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Analysis of amount of money needed for retirement in thirty years

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by

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Table of Contents Page Number

ABSTRACT

In each country, the establishment of pension system aims to prevent employees from suffering financial distress in their late life. Pension replacement rate is an essential indicator that reflects the pension system's capability of coping with the risk of population aging, and indicates the workers' general quality of live after retirement. In this thesis, the formula for calculating the replacement rate is derived based on the regulation to construct the scenario analysis model. The model calculates different replacement rates by changing variables under different assumptions, and therefore shows the relationship between variables and replacement rate under different scenarios. Multiple regression model, another methodology, is also applied in this thesis to explore the most significant economic factor affecting the replacement rate. The results of this thesis display that both retirement age and average contribution index have a positive impact on raising the replacement rate, and that inflation rate and real wage growth rate have a significant impact on the replacement rate. Based on the findings, several measures are put forward to suggest a path to improve China's pension system, including raising statutory retirement age, easing inflationary pressure, and diversifying pension investments.

Keywords: pension replacement rate, China's pension system

1. INTRODUCTION

As early as 1950, referred to the Soviet style model, China had established a state-enterprise pension model, featured by employer contribution, PAYG and a single-tire operation. However, in the context of economic system reform and rapid aging population, the shortcomings of the old model become more evident, and China calls for a reform to rebalance the system. Firstly, during 1990s, China was undergoing a transformation of the economic system from a planned economy to a market-orientated economy. Both State-owned enterprises (SOEs) and private enterprises initiated structural reform with the intention of enhancing efficiency and therefore reduced the size. The relationship between employer and employee had shifted from lifelong dependent relation to contractual relation, leading to an unemployment of over 30 million employees (Gao and Wang, 1999). Apparently, the government could no longer rely on enterprises to support the entire pension system, meaning that the old pension plan had already lost its utility. Secondly, the rapid aging population intensified some of inherent flaws of the traditional enterprise-based pension system itself. Pension financed solely by enterprise had a very limited coverage and limited the mobility of labor force, which was regard as unsustainable for long-term social welfare (Cai and Cheng, 2014). Thus, China was urgently seeking for an advanced pension system to maintain the economic growth and social stability.

In 1997, based on original enterprise pension system, China adopted a series of reform measures and established a universal basic pension system. Over the next few years, the government made several revisions, the core problem of which is the constantly adjusted weighted ratio between social pooling and individual accounts (Li and Wang, 2009). In 2005, the State Council released a Decision on improving basic old-age insurance system for enterprises employees (BOAISEE). Later, it also issued another decision on basic old-age insurance system for public institution employees (BOAISPE) (Wang et al., 2014). China has initiated a new basic

pension system, a hybrid system with a combination of social pooling and individual accounts, meaning that the pension would be undertook jointly by individuals and enterprises. The reform has accomplished the shift from state-enterprise model to state-society model has marked the end of nearly 20-year-long dual pension regulations (Zhu and Walker, 2018). In latter stages of reform, the government has focused more on expansion of coverage and better adaptation in China's economic framework and social cultural context.

Quantitative researches commonly refer pension replacement rate as an integral study object. Pension replacement rate refers to the ratio of pension income level after retirement to salary level before retirement of an eligible retiree (Biggs and Springstead, 2008). The replacement rate is one of the basic merits to measure the social equality and difference of living guarantee level before and after retirement, so it is commonly considered as a key part of pension system reform. In 2005's Decision, the State Council determined that taking a 35-year retirement as an example, target replacement rate is 59.2% (Li and Wang, 2009). However, the present replacement rate cannot reach this target level. Faced with the trend of constant decline from year to year and rapid increase in the number of retirement, the government is actively working to make the current pension system secure for retirement. The determination of replacement rate is crucial. If the target replacement rate is too low, the elderly cannot obtain enough living security in the later life. If the target replacement rate is too high, it will intensify financial burden on both people and government and aggravate the pension budget deficit.

With the development of technology and the improvement of people's living standards, the life expectancy of the population is gradually extended. China's aging population makes the social pension problem become particularly important. In the field of social endowment insurance, the replacement rate of basic pension is related to the living standard of the elderly after retirement, the financial affordability of the country, the sustainable development of

economy and society, as well as the balanced operation of individual welfare treatment and pension fund. Therefore, it is of great significance to study the relevant factors affecting the replacement rate of basic pension for guaranteeing the basic life of retired workers, promoting the balance of pension income and expenditure, and realizing the sustainable development of the pension system.

The thesis firstly provides an overview of the development of China's pension system and its calculation methods. From the perspective of replacement rate, this thesis aims to focus on the effects of three factors, including retirement age, average contribution index, and notional interest rate of individual account, on the replacement rate and retirement income by constructing and analyzing different kinds of scenarios. By adjusting the amount of variables based on various assumptions, I can see how the variable affects replacement rate and which factors have a more obvious effect on the outcome. Furthermore, the thesis adds cost of living into consideration to see how the discrepancy in price level affects the employer's purchasing power. The thesis adopts data from four cities in China as sample, and compares different pension performances in these cities. Finally, based on the results, some suggestions of pension system improvement and individual pension planning are rendered. General speaking, the thesis provides some suggestions with meaning of practice both for young employees and the government officials to be aware of the importance of pension planning and have some ideas about making improvements.

The rest of the thesis is organized as follows: Section 2 reviews the related literatures in both domestic and foreign studies to get general ideas about the existing findings and models. Section 3 derives the calculation formula, constructs the models and describes the hypothesis and sources of data. Section 4 applies data into the models and analyzes the scenarios. Section 5 presents the results of the models. Section 6 concludes the main findings in this thesis. iii

2. LITERATURE REVIEW

In both domestic and foreign studies, scholars have obtained revelatory results. They present different definitions of replacement rate and construct various pension replacement models to simulate the optimal target rate or to test the factors. They use different indicators to evaluate sustainability of pension system. Moreover, they conduct comparative studies of different pension schemes in several countries.

2.1 Background of Pension System

2.1.1 Pension Systems around the world

Since 1980s, the aging population has brought constant challenges and influences on pension system around the world. Through decades of effort, each country has undergone a series of reform of the pension system, and the study of old-age care has increasingly become one of the latest hot spots in academic circles and decision-making institutions.

For example, Bonin (2009) studies the latest pension reform in Germany, which has moved from defined benefit (DB) to a defined contribution (DC) scheme and discusses several current challenges after reform, including provision of pension income for the low-skilled employees and integration of public pension system between the East Germany and West. Bolin finds that installing a forth pillar might not be suitable for Germany. Moore (2011) depicts a general picture about the U.S. retirement income security system, and found that employment-based benefits and individual savings make the system different from others, which has led to the shift to 401(k) plans.

While Germany and U.S. represent a more traditional pension system that wildly applied in many other countries, pension system in the U.K is a typical example of universal programs. Jessoula and Hinrichs (2012) illustrate that this 'liberal' multi-pillar pension system was faced

with long-term problems, such as uneven protect across social groups and budgetary tension to provide adequate resources for the elderly.

Singapore and Chile are two representative cases of the third major type, compulsory savings programs. Chile pioneered a social pension system in Latin America. Mesa (2006) summarizes the reform from the public system to a private system, and evaluates its economic and social effects of the Chile and other Latin American countries by comparing twelve indicators, concluding that the structural reform led to an increase in fiscal costs, an eliminated employer's contributions and a declined labor-force coverage. Yu et al. (2018) analyzes the different contribution from government, market and individual to enhance the redistribution function of Central Provident Fund System (CPF), indicating that Singapore has succeeded in plugging the concept of "One more and pluralism" into multi-pronged pension system to cover people from different occupational and social groups.

While there is a considerable number of papers that conduct specific researches on pension system in one country, there are also many papers carrying out comparative study, giving another way to elaborate this topic. Bridgen and Meyer (2008) examines the relationship between pension regimes and retirement incomes of six countries. Through Rawlsian justice approach to test the redistributive potential of five multi-pillar pension systems of five European countries, Bridgen and Meyer (2009) conclude that the Dutch and Swiss pension systems outperform those of the U.K. and Germany since the basis on first pillar provides strong protection for most of people.

2.1.2 Evolution of China's pension system

In both domestic and foreign studies, many scholars discuss the development of China's pension system since it established, and evaluates the effects of reform in 1998. Zhao and Xu

(2002) analyzes the reform in earlier stage from enterprise-based PAYGO system to a system within each province. However, the transition can neither overcome the imbalanced budget and rapid aging. Cai and Cheng (2014) affirm the transition to a province-based system and analyze the reform from the perspective of the demographic structure and economic transformation. They point out that the three-part urban pension system still faces challenges, such as fragmentation, limited coverage and budget deficit. Liu and Sun (2015) find that China has gradually shift to a universal non-contributory pension that eliminates the gap between urban and rural, non-employed and employed. The pension arrangement has become less stratified, and the stratification has been flattened. The pension system, however, still has low benefit level and varies from region to region. Garnaut et al. (2018) integrates the discussions of China's 40 years of pension reform in aspects of political policy, market progress, SOE programs, and changes in fiscal and foreign exchange system.

2.2 Factors Affecting Replacement Rate

2.2.1 Replacement Rate

Replacement rate, an indicator to measure the living standards after retirement, is an integral factor used to evaluate the effectiveness of social welfare system. Generally, replacement rate measures the ratio of retirement income to average salary before retirement, but there are still variations in its definition. Biggs and Springstead (2008) explain different definition and calculation method of replacement rate when altering the definition of preretirement earnings. Yang (2009) uses OLG model to simulate possible outcomes that how the effects of the replacement rate on pension benefits. Aligetta et al. (2006) compare the consequences of three scenarios of replacement rate adjustment in INGENUE model with those drawn from similar models. On the other hand, Chybalski and Marcinkiewicz (2015) point

forward that replacement rate might not be a perfect indicator of pension adequacy and financial sustainability. Thus, they put forward a new synthetic alternative indicator called SPAI1-3, which can be applied in cross-country analyses.

2.2.2 Retirement Age

Retirement age is a very important element in the design of pension system. In particular, under the background of the sustainable development of pension systems in various countries, domestic and foreign scholars have conducted in-depth studies on retirement age. Wang et al. (2004) use baseline calibration to anticipate the economic and demographic trends over the next 50 years. Then, they combine CGE model and population growth model into a dynamic framework to test the sustainability of pension schemes by raising the retirement age. Yuan (2013) constructs a pension calculation model and calculates the replacement rate under different retirement age, finding that delaying retirement increases the income in both basic pension account and individual account. Giménez and Saavedra (2009) use a multiperiod OLG model to test the effect of delaying statutory retirement age, finding that this action can solve the sustainability problems in Spanish pension system.

2.2.3 Contribution Base

Li (2013) explores the relationship between contribution base and replacement rates. Contribution base has direct effect on basic pension and individual account pension level. However, a significant proportion of people cannot meet the requirement of making 100% of average salary contribution. Zhao and Mi (2019) apply sensitive analysis to test combined parameters, including contribution base, and find out the relationship between those parameters and the sustainability of pension system.

2.2.4 Notional Interest Rate

A large number of articles indicates the significant effect of individual account income on replacement rate. Li and Wang (2009) utilize actuarial model to quantify how replacement rate varies in different groups at different individual account return under different given salary growth rates. In the individual account, replacement rate has a positive relationship with return of individual account. Male employees generally have higher replacement rate than female employees at a same return level. Li (2013) also calculates the replacement rate to test the effectiveness of pension schemes, finding that the relative low return of individual account partially contributes to the current low replacement rate. Li suggests that if we can control the return to be the same as or higher than salary growth rate, it can enhance the present value and ensure the effectiveness of welfare system.

2.3 Effects of Cost of Living

Most previous discussions and models have not factored in price changes, but with the increasing level of cost of living, more and more researches begin to adjust their models. OECD (2009) claims that most countries legislated but often ignored the commitment to indexation of pension payment. It shows that indexation to price inflation, rather than to wage inflation, is more common and less costly, rendering a larger initial pension. Using empirical evidences, it evaluates how countries have adjusted the pension in reality adopting different indexation policies. Bikker and Vlaar (2007) exploit ALM model to test the relationship between Financieel Toestings Kader (FTK) requirements, a new appraisal framework, to a pension fund with conditional indexation. Whiteford and Whitehouse (2006) contend that the shift to indexation to price inflation protects the purchasing power of pension, but is unfavorable for long-term

political sustainability. Xu (2010) constructs an adjusted model of pension replacement rate by adding inflation rate as a variable. The adjusted model is also useful to study on the long-term balance of pension payment.

2.4 Measures to Improve China's Pension System

Scholars have come up with various approaches to solve the existing problems. Feldstein and Liebman (2006) recommend that actions must be taken to expand the coverage, reduce the payroll tax rates and increase collections of payroll contributions. Wang, Béland and Zhang (2014) calculates the fiscal burden coefficients of pensions. Based on those findings, they suggest policymakers consider figure out new ways of pension financing, improve the fund investment yield and increase the statutory retirement age. Kitao (2014) compares the effectiveness of four options to improve the sustainability of pension system: raising payroll tax, reducing replacement rate, delaying retirement age and means testing the benefits. All of these options fulfill the target to balance pension budget, but they have distinct consequences on economy and social welfare. Williamson et al. (2012) use China, Korea and Singapore, which have different pension schemes, to explore the potential utility of notional defined contribution (NDC) approach compared with other four alternatives models. They find that an introduction of an NDC pillar as an alternative of to the individual accounts can increase future contributions to the individual account and therefore benefit China pension system.

3. METHODOLOGY AND DATA

In this section, the dataset and sample for analysis are discussed. Firstly, I introduce the selected variables and elaborate the reasons why I choose these variables. Meanwhile, I define the source of the data, which is based on the disclosed information or statistics from authoritative institution and platform. Also, I explain the size of the sample and the rationale of sample periods. After the discussion of data, I introduce the methodology used in this thesis and discuss the reason why I use it or the realistic significance. Then, I offer detailed rationale and steps to illustrate the construction of the models and set specific hypotheses and assumptions to limit the models.

3.1 Dataset

According to the literature review and calculation method of pension income, the basic pension income varies based on the number of contribution years. A different retirement age also has a different government-determined annuity factor when calculating the pension of individual account. In existing empirical researches, many researchers have discussed the pivotal role that retirement age plays, and have encouraged workers to delay retirement in order to get more retirement benefit. Thus, I introduce retirement age as an independent variable to see its impact on replacement rate and pension income.

The pension income varies from worker to worker, since people make different accumulated monthly contributions to the account, which are indexed to different citywide monthly average wages. Workers divides their monthly contribution by the previous year's average monthly wages to get an index of each year. An average contribution index is calculated by summing up all indices and dividing it by number of payments, and it is mandated to be between an upper level of 3.0 and a lower level of 0.6. Hence, average contribution index is also

introduced as an independent variable to see whether accumulating more contributions into retirement account will result in a higher retirement income.

Since the basic pension fund needs to be paid monthly or even daily, the basic pension fund must have a part of the bank deposit. One-year deposit rate is used as the notional interest rate of individual account, so it is deemed that the bank deposit interest rate has a certain impact on the pension replacement rate. The notional interest rate is introduced as an independent variable representing the benefits in retirement income of individual account.

Faced with the rise in overall price level and relative depreciation of currency, pension income is under the pressure of inflation, leading to a decrease in the purchasing power of basic pension funds, so I introduce inflation rate as a variable to take price level into consideration.

The basic pension also has regional discrepancies since, under different pace of economic development, each city has a different level of average monthly wage under local employment status, the average wage has some impacts on pension replacement rate. Thus, real wage growth rate is introduced.

As for the source of data, each city has a local Municipal Human Resources and Social Security Bureau, a platform that discloses information related with the local social security affairs and manages the development of human resources, so replacement rate and average monthly wages can be obtained through each local platform. Other economic data, such as one-year deposit rate and inflation rate, are accessible from the China Statistical Yearbook compiled by National Bureau of Statistics.

3.2 Sample

As for economic factors, such as replacement rate, inflation rate and notional interest rate, since the government formally announced the establishment of a unified pension fund system

that combines social pooling account and individual account in 1997, I take the historical data from 1998 to 2017 so that the calculation methods of pension is consistent during this sample period.

I select four cities, Beijing, Shanghai, Guangzhou and Chengdu, to represent northern, eastern, southern and western regions in China respectively. I get the average monthly wage of China in recent 20 years from 1998 to 2017, and derive the real wage growth rate by calculating the percentage increase and deducting inflation rate to see how wages change in national level. Also, I obtain the average monthly wage of each city so that I can analyze the regional differences in pension incomes.

3.3 Methodology

Firstly, I construct the quantitative model to calculate replacement rate. Then, I select three variables from the expression to construct scenario analysis for each variable. By changing the number and assumptions for each variable and controlling other two variables at the same time, the results of replacement rate will be different. After obtaining the results, I will analyze how the change in variables affects the growth of replacement rate, and whether the growth is steady or exponential. Through this analysis, workers can get a more comprehensive understanding of the mechanism behind the system, and arrange a better retirement plan for themselves.

Secondly, I select three economic variables, including inflation rate, notional interest rate and real wage growth rate, to construct a multiple regression model, which helps me to figure out which economic variables have a more significant impact on the replacement rate. These three variables are national-wide, namely, does not contain differences from individual to individual. Thus, the comparison of the effects of these variables is of practical significance.

3.4 Model and Hypotheses

3.4.1 Scenario Analysis

According to the provisions of the pension calculation method issued in 2005, basic pension is consists of two parts. One is from social pooling account, while another one is from individual account. Based on a limit of a minimum 15 years of contribution, the pension will be paid after reaching the retirement age. The basic pension pays 1% of the average of the indexed individual contribution and the citywide average wages for each year of coverage. As for the individual account, employees pay 8% of wages to the account, and the accumulated fund is converted into a stream of pension payment after retirement by dividing the amount by a government-determined annuity factor, which is depend on the average life expectancy at the time of retirement, notional interest and employee's retirement age.

Basic Pension = 1% × (Average monthly wage for one year before the insurance + Retire worker's indexed monthly contribution) ÷2 × Number of contribution years

Individual Account Pension = 12 × 8% × Accumulated contributions ÷ annuity factor

In order to derive formula to illustrate the calculation of pension, I assign symbols to represent each parameter. Assume a worker contributes N years constantly. $C_{t-1}, C_{t-2}, \dots, C_{t-N}$ denote the insured worker's monthly individual contribution 1 year, 2 year, …, N years before retirement, and $W_{t-1}, W_{t-2}, \dots, W_{t-N}$ denote retire worker's average monthly wage 1 year, 2 year, …, N years before retirement, thus the average contribution index c is equal to:

$$c = \frac{\frac{C_{t-1}}{W_{t-1}} + \frac{C_{t-2}}{W_{t-2}} + \cdots + \frac{C_{t-N}}{W_{t-N}}}{N}$$

Assume W_0 denotes average monthly wage of the previous year before enrolling to be insured and g denotes real wage growth rate. If P_b denotes the basic pension, the formula is:

$$P_b = \frac{1\%}{2} \times (W_0 \times (1+g)^N + c \times W_0 \times (1+g)^N) \times N$$

$$= \frac{1\%}{2} \times N \times (1+c) \times W_0 \times (1+g)^N$$

As for the calculation of individual account pension, r denotes one-year notional interest rate; i denotes inflation rate. Assume r denotes the notional interest rate and r is not equal to real wage growth rate g, so the accumulated contribution F in the individual account until retirement will be:

$$F = c \times W_0 \times [(1+r)^N + (1+g)(1+r)^{N-1} + \ldots + (1+g)^{N-1}(1+r)^1]$$

$$= c \times W_0 \times (1+g) \times \frac{(1+g)^N - (1+r)^N}{(g-r) \times (1+g)^N} \qquad (r \neq g)$$

To simplify the expression, assume G denotes 1+g and R denotes 1+r, so M denotes $\frac{R}{G}$. If P_i denotes the individual account pension and k denotes the annuity factor, the formula will be:

$$P_i = \frac{12 \times 8\%}{k} \times F \times (1+g)^N$$

$$= \frac{12 \times 8\%}{k} \times c \times W_0 \times (1+g)^N \times \frac{1-M^N}{1-M} \qquad (r \neq g)$$

$$= \frac{12 \times 8\%}{k} \times c \times W_0 \times (1+g)^N \times N \qquad (r = g)$$

Now, if we combine the formula of basic pension and individual account pension, we can derive the formula of total pension payment P:

$$P = \frac{1\%}{2} \times N \times (1+c) \times W_0 \times (1+g)^N + \frac{12 \times 8\%}{k} \times c \times W_0 \times (1+g)^N \times \frac{1-M^N}{1-M} \quad (r \neq g)$$

$$= \frac{1\%}{2} \times N \times (1+c) \times W_0 \times (1+g)^N + \frac{12 \times 8\%}{k} \times c \times W_0 \times (1+g)^N \times N \quad (r = g)$$

According to the definition of replacement rate, it is a ratio of monthly pensions to average monthly wages of individual employee, which reflects the discrepancy of worker's living standard

before and after the retirement. If R denotes the replacement rate, the calculation model can finally be constructed by dividing $W_0 \times (1+g)^N$ as follows:

$$\mathrm{R} = \frac{1\%}{2} \times \mathrm{N} \times (1+\mathrm{c}) + \frac{12\times 8\%}{k} \times \mathrm{c} \times \frac{1-M^N}{1-M} \quad (\mathrm{r} \neq g)$$

$$= \frac{1\%}{2} \times \mathrm{N} \times (1+\mathrm{c}) + \frac{12\times 8\%}{k} \times \mathrm{c} \times \mathrm{N} \quad (\mathrm{r} = g)$$

The annuity factor k is listed in Table 1 as follows:

Retirement Age (A)	55	56	57	58	59	60	61	62	63	64	65
Annuity Factor (k)	170	164	158	152	145	139	132	125	117	109	101

Table 1 – Government-Determined Annuity Factors

From the expression of replacement rate, we can easily find that number of contribution years, retirement age, average contribution index and notional interest rate all have direct impacts on replacement rate. Now, I construct three scenario analysis to figure out each variable's impacts on the replacement rate.

Firstly, I focus on how does retirement age affect replacement rate based on an assumption under which the average contribution index is equal to 1 and m is 93.05%. To the calculate the value of m, I use actual data of both real wage growth rate and notional interest rate in last twenty years to obtain an average value, so these two rates reflects real situation.

Secondly, I regard average contribution index as variable to see its impact on replacement rate. Average contribution index has a mandated range from 0.6 to 3.0, thus 0.6, 1.0, 1.5, 2.0, 2.5, and 3.0 are chose to conduct the analysis. In the second analysis, I specify the scenario in which workers retire at age of 60, so 139 is used as the annuity factor.

Finally, under an assumption that workers retire at age of 60 and have an average contribution index of 1, the relationship between notional interest rate and real wage growth rate and its impact on replacement rate are discussed under this scenario.

3.4.2 Multiple Regression Model

Now, I'm going to construct a multiple regression model that assumes replacement rate as independent variable Y. Suppose inflation rate, one-year notional interest rate, and real wage growth rate as dependent variables X1, X2, X3 respectively. Then, the model is as follows:

$$\mathrm{Y} = \beta_0 + \beta_1 X1 + \beta_2 X2 + \beta_3 X3 + \varepsilon_1 + \varepsilon_2 + \varepsilon_3$$

The null hypotheses for this multiple regression model are as follows:

H_0: Inflation rate has no significant impact on replacement rate.

H_0: Notional interest rate has no significant impact on replacement rate.

H_0: Real wage growth rate has no significant impact on replacement rate.

4. ANALYSIS AND FINDINGS

In this section, I provide detailed interpretation of the results of the scenario analysis model and multiple regression model. For the discussion of scenario analysis, I illustrate the effects of different factors on pension replacement rate. For the discussion of multiple regression model, I test three hypotheses regarding whether the economic variables have significant impact on replacement rate, and compare which variables have the most impact.

4.1 The Effect of Retirement Age on Replacement Rate

Replacement Rate under Different Retirement Ages								
Assumptions	**Retirement Age (A)**	**Number of Contribution Years (N)**						
r=3.22%		**15**	**20**	**25**	**30**	**35**	**40**	**AVG**
g=10.93%	**55, k=170**	20.37%	26.20%	31.78%	37.19%	42.47%	47.67%	**34.28%**
m=93.05%	**60, k=139**	21.56%	27.59%	33.30%	38.79%	44.14%	49.38%	**35.79%**
c=1	**65, k=101**	24.03%	30.44%	36.42%	42.10%	47.58%	52.91%	**38.91%**

Table 2 – Replacement Rates under Different Retirement Ages

From the results in Table 2, I find that delaying retirement age has a relatively significantly positive impact on replacement rate. For example, people retiring at 55 years old have an average replacement rate of 34.28%, while people retiring at 65 years old have an average replacement rate of 38.91%, 4.63% higher than the previous one. In addition, delaying retirement rate can accelerate the growth of increase. From retirement age of 55 to 60, the average replacement rate increases 1.51%. However, from retirement age of 60 to 65, the average replacement rate increases 3.12%.

On the one hand, the increase in retirement age enhances number of contribution years. For those who retire at the same age, the earlier they start contributing to the account, the higher income they obtain after retirement. Meanwhile, delaying retirement age can also reduce the annuity factor. Thus, both changes results in an increase in replacement rate. This situation illustrates that the government intentionally render incentives for people to start contributing as early as possible and appropriately delay the retirement to obtain higher benefits.

4.2 The Effect of Average Contribution Index on Replacement Rate

Replacement Rate under Different Average Contribution Indices								
Assumptions	**Number of Contribution Years (N)**	**Average Contribution Index (c)**						
A=60 k=139 m=93.05%		**0.6**	**1.0**	**1.5**	**2.0**	**2.5**	**3.0**	**AVG**
	15	15.94%	21.56%	28.60%	35.63%	42.66%	49.69%	**32.35%**
	20	20.55%	27.59%	36.38%	45.17%	53.96%	62.76%	**41.07%**
	25	24.98%	33.30%	43.70%	54.09%	64.49%	74.89%	**49.24%**
	30	29.28%	38.79%	50.69%	62.59%	74.48%	86.38%	**57.04%**
	35	33.48%	44.14%	57.46%	70.78%	84.10%	97.42%	**64.56%**
	40	37.63%	49.38%	64.07%	78.76%	93.45%	108.14%	**71.91%**
	AVG	**26.98%**	**35.79%**	**46.82%**	**57.84%**	**68.86%**	**79.88%**	

Table 3 - Replacement Rates under Different Average Contribution Indices

From the results in Table 3 of replacement rate under different average contribution index, average contribution index also has a positive relationship with replacement rate. Higher

average contribution index leads to a higher replacement rate. For example, if people have all contributed to their accounts for 15 years, people with an average contribution index of 3.0 have a replacement rate of 49.69%, which is 33.75% higher than that of people with an average contribution index of 0.6. The highest replacement rate occurs when people make 40-year long contributions and have an average contribution index reaching the upper level 3.0, in which case people can have a replacement rate of 108.41%, meaning that they can maintain a same income level as that before retirement.

4.3 The Effect of Notional Interest Rate on Replacement Rate

Replacement Rates under Different Notional Interest Rates								
Assumptions	**Real Wage growth rate (g)**	**Notional Interest Rate (r)**						
A=60 N=35 k=139 c=1		**2.50%**	**5.00%**	**7.50%**	**10.00%**	**12.50%**	**15.00%**	**AVG**
	5.00%	51.53%	35.69%	72.09%	94.39%	133.50%	202.83%	**98.34%**
	10.00%	44.27%	47.21%	51.80%	35.69%	71.34%	91.81%	**57.02%**
	15.00%	41.24%	42.61%	44.59%	47.53%	52.05%	35.69%	**43.95%**

Table 4 - Replacement Rates under Different Notional Interest Rates

According to the Table 4, the effect of notional interest rate interact with the effect of real wage growth rate, and the relation of these two rates has an ultimate impact on replacement rate. Firstly, according to the formula of replacement rate when real wage growth rate is equal to the notional interest rate, only number of contribution years and average contribution index have an impact on replacement rate. In this case, average contribution index and number of contribution years are considered as control variables and are fixed, so the replacement rates are the same, about 35.69%, when both real wage growth rate and notional interest rate equal to 5.00%, 10.00% and 15.00%.

Secondly, when real wage growth rate is higher than notional interest rate, the speed of growth is much faster than that of growth when real wage growth is lower than notional interest

rate. For example, if real wage growth rate is 5.00%, the replacement rate increases by 39.11% when notional interest rate rises from 10.00% to 12.50%. However, if real wage growth rate is 15.00%, the replacement rate increases by 4.52% when notional interest rate rises from 10.00% to 12.50%. This discovery is consistent with the findings of Li and Wang (2009) that when the notional interest rate is larger than real wage growth rate, replacement rate increases exponentially. When it comes to the opposite situation, replacement rate increases logarithmically.

4.4 Results of Multiple Regression Model

	Coefficients	t Stat	P-value
Intercept	0.351527295	3.014042412	0.008234637
X Variable 1	-2.051468797	-2.12262602	0.049739986
X Variable 2	1.205879642	0.991952889	0.335985926
X Variable 3	1.717795897	2.253549989	0.03860491

Table 5 – Results of Multiple Regression

Based on the data calculated in the Table 5, the regression model is fulfilled as below.

$$Y = O.3515 - 2.0515X1 + 1.2059X2 + 1.7178X3$$

In the equation, the constant is 0.3515, which means that with explanatory variables staying at zero, the average of dependent variable Y is 0.3515. The sign of the correlation coefficients shows the tendency of explanatory variables with dependent variable.

For inflation rate (X1), the mark is negative, which means inflation rate has an inverse relationship with replacement rate (Y). The correlation coefficient indicates that if inflation rate increases each additional 1 point, replacement rate will decrease 2.0515 points. The value of correlation coefficient for notional interest rate (X2) is positive, indicating that notional interest rate has a positive relationship with replacement rate (Y). Each time when notional interest rate increases 1 point, replacement rate increases 1.2059 points. Similar to notional interest rate, real

wage growth rate (X3) has a positive correlation coefficient, representing that it has a positive relationship with replacement rate (Y). When real wage growth rate increases every addition of 1 point, replacement rate increases 1.7178 points.

By comparing absolute value of each correlation coefficient, I find that inflation rate has the most significant impact, though negatively, on the replacement rate among the three factors, while notional growth rate has the least significant impact.

Now I conduct a t-test under a significant level of 0.5, and then interpret the results. Firstly, as for the inflation rate, since p-value (0.0497) is lower than significant level α (0.05), Ho is rejected, meaning that inflation rate has a significant impact on replacement rate. Then, as for notional interest rate, since p-value (0.3360) is higher than the significant level α (0.05), Ho is not rejected, which indicates that notional interest rate has no significant impact on replacement rate. Finally, as for real wage growth rate, since p-value (0.0386) is lower than significant level α (0.05), Ho is rejected, meaning that real wage growth rate has a significant impact on replacement rate.

From the test, both inflation rate and real wage growth rate have a significant impact on the replacement rate, while notional interest rate does not. By comparing the absolute value of the coefficients, inflation rate has the largest value, indicating that it has the most significant impact on the replacement rate among these three economic factors. To be more specific, inflation rate has a negative impact on the dependent variable, while real wage growth rate has a positive one.

The results of the multiple regression model renders several implications. Inflation rate has the most significant impact on replacement rate, and they are negatively related. Thus, the government may put more focus on the role of fiscal and monetary policy to control the inflation rate, which at least partially prompt the improvement of social welfare. Moreover, since notional

interest rate does not have a significant impact on replacement rate, people can choose to do investments more freely using other financial tools other than bank deposits.

4.5 Analysis of Cost of Living

	Cost of Living Analysis in Four Cities			
	Beijing	**Shanghai**	**Guangzhou**	**Chengdu**
Cost of Living Index in 2019	44.89	49.28	40.92	40.01
Relative Level with National Average	10.73%	21.56%	0.94%	-1.31%
Average Monthly Wage in 2017	8467	7132	8127	5425
Estimated Monthly Wage in 2019	10419	8776	10001	6676
Net Monthly Wage in 2019	9301	6884	9907	6763

Table 6 – Cost of Living Analysis in Four Cities

Now, I take a new factor, cost of living index, into consideration in this analysis to specify the scenarios in reality and the results are shown in Table 6. Beijing, Shanghai, Guangzhou and Chengdu are the four sample cities to represent north, east, south and west regions respectively, since they are the most developed cities among the regions. According to the statistics from Numbeo database, the national average cost of living index of China in 2019 is 40.54. Compared with the average amount, I calculate the relative level for each of the four cites. For example, the price level in Beijing is 10.73% higher than the national average level. Then, average monthly wage in 2017 of four cities and the average real wage growth rate in last twenty years, which is 10.93%, are applied to estimate monthly wage in 2019. The data of average monthly wage and real wage growth rate are shown in Appendix A and B. At last, adjusting the wage by considering cost of living, the net monthly wages of four cities in 2019 are derived as above.

From Table 6, the highest net monthly wage occurs in Guangzhou, indicating that Guangzhou is the city in which the purchasing power of income is the strongest among these four cites. In Guangzhou, the average monthly wage is the second highest, while its cost of living level is just around the national average level. Beijing is the city with the highest average monthly

wage among these four cites, but since its price is about 10% more expensive than the average, the net monthly wage only ranks the second place.

The rest two cities, however, have about the same net monthly wage after considering cost of living, though the difference between estimated monthly wage is every large. Shanghai is the most expensive city in China, where the price level is about 21% higher than the average, while that of Chengdu is a little bit lower than the average level.

These practical results provide a general idea for workers that cost of living play an important role in affecting the purchasing power of monthly income. Being aware of this idea can help workers to be wiser when choosing their future working places, and thus make a better career plan and retirement plan.

4.6 Implications for Improvement of China's Pension System

From the results, although both average contribution index and number of contribution year have a positive relationship with replacement rate, delaying retirement age to contribute more years has a more significant impact. Thus, this conclusion could be applied when the government attempts to encourage employees to start deposits as early as possible and to make contributions constantly to enhance their replacement rate. In addition, crucial economic factors should also be considered, such as inflation rate and real wage growth rate. Thus, based on those analysis results, several measures provided to improve China's Pension System are as follows.

4.6.1 Raise the Retirement Age

Currently in China, the statutory retirement age is 60 for male employee and 55 for female employee, a standard that was set in 1950s. However, nowadays, there has been a big increase in average living expectancy and China's population is continuing aging, so the situations cannot

be comparable anymore. Especially for female employees, they have a relative lower number of contribution years but a relative longer period of receiving payments, so their replacement rate is usually lower than that of male employees'. At the same time, low retirement age brings huge pressure for the government to keep the balance of payment. Just as Wang et al. (2004) and Yuan (2013) have studied, raising the retirement age could efficiently release the pressure of keeping balance of payment and enhancing the replacement rate.

4.6.2 Ease Inflationary Pressure

Since the inflation rate, or the cost of living, can directly affect the purchasing power of people's income, the government should also take full advantage of fiscal policy and monetary police, linking the results of economic development with the living standard of residuals. The government should be a more comprehensive pension system which has a larger coverage among urban and rural areas. It can also outlaw regulations to subsidize or compensate some poor and rural households in aspect of employment, housing and education, thus these people could have a basic guarantee for living standard to prevent themselves from inflation.

4.6.3 Diversify Pension Investments

Bank saving is the safest investment, but it only offer low returns. If people expect an appreciation in their pension funds, they can choose other financial products to diversify its own portfolio of the pension funds. Yu et al. (2018) provides an adequate explanation of Singapore's Central Provident Fund System (CPF), which plugging a concept of "One more and pluralism" into multi-pronged pension system. The pension funds could be arranged and operated by financial institutions who are eligible for managing investment funds and approved by the government,

thus the market for pension insurance could become larger, enhancing replacement rate and easing the government deficits pressure.

5. CONCLUSION

In this thesis, I firstly discussed the evolution of China's pension system. Since China underwent a transformation to a market-orientated economy and increasingly intense population aging, China adopt a series of reform measures to establish a universal basic pension system since 1997. Then, I reviewed both domestic and foreign related literatures. Some foreign studies discuss the issue under foreign pension systems, which are not applicable for China. Meanwhile, some domestic studies use data long time from now, which are not able to reflect the recent trend of the development of pension system. Thus, this thesis is helpful to update the latest data for studying replacement rate and its factors under the Chinese system, the results of which is of practical meaning for workers to prepare a better retirement planning and for the government to provide a better social welfare program.

I have obtained my data from National Statistics Bureau and local Social Security Bureau. To ensure the calculation method of replacement rate keep consistent to reflect the effectiveness of the current basic old-age insurance system for enterprises employees (BOAISEE), the sample period is from the year of establishment to the latest year, namely 1998 to 2017. Through the construction of scenario analysis model, replacement rates under different scenarios and assumptions are examined and analyzed. Both retirement age and average contribution index have a positive effect on raising replacement rate. Nevertheless, in reality, since it hardens financial burden, increasing the average contribution index is a more difficult way for employees' pension income, while delaying retirement is a more effective way. The effect of notional interest rate on the replacement rate depends on its relative relationship to the real wage growth rate.

From the results, it has a more significant impact when notional interest rate is larger than real wage growth rate. Secondly, through the multiple regression model among three economic factors, inflation rate has the most significant impact on replacement rare, and they are negatively correlated, while notional interest rate has no significant impact on the outcome. Real wage growth rate has a positive impact on the replacement rate. By adding cost of living into consideration to specify the model in reality, among the four cities representing four regions in China, Guangzhou is the city that has the highest purchasing power of income, since it has the second highest monthly average wage, but a relative low cost of living index that near the national average level. Based on the results, I put forward three recommendations for improving China's pension system, including raising statutory retirement age, easing inflationary pressure and diversifying pension investments.

The findings, however, still have some limitations. Firstly, the data for calculation is only available for twenty years, which is not very enough to make the model representative. In the future, if I am able to have access to the accurate statistics regarding the local average retirement income for the four cities, I will have more observations to carry out more specific analysis of replacement rate. Also, the assumptions in the model are that the notional interest rate and real wage growth rate are both obtained by calculating the average amount for the past twelve years. However, in the past twenty years, China has underwent a huge transformation in the economic system, so the average rate may not represent the latest economic status very well.

In the future studies, I might try to specify the analysis into the two separate account. Through the derived formula, social pooling account and individual account have distinct expressions, indicating that these two account have different sensitivity towards a same variable. Also, comparing the effectiveness of these two accounts in raising the replacement rate is worth further exploring.

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APPENDICES

Appendix A

Year	Average Monthly Wage			
	Beijing	Shanghai	Guangzhou	Chengdu
2017	8467	7132	8127	5425
2016	7706	6504	7425	5111
2015	7087	5939	6764	4790
2014	6463	5451	6187	4307
2013	5793	5036	5808	3970
2012	5223	4692	5313	3185
2011	4672	4331	4789	2833
2010	4201	3896	4541	2543
2009	4037	3566	4101	2273
2008	3726	3292	3780	2058
2007	3322	2892	3349	1828
2006	3008	2464	3027	1608
2005	2734	2235	2820	1440
2004	2362	2033	2585	1220
2003	2004	1847	2353	965
2002	1727	1623	2092	917
2001	1508	1480	1845	837
2000	1311	1285	1581	744
1999	1148	1179	1350	674
1998	1024	1005	1194	618

Appendix B

Year	Real Wage Growth Rate			
	Beijing	**Shanghai**	**Guangzhou**	**Chengdu**
2017	9.86%	9.66%	9.45%	6.14%
2016	8.75%	9.51%	9.77%	6.70%
2015	9.64%	8.95%	9.33%	11.22%
2014	11.56%	8.24%	6.53%	8.48%
2013	10.92%	7.33%	9.32%	24.65%
2012	11.80%	8.34%	10.94%	12.41%
2011	11.20%	11.17%	5.46%	11.40%
2010	4.07%	9.25%	10.73%	11.88%
2009	8.34%	8.32%	8.49%	10.49%
2008	12.16%	13.83%	12.87%	12.53%
2007	10.44%	17.37%	10.64%	13.73%
2006	10.02%	10.25%	7.34%	11.66%
2005	15.73%	9.94%	9.09%	18.04%
2004	17.90%	10.07%	9.86%	26.36%
2003	16.00%	13.80%	12.48%	5.26%
2002	14.57%	9.66%	13.39%	9.60%
2001	15.05%	15.18%	16.70%	12.50%
2000	14.14%	8.99%	17.11%	10.40%
1999	12.15%	17.31%	13.07%	8.95%
AVG	11.81%	10.90%	10.66%	12.23%

Appendix C

Dataset of Multiple Regression Model		
Inflation rate	**Notional interest rate**	**Real wgae growth rate**
X1	**X2**	**X3**
7.50%	8.31%	2.83%
3.00%	8.31%	6.10%
1.40%	2.75%	8.85%
1.50%	2.50%	7.99%
3.20%	3.00%	6.88%
2.60%	3.00%	9.51%
5.40%	3.25%	8.88%
3.30%	2.50%	10.17%
-0.70%	2.25%	12.70%
5.90%	3.06%	11.33%
4.80%	3.47%	13.92%
1.50%	2.52%	12.86%
1.80%	2.07%	12.80%
3.90%	2.07%	10.23%
1.20%	1.98%	11.83%
-0.80%	1.98%	15.08%
0.70%	2.25%	15.30%
0.40%	2.25%	11.88%
-1.40%	2.25%	12.99%
-0.80%	4.59%	16.40%