Lou, F. (2020). The Progress, Problems and Suggestions of the Three Pillars Pension System Construction in China. *Journal of Financial Development Research, No. 2,* 69-74. (In Chinese) https://doi.org/10.19647/j.cnki.37-1462/f.2020.02.009

Novy-Marx, R., & Rauh, J. D. (2014). Linking Benefits to Investment Performance in US Public Pension Systems. *Journal of Public Economics, 116,* 47-61. https://doi.org/10.1016/j.jpubeco.2014.01.007

Pavolini, E., & Seeleib-Kaiser, M. (2018). Comparing Occupational Welfare in Europe: The Case of Occupational Pensions. *Social Policy & Administration, 52,* 477-490. https://doi.org/10.1111/spol.12378

Pu, X., & Wang, Y. (2021). Study on the Calculation of Pension Benefits of Government and Institutions after the Completion of Occupational Annuity Payment. *Social Security Studies, No. 4,* 11-21. (In Chinese)

Turner, J. A., Klein, B. W., & Stein, N. P. (2016). Financial Illiteracy Meets Conflicted Advice: *The Case of Thrift Savings Plan Rollovers. The Journal of Retirement, 3,* 47-65. https://doi.org/10.3905/jor.2016.3.4.047

Wang, X., & Ren, W. (2013). Studies on the Financial Sustainability of Social Pension System in China. *Insurance Studies, No. 4,* 118-127. (In Chinese) https://doi.org/10.13497/j.cnki.is.2013.04.014

Xu, D., & Hao, A. (2020). An Actuarial Analysis on the Payment Patterns of Occupational Annuity in State Organs and Institutions. *Insurance Studies, No. 1,* 116-127. (In Chinese) https://doi.org/10.13497/j.cnki.is.2020.01.009

Xue, H., Wang, Y., & Huang, A. (2020). Target Replacement Rate, Cross Replacement Rate, Lifetime Replacement Rate, and Average Replacement Rate—Classified Calculation and Comparison of Basic Pension Replacement Rate for Urban Employees. *Decision & Information, No. 1,* 48-58. (In Chinese)

Yang, C., Liu, Y., & Wang, K. (2021). Will the Pension Insurance Reform of Government Agencies and Institutions Bring about a New Pension Gap. *Social Security Studies, No. 3,* 15-27. (In Chinese)

Zhang, X. (2014). Study on the Occupational Pension scheme in Government Institutions. *Social Security Studies, No. 5,* 10-16. (In Chinese)

Zhang, X., & Xue, H. (2019). A Study on the Lifetime Replacement Rate and Sensitivity of Old-Age Insurance in Organs and Institutions. *Journal of Statistics and Information, 34,* 58-66. (In Chinese)

Zhang, Y., & Lu, Y. (2021). "Hybrid Accounting" Management of China's Occupational Annuity and Its Attributes, Issues and Policy Proposals. *Journal of Huazhong University of Science and Technology (Social Science Edition), 35,* 57-65. (In Chinese) https://doi.org/10.19648/j.cnki.jhustss1980.2021.03.06

Zheng, W. (2015). The TSP Plan of the United States and Its Implications for Occupational Annuity of China's Government and Public Institutions. *Comparative Economic & Social Systems, No. 1,* 152-160. (In Chinese)

Zhou, X., Deng, L., & Gong, F. (2020). Population Aging, Pension Insurance Contribution Rate and Target Replacement Rate of Basic Pension Insurance. *Finance and Trade Research, 31,* 57-67. (In Chinese) https://doi.org/10.19337/j.cnki.34-1093/f.2020.02.005

Appendix

Table A1. The Probability that life aged x dies within one year in *China Life Insurance Mortality Table* (2010-2013)[11]

Age, x	Table 1 of Non-pension business		Table 2 of Non-pension business		Pension business table	
	The Probability that life aged x dies within one year					
	Male (CL1)	Female (CL2)	Male (CL3)	Female (CL4)	Male (CL5)	Female (CL6)
50	0.004249	0.001859	0.002908	0.001321	0.002148	0.00095
51	0.004633	0.002037	0.00315	0.001439	0.00234	0.001031
52	0.005032	0.002226	0.003409	0.001568	0.002544	0.00112
53	0.005445	0.002424	0.003686	0.001709	0.002759	0.001219
54	0.005869	0.002634	0.003982	0.001861	0.002985	0.001329
55	0.006302	0.002853	0.004297	0.002027	0.003221	0.00145
56	0.006747	0.003085	0.004636	0.002208	0.003469	0.001585
57	0.007227	0.003342	0.004999	0.002403	0.003731	0.001736
58	0.00777	0.003638	0.005389	0.002613	0.004014	0.001905
59	0.008403	0.00399	0.005807	0.00284	0.004323	0.002097
60	0.009161	0.004414	0.006258	0.003088	0.00466	0.002315
61	0.010065	0.004923	0.006742	0.003366	0.005034	0.002561
62	0.011129	0.005529	0.007261	0.003684	0.005448	0.002836
63	0.01236	0.006244	0.007815	0.004055	0.005909	0.003137
64	0.013771	0.007078	0.008405	0.004495	0.006422	0.003468
65	0.015379	0.008045	0.009039	0.005016	0.006988	0.003835
66	0.017212	0.009165	0.009738	0.005626	0.00761	0.004254
67	0.019304	0.01046	0.010538	0.006326	0.008292	0.00474
68	0.021691	0.011955	0.011496	0.007115	0.009046	0.005302
69	0.024411	0.013674	0.012686	0.008	0.009897	0.005943
70	0.027495	0.015643	0.014192	0.009007	0.010888	0.00666
71	0.030965	0.017887	0.016106	0.010185	0.01208	0.00746
72	0.034832	0.020432	0.018517	0.011606	0.01355	0.008369
73	0.039105	0.023303	0.02151	0.013353	0.015387	0.009436
74	0.043796	0.026528	0.025151	0.015508	0.017686	0.01073
75	0.048921	0.030137	0.02949	0.018134	0.020539	0.012332
76	0.054506	0.034165	0.034545	0.021268	0.024017	0.014315
77	0.060586	0.038653	0.04031	0.024916	0.028162	0.016734
78	0.067202	0.043648	0.046747	0.029062	0.032978	0.019619
79	0.0744	0.049205	0.053801	0.033674	0.038437	0.022971
80	0.08222	0.055385	0.061403	0.038718	0.044492	0.02677
81	0.0907	0.062254	0.069485	0.04416	0.051086	0.030989

[11]http://www.cbirc.gov.cn/cn/view/pages/ItemDetail.html?docId=372677&itemId=925&generaltype=0.

Continued

82	0.099868	0.06988	0.077987	0.049977	0.058173	0.035598
83	0.109754	0.07832	0.086872	0.056157	0.065722	0.040576
84	0.120388	0.087611	0.09613	0.062695	0.073729	0.045915
85	0.131817	0.097754	0.105786	0.069596	0.082223	0.051616
86	0.144105	0.108704	0.1159	0.076863	0.091239	0.057646
87	0.157334	0.120371	0.126569	0.084501	0.1009	0.064084
88	0.171609	0.132638	0.137917	0.092504	0.111321	0.070942
89	0.187046	0.145395	0.150089	0.100864	0.122608	0.078241
90	0.203765	0.158572	0.163239	0.109567	0.13487	0.086003
91	0.221873	0.172172	0.177519	0.118605	0.148212	0.094249
92	0.241451	0.186294	0.193067	0.127985	0.162742	0.103002
93	0.262539	0.201129	0.209999	0.137743	0.178566	0.112281
94	0.285129	0.21694	0.228394	0.147962	0.195793	0.122109
95	0.30916	0.234026	0.248299	0.158777	0.214499	0.13254
96	0.334529	0.252673	0.269718	0.17038	0.23465	0.143757
97	0.361101	0.273112	0.292621	0.18302	0.25618	0.155979
98	0.388727	0.295478	0.316951	0.196986	0.279025	0.169421
99	0.417257	0.319794	0.342628	0.212604	0.30312	0.184301
100	0.446544	0.345975	0.369561	0.230215	0.328401	0.200836
101	0.476447	0.373856	0.397652	0.250172	0.354803	0.219242
102	0.50683	0.403221	0.426801	0.272831	0.382261	0.239737
103	0.537558	0.433833	0.456906	0.298551	0.41071	0.262537
104	0.568497	0.465447	0.487867	0.327687	0.440086	0.287859
105	1	1	1	1	1	1