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### **VALUING THE CHINESE REIMBURSEMENT SYSTEM OF THE RETIREMENT PENSION INSURANCE FOR URBAN EMPLOYEES<sup>†</sup>**

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#### **Abstract**

This study investigates the funding and implementation of China's reformed pension system, particularly the impact of population aging on the system and the government's recessive debt on pensions. We performed a literature review of relevant publications on the pension system in China as well as similar systems abroad. We also performed an in-depth analysis of the pension insurance fund in China's Zhejiang province, based on available data from 2001 through 2014. Using a time series ARIMA forecasting model and a comprehensive prediction model, in conjunction with theories from economics, statistics and sociology, we tried to establish the implicit pension debt (IPD) for Zhejiang and determine the pension payment feasibility for the next 15 years. We use our findings to explain the current problems with the pension system in Zhejiang and offer suggestions for improvement.

**Keywords:** Retirement Pension Insurance, Recessive Debt, Payment

**JEL Classification:** P36, O53, C41, E61, H75, I38

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#### **1. Introduction**

Recessive debts are those that a government takes on responsibility for due to public expectations or political pressure, even when the debts are not bound by laws or government contracts (Guo, 2000). In economics, this is so-called recessive debt from government to workers. The government's main recessive debts are social security funds and pensions. This literature review investigates the Chinese government's recessive debts of pension. Recessive debts of pension have arisen through the process of switching from the pension contribution and payment system to the social security fund system, where the government promises to pay for workers' retirement funds if they are inadequately accumulated.

Nowadays, China's social security fund system is implemented according to the National Council's law "On the Decision to Improve the Basic Pension Insurance System for Company Workers", henceforth simplified as "Decision" going forward). According to the State Council's "On the Decision to Build a Unified Basic Pension Insurance System for Company Workers", anyone who started to work and paid for their pension within 15 years of the implementation of "National Issue [1997] No. 26" would be able to get the basic monthly pension after retirement. The basic pension consists of the fundamental pension and the individual pension account. From this point of view, China's pension system is based on the individual pension account combined with a partial fund accumulated from the fundamental pension (The State Council, 2005). For those who are 'new' to the system after the implementation of the Decision and have their own individual pension accounts, their retirement funds can be directly withdrawn based on new system calculation, without consideration of other factors. The problem is, the "old people" and "middle people" who started to retire or work, respectively, before the Decision, and those who have not paid into their individual pension account, will not get their pension. "Old people" means those who are 'old' than the active pension system but have their own individual accounts, and their retirement funds can be directly withdrawn based on old system calculation. "Middle people" means those who are 'middle' entry to the pension system, they have their own individual accounts for some years, their retirement funds can be directly withdrawn based on the system calculation. The historical reason for coordinating accounts and empty individual pension accounts is the "new people" (working after implementation of the "Decision") providing for the "old people," resulting in empty individual pension accounts which also accumulate. "New people" means those who are 'new' to the system after the implementation of the Decision and have their own individual pension accounts, their retirement funds can be directly withdrawn based on new system calculation. With the execution of the Decision, the government promised to provide pensions to all companies' employees. Working employees support retired "old people's" pensions, and in return, the government promises to pay for their pensions when they retire. These long-term promises become the government's recessive debts.

As of 2014, the retirement age is 60 for Chinese male residents, 55 for female officers, and 50 for female workers (Dunaway and Arora, 2007; Oksanen, 2010). However, the average life expectancy in China is 74.83, and it is gradually rising (Cai and Cheng, 2014). The "Healthy China 2020 Strategy Research Report" released in 2012 predicted that in 2020, the average life expectancy would be up to 77 years (Healthy China 2020 Strategical Research Report Editorial Board, 2012). The aging population caused the proportion of incumbents and retirees to fall from 10:1 in the 1990s to the current 3:1, resulting in a short period of pension contributions—but as the period of payment increases, so does the fund gap.

By the end of 2014, China's elderly population aged over 60 had reached 212 million, 15.5% of the total population. (Social Development and Reform Commission of Zhejiang Province, 2014) In Zhejiang province, the elderly population aged over 60 reached 9.4508 million, 19.44% of the total population (Qian, 2015). With Zhejiang's aging population exacerbated, the total working population remained the same. Zhejiang was one of the first provinces to establish a unified pension insurance system for urban and rural residents. By the end of 2013, the province's total number of insured residents reached 13.56 million, an insured rate of 95% or more; of these, 5.77 million were pensioners.

Due to the increase in the elderly population and flaws in the management of the current urban pension system fund, the system is now faced with the problem of the funding gap—the social pooling of funds is insufficient to pay for retired workers' pensions. In the absence of other funding sources, there will be misappropriation of individual account funds to fill the vacancies, and there are many hidden losses. By the end of 2014, China's recessive debt of pension was up to 50% of GDP, which created high pressure; in the future, having sufficient solvency will be vital. As the first province in the country to establish an urban and rural pension system, Zhejiang can provide a valuable reference for all other regions.

Studying the issues that pension insurance reimbursement has created for China's social stability and economic development are significant in a few ways:

- The study of pension reimbursement feasibility is conducive to improving China's social security system, and thereby promoting social harmony. Pension issues affect the public's livelihood, social harmony, and economic stability and growth. Pensions are the main livelihood of retired workers. If the problem cannot be resolved as soon as possible, in the near future, as China's population ages, many retirees will not receive pension insurance, resulting in "old people, no support" and affecting the normal implementation of the pension system. Solving this problem in a timely manner and figuring out how to balance the relationship among "the old people, the middle, and the new" will ensure the normal operation of the social security system to guarantee the basic livelihood of the people, safeguard social stability, and further overall social harmony.

- The resolution of pension payment issues is relevant to the government policy of protecting retired workers for a "sense of security". At present, the economic and social pressures on young workers are growing. The cost of living is increasing. The vast majority of workers are able to pay pension insurance in advance for a "sense of security" in the future. While coverage of basic pension for urban employees has expanded as part of China's economic and social reforms, many unresolved issues remain. First, recessive debts' restructuring costs also constitute a pension system reform. If the compensation issues are not resolved, the restructuring of the pension system will not succeed—it will not be able to cope with the payment issues when the aging population is exacerbated, and a large number of transfers will affect social stability. To help figure out the optimal design for a pension system and implement long-term correct decisions in order to avoid social instability, aging research is undoubtedly proactive. With the improvement of people's living standards and rising wages, the government has a tendency to expand pensions. The fiscal burden of the government will therefore tend to increase—so the government needs to make the right decisions.

It is valuable to study the feasibility of pension reimbursement with Zhejiang as the research object, so that this province's pension system experience can provide reference for other administrative areas.

Zhejiang province is the first batch of pilot provinces for the pension system test. After years of practice, the province has accumulated some experience, but still faces problems related to future pension payments. This study will enable the Zhejiang provincial government to grasp the situation of the current pension security system, allowing them to develop a better way to guarantee paid pension benefits for retired workers and improve the pension system. The pension reimbursement system of Zhejiang province is used as a sample to provide other areas better reference and practical value, provide useful suggestions for government officers, and promote regional economic and social development.

## **2. Literature Review**

The reformation of the state pension provision system is becoming one of the pressing issues in many countries. Poteraj (2008) pointed out that reforming the pension system could be growing pension contributions or increasing retirement age in the European countries. Grech (2010) argued that the principle of reducing government spending through the reform of the majority of the pension system was carried out under limited sustainability.

According to Ionescu (2013), if in Europe, the share of the people who are older than 65 years reaches 25 percent, in subsequent 20-30 years, dependency rate will exceed 40 percent. In most of the countries, the replacement rate maintains very high, about 60-70 percent. In order to fix the mentioned problems dealing with the development of the pension system in the country, this scientist draws attention to developing private pension provision; mixed managing system of government and private system; decreasing payment of social protection systemically.

Vakhobov (2003) pointed out that pension fund is leading one among the social funds of the state. The market relations pave the way for the necessity to reform the pension systems in order to stimulate economic activeness of people. He also noted the significance of the development of the saving pension fund and the development of the fund's investment activities.

With an aging population in China, "Pay as you go" ("PAYG") systems appear deeply flawed. Combined with low levels of economic development, a large population, and a weak

economic foundation for basic national needs, this problem led the government to replace the former pension system with the social pooling and individual accounts hybrid system. However, compared with some developed countries, China's pension system started relatively late. While the pension system is not perfect, its flaws were exacerbated by the aging of the Chinese population early in its duration. It is a scenario where social and economic developments are incompatible—the country becomes old before getting rich. (Du and Yang 2014; Dunaway and Arora, 2007; Guo, 2000)

Since a nationwide pension system was established in China, various experts published papers about China's recessive debts, with major differences between them. In 1995, the World Bank took the actuarial approach to the size of the implicit pension recessive debt. Since the total payment of pensions in 1994 accounted for 2.3% of GDP, Chinese pension liabilities size was calculated to be between 2014.7 and 3022.1 billion Yuan (Healthy China 2020 Strategical Research Report Editorial Board, 2012). In 2004, Lu and Huang (2004) calculated China's pension recessive debt at the end of 1996 by using actuarial science and other basic principles. In 1996, Ho (2001) calculated the recessive debt using a frame algorithm. He found that enterprise "old people" of recessive debts were the product of the existing number of elderly, the average level of existing retirement, and the average expected remaining lifespan of the elderly. Using refined algorithms, he derived the recessive debts, which were the sum of "the old" PAYG, "the middle" transitional pension, "the middle" individual account compensation, and "the new" individual account compensation. After analyzing a few different methods of calculating recessive debt, it can be concluded that different methods will yield very different estimates (Ho, 2001; Lu and Huang, 2004). Overall, however, most scholars believe that China's recessive debts are huge (Ho, 2001; Lu and Huang, 2004).

Research on recessive debts can benefit from Western economic theory. For example, pension reform in Chile has involved compulsory contribution plans based on individual accounts. Under the Chilean model, the government fostered mutual promotion and increased the value of coordination between pension and capital market development. Argentina drew on the Chilean pension reform model uses compensatory pensions to compensate for pension reform recessive debt (Healthy China 2020 Strategical Research Report Editorial Board, 2012). The Argentinian government issued special bonds to solve the problem of transitional recessive debt, an approach worth learning more about. Also, Europe 2020 represents a strategic plan for European Union development until 2020, having as main objective raising the standard of living and the quality of life for European citizens by education and creation, and so on (Ion and Vespan, 2016).

There is no international unified pension system model. The organizational structures of pension systems in various countries are all different. Whether the social security system in question is mature or immature, pension recessive debt issues are worthy of our consideration. For the corresponding active private economy in China's Zhejiang province, we can use different methods to derive estimates of Zhejiang's recessive debt.

## 2.1. Retirement Plans

China's basic retirement plans use a combined model of social pooling and individual accounts. Basic pension systems cover all workers in urban enterprises; all urban enterprises and their employees are obligated to pay the basic pension. At present, the contribution rate of enterprises is about 20% of the total payroll, while the personal contribution rate is 8% of wages. Part of the companies' contribution to the basic pension establishes the overall fund; the rest goes to individual accounts. Individuals' contributions go to their individual accounts. The basic pension consists of the basic pension and individual pension accounts. The basic pension is paid by the social security pool fund; the monthly basic pension is equal to 20% of the worker's average wage. The monthly pension for an individual account is 1/120 the total amount accumulated in the individual account's fund. Pensions in individual accounts can be inherited. Those who worked before the implementation of the new system, and retired after the implementation, can get an additional transitional pension.

Since 2005, China has improved the basic pension for enterprise retirees for nine consecutive years. To ensure the timely and full payment of the basic pension, in recent years, the Chinese government has made efforts to improve the basic pension fund to the provincial coordination, increasing the financial input in the basic pension fund. In 2014, urban basic pension individual accounts accumulated to 4.0974 trillion Yuan; however, the China Pension Development Report 2015 (CASS Institute of World Social Security Research Center, 2015) pointed out that by the end of 2014, the urban basic pension fund accumulated balance reached 3.18 trillion Yuan, while the cumulative amount of individual accounts exceeded the accumulated fund balance by 917.4 billion Yuan. In other words, if all urban basic pension funds were used to fill the individual accounts, and there were still large deficits, the gap compared expanded by 233.4 billion between 2013 and 2014. The report further pointed out that, from 2006 to 2014, the ratio of the contribution percentage toward the basic pension system for urban employees in the corporate sector to the number of insured workers continued to decline, from 89.98% to 81.19%. When it comes to the payment of Chinese pension premiums, Guangdong and Beijing pay the proportion of less than 70%; Zhejiang, Henan, Hebei and other provinces pay the proportion of less than 80%; Xinjiang's contribution accounts for 96.59%, the highest rate in the country (Wu, 2015).

## **2.2. Pension System**

China's reformed pension system is divided into three levels: (1) basic pension; (2) enterprise supplementary pension; (3) individual savings pension (Lu and Huang, 2004). The basic pension system is designed to protect the basic needs of the majority of retirees according to the unified state policies and regulations. When employees reach retirement age or for other reasons exit their working positions and enter the process of retirement, social insurance agencies pay the basic pension to the retired workers (Cai and Cheng, 2014).

The enterprise supplementary pension is based on its economic strength. It was stipulated by the State for enterprise workers to establish a supplementary pension, which is macro-guided by the State and implemented by the enterprise's internal decision.

The individual savings pension is voluntary for individual workers. It is managed by supplemental insurance agencies, with specific measures developed by social security authorities to pay for pension premiums, according to workers' wages. For the last two levels, both businesses and individuals can be required to deposit pension fees into the accounts established by the Social Insurance Agency or to commercial insurance companies.

## **2.3. Pension Payment System**

The key to the pension payment system is the solvency of the insurance company. Solvency theory originated from insurance—it pertains to the insurer's compensation and ability to pay the insured in accordance with the provisions of the insurance contract. Pension solvency refers to the total assets of the pension system at their disposal (i.e., pension funds) to ensure future pension payment capability under a certain accumulation mode, especially the payment capability for an aging population under the Pension Fund.

On March 29, 2012, the China Insurance Regulatory Commission issued China's Second Generation of Solvency Regulation System Construction Plan. Plan put forward the formation, within three to five years, of a solvency regulatory system, which meets the international standards and aligns with the stage of development of the insurance industry in China. Plan calls for the second generation of the solvency regulation system to use a system of "three pillars" for its overall framework. The first pillar is "capital adequacy requirements", the second pillar is "risk management requirements", and the third pillar is "disclosure requirements".

Due to a lack of fund accumulation before the Accumulation System was implemented, and the necessity of maintaining present and future retiree pensions, especially in the reality of the aging population, the pension fund gap has increased greatly. According to the 2002 edition of the Urban Basic Pension Annual Statistical Bulletin, released by the Ministry of Human

Resources and Social Security, the central government subsidies 40.82 billion Yuan. By 2014, the financial subsidy level for the basic pension fund had reached 354.8 billion Yuan. In the 13 years from 2002 to 2014, the amount of the pension levels of financial subsidies reached 2.0748 trillion Yuan. The growth of the subsidy amount increased over nine years from 40 billion Yuan to 200 billion Yuan. In 2011, it reached 227.2 billion Yuan; in 2013, the subsidies were up to 301.9 billion Yuan. According to the 2015 National Social Insurance Fund Budget Situation, reported by the Ministry of Finance, the budget for financial assistance in 2015 was 367.12 billion Yuan. (Zhejiang News, 2015) The statistical bulletin also showed that provinces' pension expenditure over income increased. When the level of pension benefits increases year after year, pension fund expenditures continue to increase. With an aging population, the number of retirements increases faster than the number of payments. Some regions have relatively large retired populations and hence heavier burdens. The situation of pension solvency undoubtedly faces enormous pressure.

### **3. Problem Analysis**

#### **3.1. Pension Situation**

Zhejiang was one of the first provinces to implement basic pension reform. After the "Decision on the Unified Establishment of Enterprise Employees' Basic Pension System", set up by the China State Council in 1998, in 2008, the State Council chose Zhejiang, Shanxi and three other provinces and cities to carry out pension system reform. On September 26, 2001, the Zhejiang Provincial Government promulgated the "Notice to Urban Workers on a Number of Issues Pertaining to the Current Basic Pension". Zhejiang Province also led the way in promulgating local regulations with its release of "Zhejiang Province, the Basic Pension Regulations" in July 25, 1997 and amendments in 2008. In January 2010, the Zhejiang provincial government implemented "On the Establishment of Urban and Rural Residents' Social Pension System Opinions". In August 2014, Zhejiang implemented the Ministry of Human Resources and Social Security and Ministry of Finance "Notice on the Issuance of Interim Measures for the Urban and Rural Pension System Convergence". Meanwhile, in June 2009, the provincial government introduced the "Notice on the Issuance of Zhejiang Enterprise Employees' Basic Pension at the Provincial Level". In 2015, Zhejiang Human Resources and Social Security introduced the "Notice on the Adjustment of the Basic Pension for Enterprise Retirees". Pension security work has been at the forefront of the country's priorities.

By the end of 2015, the total number of insured in Zhejiang Province reached 13.42 million. The insured rate remained above 95%, with over 5.8 million pensioners. Beginning January 1, 2015, the minimum standard of 100 Yuan per person per month was adjusted to 120 Yuan for the province's urban and rural residents receiving the Zhejiang basic pension. For enterprise retirees, the basic pension increased from 125 to 133 Yuan per person per month. In 2015, the average income of urban residents in Zhejiang was 40,393 Yuan, an increase of 8.9% from the previous year. For rural residents, the average income per capita was 19,373 Yuan, an increase of 10.7%. As residents' incomes and Zhejiang's pension fund grow, the gap in pension expenditure widens.

#### **3.2 Existing Problems in the Pension System**

With an aging population, as well as employment diversification and urbanization, pension issues in Zhejiang will become more and more pressing over time. The Zhejiang pension presents the following problems:

(1) Pension imbalance still exists. On December 23, 2014, the Standing Committee of the 12th National People's Congress of China's clearly stated that China would promote enterprise pension reform and the establishment of a unified urban worker pension system—that is, government agencies and institutions would establish the same basic pension system as that in enterprises, with implementation units and individual contributions, and implement reform of pension calculation and payment methods, in order to free the long-standing institutions and urban enterprise workers from the two-track pension system and mechanism contradiction.

Although various provincial departments are actively expanding coverage, with the significant progress of urbanization, the rural population is rapidly relocating (Salditt *et al.*, 2007). In Zhejiang province, where the private economy is highly developed, enterprises fulfill their employee pension benefits in accordance with their own economic means and voluntary payments. Thus, enterprises with high and low levels of efficiency provide different levels of insurance. Loss-making enterprises may not even be insured, resulting in incomplete pension coverage. There are also some differences in the pension contribution base in Zhejiang. The various municipalities coordinate the pension system, weakening the urban-rural split, while social security strengthens the degree of disparity in pensions. While the system strives to bridge the gap in the level of benefits people receive, it has widened the pension income gap among regions, resulting in inequality (Salditt *et al.*, 2007). This is sure to affect the direction of labor migration, regional population size, as well as labor and market development.

(2) Payment of the basic pension and the use of individual accounts should be regulated. For a long time, due to the pension funding channels from national government budgets and businesses being charged to production gains, funding and financing channels being relatively small, and the system not encouraging individuals to deposit more pension premiums, "empty accounts" in pension funds have been a growing problem. For a long time, pooling accounts and individual accounts were managed jointly, so the transfer of funds from individual accounts to pooling accounts coincided with the aging society in the future. This, coupled with the reality of "the new feeds the old", has caused the "empty accounts" to increase dramatically in each province. Zhejiang Province has no exception. The CPC Central Committee in the "Twelfth Five-Year Planning" proposals set out to formalize individual accounts, prevent pension funds from being diverted or misappropriated, increase the yield of the pension fund, reduce long-term dependence on the state financial support. According to the Provincial People's Congress, enacted in 1999 and amended in the 2002 Article VIII of "Zhejiang basic pension regulations", people's governments above the county level shall arrange a certain percentage of the annual financial capital invested in the basic pension fund and included in the financial budget. This was followed by the introduction of a variety of legislation to further regulate the pension system in Zhejiang. Governments at all levels need to fully implement these policies and regulations to improve the operation of the pension system.

(3) It is necessary to strengthen the management of pension funds and improve the implementation of the relevant regulatory regimes. In 2012, the "Notice on Strengthening and Standardizing the Social Security Fund Fiscal Account Management", released by the Ministry of Finance, stated that local verification of the financial accounts found multiple accounts and repeated accounts in the social security fund in some places. The "Basic Pension Fund Investment Management Approach," implemented in 2016, will be a unified process to allocate the surplus funds of local pension funds, steadily promoting the market-oriented operation of pension funds. Government officials should check that companies implement the "low threshold access, low standard of enjoyment". At present, the required enterprise payment in Zhejiang province is about 20% of the total wage ratio, but the actual amount collected is not satisfactory. For example, in 2005, the Zhejiang pension fund revenue was 29 billion Yuan, of which the individual insured workers paid about 13 billion Yuan. If the companies had paid the full required 20 percent, their contribution would be at least 32.5 billion Yuan; instead, there was a shortage of 16.5 billion Yuan. In 2010, the enterprise employees' basic pension fund expenditure was 38.6 billion Yuan, an increase of 70.6% from 2007. The fund's income over the same period grew by only 48.1%. It is expected to take 100 working people (16-59 years old) to feed 24 elderly (60 years or older). This was increased to 31 elderly dependents between the end of the Eleventh Five-Year Plan period and the end of the Twelfth Five-Year Plan period. So far, many pension policies enacted in Zhejiang have expressly required enterprises to pay, but the companies have not gone far enough to meet these requirements, failing to fulfill their responsibilities to their workers. The implementation of these policies needs to be strengthened. Fund management efficiency and effectiveness have to be high; otherwise, the already inadequate pension funds will dwindle even more.

(4) Basic pension system construction has to be done. Since the merger of the basic pension policy was implemented at the end of 2014, pension funds and investment are still

inadequate. The construction of the basic pension system has just begun. According to the Zhejiang Provincial People's Government, as explained in "On the Opinions About Accelerating the Pension Service System Construction" and the "Zhejiang Provincial Civil Affairs Development Twelfth Five-Year Plan," from 2015 onwards, the Zhejiang provincial government will establish a yearly pension for private non-profit agencies, purchase service systems for home care service centers, expand the scope of subsidies for pension services, and invest government and social capital to explore cooperation (PPP) for a model-building pension agency. The "Social Pension Service System in the Zhejiang Province Twelfth Five-Year Plan" promoted more advanced pension service system construction. In 2015, new basic pensions increased by 2.2 million, basic medical insurance increased by 1.19 million, new retirement beds increased by 37,000, and new residential care centers for old-age service increased by 8,147. By 2020, Zhejiang Province plans to achieve the "9643" pattern of pension services—namely, 96% of the elderly will receive services at home, 4% of the elderly will be in nursing homes, and more than 3% of the elderly will enjoy a pension service subsidy. The construction of the basic pension system undoubtedly raised the requirements and challenges for the use of funds.

#### 4. Methodology

##### 4.1. "The Old" Actuarial Model of Recessive Debt

Let  $n$  be the year, with  $(n, n + 1)$  years, and let  $i$  be the age of the "old man."  $\overline{w(n)}$  is the average social wage,  $g(n)$  is the average wage growth rate,  $f$  is the substitution rate,  $v$  is the interest rate the discount factor, and  $d$  is the ratio of the annual pension to average wage index adjustment in the rate of increase. So  $n_1 = n - i + r - 1$ , and the  $i$ -year-old's average wage in a given year before retirement is:

$$\overline{w(n_1)} = \frac{\overline{w(n)}}{\prod_{k=0}^{i-r} (1 + g(n-k))} \tag{1}$$

$i$ -year-old's accumulated retirement pensions in a given year:

$$b(n_{1+i}, r) = f * \overline{w(n)} * \left[ \prod_{k=0}^{i-r} (1 + g(n-k)) \right]^{-1} \tag{2}$$

$$i\text{-year-old's pension for year } n : b(n, x) = \frac{f * \overline{w(n)}}{1 + g(n)} * \pi(n, x) \tag{3}$$

$$\text{Among them, } \pi(n, x) = \begin{cases} \prod_{k=1}^{i-r} \left( \frac{1 + d * g(n-k)}{1 + g(n-k)} \right), & i > r \\ 1, & i = r \end{cases} \tag{4}$$

Beginning with the present value of the pension due to annual wage growth rate indexation, the value of an  $i$ -year-old's Life Annuity in year  $n$  :

$$\begin{aligned} H(n, i) &= b(n, i) * \left[ 1 + \sum_{m=1}^{w-i-1} \prod_{k=1}^m (1 + dg(n+k)) * v^m * p_i \right] \\ &= \frac{f * \overline{w(n)}}{1 + g(n)} * \pi(n, x) * \left[ 1 + \sum_{m=1}^{w-i-1} \prod_{k=1}^m (1 + dg(n+k)) * v^m * p_i \right] \end{aligned} \tag{5}$$

For age  $i$ ,  $l(n, i)$  was the beginning of the actuarial present value of the life annuity paid:

$$l(n, i) * H(n, i) \tag{6}$$

For age  $i$ , the life annuity actuarial present value :

$$L_i = \sum_{i=r}^{w-1} l(n, i) * H(n, i) \tag{7}$$

**4.2. “The Middle” Transitional Pension Debt Actuarial Model**

“The middle” transitional pension debt pertains to those who worked before the pension reform. Beginning three years after the reform, the replacement rate for retirement and work experience was used to determine the pension debt. “The Middle” retirement point was after January 1, 2001.

Let n be the year, with (n, n + 1) years, x(x < r) be the years of “the middle,” z (n, x) be the size, and y(y > r) be the years of “the middle” size as z(n, y). The average social wage is  $\overline{w(n)}$ , the average wage growth rate is g(n), the substitution rate is f, the predetermined rate is m, the interest rate discount factor is v, and the ratio of indexation of pensions to the average wage annual growth rate is d. The average social wage for an x-year-old who retired a year ago:

$$\overline{w(n_1)} = \overline{w(n)} * \prod_{k=1}^{r-x-1} (1 + g(n+k)) \tag{8}$$

The average wage of a y-year-old one year before retirement:

$$\overline{w(n_2)} = \overline{w(n)} * \prod_{k=0}^{y-r} (1 + g(n-k))^{-1} \tag{9}$$

Among them,

$$n_1 = n - x + r - 1, n_2 = n - y + r - 1. \tag{10}$$

Similar to the previous section on “the old” actuarial model:

If n is the year and i is the age, the transitional pension for an i-year-old is:

$$b(n, x) = \frac{f * \overline{w(n)} * (y - a)}{(1 + g(n))^{(r-a)}} * \pi(n, x). \tag{11}$$

Among them,

$$\pi(n, x) = \begin{cases} \prod_{k=1}^{i-r} \left( \frac{1 + d * g(n-k)}{1 + g(n-k)} \right), & y > r \\ 1, & y = r \end{cases} \tag{12}$$

Beginning with the present value of the pension due to annual wage growth rate indexation, the value of an i-year-old’s Life Annuity in year n :

$$H(n, x) = b(n, x) * \left[ 1 + \sum_{m=1}^{w-x-1} \prod_{k=1}^m (1 + dg(n+k)) * v^m * p_x \right] * v^{r-x} * p_x \tag{13}$$

Beginning with the actuarial present value of the life annuity paid between n and y years:

$$H(n, y) = \frac{f * \overline{w(n)} * (y - a)}{(1 + g(n))^{(r-a)}} * \pi(n, y) * \left[ 1 + \sum_{m=1}^{w-y-1} \prod_{k=1}^m (1 + dg(n+k)) * v^m * p_y \right] \tag{14}$$

Year i, z(n, x): “The middle” was beginning at the actuarial present value of the life annuity paid: z(n, x) \* H(n, x)

Year i, z (n, y): “The middle” was beginning at the actuarial present value of the life annuity paid: z(n, y) \* H(n, y)

Therefore, for year  $i$ , “the middle” transitional pension debt is:

$$L_i = \sum_{x=a}^{r-1} z(n, x) * H(n, x) + \sum_{x=r}^{t-2001+r} z(n, y) * H(n, y) \tag{15}$$

## 5. Empirical Analysis

In this section, we will adopt the data yearbook, the relevant actuarial data model required for statistical analysis, and make predictions. By studying pension income and expenditure and its influencing factors, we can predict the value obtained in the subsequent annual pension.

### 5.1. Influencing Factors

#### 5.1.1. Analysis of Factors Affecting Fund Income

In this section, we perform statistical analysis of the number of pension premiums in each year and the annual average wage, as well as other factor analyses. We use multiple linear regression to analyze the quantitative relationship between the use of contributory pension income, the number of pension premiums and employees’ annual average wage, and explore the impact of these factors.

Suppose that for the income fund ( $R$ ), the number of pension premiums ( $A$ ), and the annual average wage ( $X$ ), the relationship between the three is as follows:

$$R = C_1 * A * X \tag{16}$$

where  $C_1$  is a constant to be determined (it can be regarded as a proportion).

Using the variables in the natural logarithm model, we can draw a linear model revision:

$$\ln R = \ln(C_1 \times A \times X) \tag{17}$$

That is:

$$\ln R = \ln C_1 + \ln A + \ln X \tag{18}$$

Thus, there is a linear correlation between  $\ln R$ ,  $\ln A$ , and  $\ln X$ . In order to determine the value of the constant  $C_1$ , we will process the data in Table 1.

**Table 1. The number of pension premiums, annual average wage, and fund income for each year**

Year	The number of pension premiums (ten thousand) $A$	$\ln A$	The annual average wage (ten thousand Yuan) $X$	$\ln X$	Fund income (ten thousand Yuan) $R$	$\ln R$
2001	360.1670	5.8866	15770	9.6659	1356393	14.12
2002	435.8000	6.0772	18227	9.8107	1737580	14.368
2003	512.7623	6.2398	20853	9.9453	2173528	14.592
2004	735.5463	6.6006	23101	10.048	2369650	14.678
2005	801.3444	6.6863	25572	10.149	2895812	14.879
2006	881.7271	6.7819	27567	10.224	3527193	15.076
2007	984.8194	6.8925	30854	10.337	4150354	15.239
2008	1192.1007	7.0835	34146	10.438	4968370	15.419
2009	1317.8300	7.1837	37395	10.529	5264956	15.477
2010	1478.6068	7.2989	41505	10.634	6051301	15.616
2011	1665.8000	7.4181	46660	10.751	9012000	16.014
2012	1835.5000	7.5151	50813	10.836	12272000	16.323
2013	1985.4000	7.5936	56571	10.943	15631690	16.565
2014	2144.3100	7.6705	61572	11.027	18991380	16.759

Here, we use a multiple linear regression model to describe the relationships among  $\ln A$ ,  $\ln X$  and  $\ln R$  in Table 1, and to determine the constant  $C_1$ , the regression parameters we obtained are shown in Tables 2.

**Table 2. Regression analysis of fund income**

Source	df	B	Std. Error	under null hypothesis	Part > r
Constant	1	-8.51617	2.92276	-2.91	0.0172
A	1	-0.72619	0.36831	-1.97	0.0801
X	1	2.78272	0.52440	5.31	0.0005

Based on the model parameter table, we can see a high degree of linear correlation between these factors, with very good model fit and a very high significance level. The number of pension premiums (A) is negatively correlated with the income fund (R), and the annual average wage (X) is positively correlated with the income fund (R).

**5.1.2. Expenditures of the Fund Analysis**

Similar to the previous section, in this section, we will use statistical analysis for each year the number of retirees receive guaranteed annual average wages and other factors. We will use multiple linear regression in an effort to quantify the relationship between pension expenditure and these other factors.

Suppose that for fund expenditures (O), the number of people getting the fund (B), and the annual average wage (X), the relationship among them is:

$$O = C_2 * B * X \tag{19}$$

Where  $C_2$  is a constant to be determined (it can be regarded as a proportion). Using a natural logarithm model, we can draw a revised linear model:

$$\ln O = \ln(C_2 * B * X) \tag{20}$$

Which is:

$$\ln R = \ln C_2 + \ln B + \ln X \tag{21}$$

Therefore, for  $\ln O$  and  $\ln B$  there exists a linear correlation with  $\ln X$ . In order to determine the constant  $C_2$ , we will process the data in Table 3 to get the results in Table 4.

**Table 3. The number of retirees, annual average wage, and fund expenditures (Unit: Ten thousand)**

Year	The number of retirees(B)	Annual average wage(X)	Expenditure of the fund(O)
2001	125.0981	15770	1098086
2002	132.6000	18227	1371801
2003	144.2067	20853	1493128
2004	152.4426	23101	1640640
2005	160.9221	25572	1916798
2006	170.8556	27567	2219416
2007	182.2839	30854	2655601
2008	194.8049	34146	3193013
2009	209.6017	37395	3696720
2010	223.6107	41505	4290709
2011	253.4000	46660	5432000
2012	347.8000	50813	7835000
2013	449.7000	56571	10420550
2014	551.6000	61572	13306100

**Table 4. The number of people paying premiums, annual average income, and fund income for each year**

Year	lnB	lnX	lnO
2001	4.8291	9.6659	13.9091
2002	4.8873	9.8107	14.1316
2003	4.9712	9.9453	14.2164
2004	5.0268	10.0476	14.3106
2005	5.0809	10.1493	14.4662
2006	5.1408	10.2244	14.6128
2007	5.2056	10.3370	14.7922
2008	5.2720	10.4384	14.9765
2009	5.3452	10.5293	15.1230
2010	5.4099	10.6336	15.2720
2011	5.5350	10.7506	15.5078
2012	5.8516	10.8359	15.8741
2013	6.1086	10.9433	16.1593
2014	6.3128	11.027	16.4037

Here, we use a multiple linear regression model to describe the relationship shown in Table 2 among lnR, lnA and lnX, and to determine the constant  $C_1$ . The regression parameters we obtained are shown in Tables 5, Table 6.

**Table 5. Regression analysis of variance**

Source of Variation	df	SS(Sum of squares)	MS(Sum of Mean Squared)	F-Ratio	Pr>F
Model	2	3.94549	1.97274	858.22	<.0001
Error	9	0.02069	0.00230		
Corrected Total	11	3.96618			

**Table 6. Regression analysis of fund expenditure**

Source	df	B (parameter estimation)	Std. Error (Standard Error)	under null hypothesis	Part > r  probability
Constant intercept	1	1.21118	0.60122	2.01	0.0748
X1	1	1.09569	0.17779	6.06	0.0002
X2	1	0.76289	0.13941	5.47	0.0004

According to the model parameter table5 and Table6, we can see there existed a high degree of linear correlation between these factors. The model fit is very good, with a very high significance level. The resulting linear regression model is:

$$\ln O = 1.21118 + \ln B + \ln X \tag{22}$$

The model of relationship between fund expenditure (O) and retirement guarantee number (B) and annual social average wage (X) can be obtained by means of index reduction:

$$O = 0.484377135 \cdot B \cdot X \tag{23}$$

**5.1.3. Insured Composition Analysis**

Let  $n$  be years after 2014 and  $i$  be the age. The population is  $P_N(i)$ , therefore:

$$P_{N+1}(i) = P_n(i - 1) \tag{24}$$

This is because the number of  $i$ -year-olds after  $(n + 1)$  years is equal to the number of  $(i - 1)$ -year-olds after  $n$  years. We assume that the province's population inflow and outflow numbers are equal, so their influence is negligible (see as Table 7).

**Table 7. Age populations  $P_a(i)$  in 2014 (Unit: Ten thousand people)**

Age	The amount of population	Age	The amount of population	Age	The amount of population
0	445591.944	26	652908.471	52	805364.56
1	445591.944	27	652908.471	53	805364.56
2	445591.944	28	652908.471	54	805364.56
3	445591.944	29	652908.471	55	805364.56
4	445591.944	30	652908.471	56	805364.56
5	445591.944	31	652908.471	57	805364.56
6	445591.944	32	652908.471	58	805364.56
7	445591.944	33	652908.471	59	805364.56
8	445591.944	34	652908.471	60	500818.50
9	445591.944	35	805364.560	61	500818.50
10	445591.944	36	805364.560	62	500818.50
11	445591.944	37	805364.560	63	500818.50
12	445591.944	38	805364.560	64	500818.50
13	445591.944	39	805364.560	65	500818.50
14	445591.944	40	805364.560	66	500818.50
15	445591.944	41	805364.560	67	500818.50
16	445591.944	42	805364.560	68	500818.50
17	445591.944	43	805364.560	69	500818.50
18	652908.471	44	805364.560	70	500818.50
19	652908.471	45	805364.560	71	500818.50
20	652908.471	46	805364.560	72	500818.50
21	652908.471	47	805364.560	73	500818.50
22	652908.471	48	805364.560	74	500818.50
23	652908.471	49	805364.560	75	500818.50
24	652908.471	50	805364.560	76	500818.50
25	652908.471	51	805364.560	77	500818.50

The total number 18-to-59-year-olds in a population in a year  $n$  is the total working population  $z(n)$ . The total number of 60-to-77-year-olds is the number of retirees  $t(n)$ . Setting  $n = 15$  yields the results in Table 8.

**Table 8. Incumbency and expected retirements for each year**

Year	The number of incumbency z (n)	The number of expected retirements t (n)
2015	$3.0960 \times 10^7$	$9.9284 \times 10^6$
2016	$3.0600 \times 10^7$	$1.0233 \times 10^7$
2017	$3.0240 \times 10^7$	$1.0537 \times 10^7$
2018	$2.9880 \times 10^7$	$1.0842 \times 10^7$
2019	$2.9521 \times 10^7$	$1.1147 \times 10^7$
2020	$2.9161 \times 10^7$	$1.1451 \times 10^7$
2021	$2.8801 \times 10^7$	$1.1756 \times 10^7$
2022	$2.8441 \times 10^7$	$1.2060 \times 10^7$
2023	$2.8081 \times 10^7$	$1.2365 \times 10^7$
2024	$2.7722 \times 10^7$	$1.2669 \times 10^7$
2025	$2.7362 \times 10^7$	$1.2974 \times 10^7$
2026	$2.7002 \times 10^7$	$1.3278 \times 10^7$
2027	$2.6642 \times 10^7$	$1.3583 \times 10^7$
2028	$2.6283 \times 10^7$	$1.3887 \times 10^7$

The aging trend can be seen in Table 8—the working population is getting smaller and smaller, while more and more people retire. Statistics indicate that in 2014, the pension participation rate in Zhejiang was 45%. In order to facilitate research, the annual participation rate is assumed to remain unchanged. Thus, the incumbency and retirement numbers in Table 10 can be expected to yield the numbers of people paying and receiving pensions shown in Table 9.

**Table 9. Expected numbers paying and receiving pensions each year**

Year	Expected number of paying pension A (n)	Expected number of receiving pension B (n)
2015	$1.3932 \times 10^7$	$4.4678 \times 10^7$
2016	$1.3770 \times 10^7$	$0.4605 \times 10^7$
2017	$1.3608 \times 10^7$	$0.4742 \times 10^7$
2018	$1.3446 \times 10^7$	$0.4879 \times 10^7$
2019	$1.3284 \times 10^7$	$0.5016 \times 10^7$
2020	$1.3122 \times 10^7$	$0.5153 \times 10^7$
2021	$1.2960 \times 10^7$	$0.5290 \times 10^7$
2022	$1.2799 \times 10^7$	$0.5427 \times 10^7$
2023	$1.2636 \times 10^7$	$0.5564 \times 10^7$
2024	$1.2475 \times 10^7$	$0.5701 \times 10^7$
2025	$1.2313 \times 10^7$	$0.5838 \times 10^7$
2026	$1.2151 \times 10^7$	$0.5975 \times 10^7$
2027	$1.1989 \times 10^7$	$0.6112 \times 10^7$
2028	$1.1827 \times 10^7$	$0.6249 \times 10^7$

### 5.1.4. The Average Wage Forecast

Based on the previous sections of analysis, we found that the average wage level has a direct impact on the income of pension funds. The forecast average wage is a key factor in forecasting pension income and expenditure. Here, a trend growth model was used to predict the average wage of workers in Zhejiang. Table 10 indicates the average annual wage of Zhejiang for each year, and the year-on-year growth in the data. For years after 2015, we used predicted values.

**Table 10. Average wage of employees in Zhejiang province**

Year	Average wage	Growth rate	Year	Average wage	Growth rate
2001	15770	0.1558	2015	71653	0.1065
2002	18227	0.1441	2016	79284	0.0980
2003	20853	0.1078	2017	87053	0.0892
2004	23101	0.1070	2018	96263	0.1058
2005	25572	0.0780	2019	106448	0.0945
2006	27567	0.1192	2020	116507	0.1399
2007	30854	0.1067	2021	132806	0.1242
2008	34146	0.0951	2022	149301	0.0990
2009	37395	0.1099	2023	164082	0.1103
2010	41505	0.1242	2024	182180	0.1238
2011	46660	0.0890	2025	204734	0.1088
2012	50813	0.1133	2026	227009	0.1134
2013	56571	0.1231	2027	252752	0.1254
2014	63534	0.1278	2028	284447	0.1134

### 5.1.5 Pension Fund Income and Expenditure Forecast

To utilize the predictive value of the average wage from the above section, we substitute the value into Section 5.1.1 of the fund's income factor model (1) and section 5.1.2 of the fund expenditure factor model (2). From this, we can predict the fund income and expenses from 2015 to 2028, as shown in Table 11 and drawn from each year's accumulated surplus.

According to Table 11, fund expenditures are expected to exceed the fund's income in 2024. The accumulated surplus shows a downward trend, which creates the gap.

**Table 11. 2015-2028 Pension Fund Income and Expenditure Forecast for Zhejiang**

Year	Pension fund income	Pension fund expenditure	Accumulated surplus
2015	21948004	15506427	37651607.97
2016	24003064	17684746	43969925.94
2017	26045052	19995346	50019631.80
2018	28457693	22749604	55727720.30
2019	31089487	25862986	60954221.30
2020	33612378	29080093	65486505.94
2021	37841634	34029612	69298527.76
2022	42013217	39246974	72064771.63
2023	45584558	44221319	73428009.76
2024	49967594	50307805	73087798.24
2025	55424405	57894552	70617651.05
2026	60646017	65699887	65563781.37
2027	66623086	74827559	57359308.13
2028	73964468	86098486	45225290.15

### 5.2. Recessive Debt Actuarial Analysis

With related indicators forecast in the previous section, we can use the actuarial model to predict Zhejiang urban workers' recessive debts of pension from 9.85 billion Yuan to 13312.62 billion Yuan for 2015–2028 in Table 12.

**Table 12. Zhejiang Recessive Debt Fact Sheet (Units: Ten Thousand Yuan)**

Year	Recessive debts	Year	Recessive debts
2001	46617.13	2015	985457.43
2002	51465.31	2016	1661481.23
2003	57949.94	2017	2784642.55
2004	66526.53	2018	4611368.06
2005	79432.68	2019	8166732.83
2006	95478.08	2020	14071280.66
2007	118297.34	2021	24512170.92
2008	148581.46	2022	42626665.23
2009	185281.08	2023	74255650.82
2010	232713.04	2024	131506757.61
2011	302759.66	2025	233161481.24
2012	438093.23	2026	415260598.08
2013	497404.32	2027	740824906.98
2014	646625.61	2028	1331262357.83

### 5.3. Accumulated Surplus and Recessive Debt Balance Analysis

Summarized sections 5.1.5 and 5.2 of the relevant data and indicators can be drawn after deducting the balance of pension funds under the recessive debts, as shown in Table 13 and Figure 1.

**Table 13. Balance of Pension after Deduction of Recessive Debts in Zhejiang (Units: Ten Thousand Yuan)**

Year	Balance	Year	Balance
2001	913789.87	2015	36666150.54
2002	1274802.69	2016	42308444.70
2003	1948752.06	2017	47234989.26
2004	2669185.47	2018	51116352.24
2005	3635293.32	2019	52787488.47
2006	4927024.92	2020	51415225.27
2007	6398958.66	2021	44786356.84
2008	8144030.54	2022	29438106.41
2009	9675566.92	2023	-827641.07
2010	11388727.96	2024	-58418959.37
2011	14899240.34	2025	-162543830.19
2012	19200906.77	2026	-349696816.71
2013	24352735.68	2027	-683465598.85
2014	30563405.31	2028	-1286037067.68

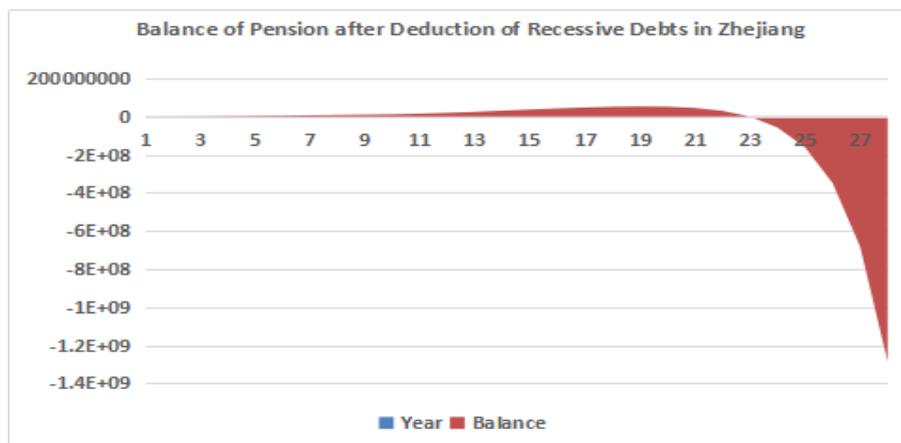


Figure 1. Balance of Pension of Zhejiang

Note: Data source from Table 13.

## 6. Conclusions and Suggestions

### 6.1. Conclusions

Rakhmonov (2016), through the experience of the European Union countries' study, found out that it is necessary to pay attention to the coverage of the pension plan, adaptability of payments of pension plan, payment of contributions to pension fund, gaining incomes in the system of pension plan, special pension system for self-employed people, all these factors in holding reforms in pension plan. So we also considered these factors in Chinese pension system rather than doing the calculation. Based on the above calculation results, combined with the data on the actual situation, we can reasonably draw the following conclusions:

(1) With economic development, the number of insured pensioners has increased year by year for 13 years. The growth rate of the population has fluctuated, with the highest growth rate in 2008. The number of basic medical insured is 10.54 million, an increase of over 23.3% since the end of 2007.

(2) With the number of insured pensions increasing each year, the numbers of insured workers and retirees are also increasing year by year. Both growth rates are fluctuating. The growth rate of the number of workers insured is much larger than that of the number of retirees. For example, in 2008, the number of people participating in corporate pension was 12.93 million, and the growth rate of the number of insured workers was the highest, up 20.2% from the end of 2007.

(3) From 2001 to 2014, the proportion of the pension fund's income has gone from smaller to larger, but it still accumulated a surplus as high as 1.399922 trillion Yuan. The projected 2001–2028 cumulative balance is -20452.444 billion Yuan. It is expected that in 2024, fund expenditures will exceed the fund's income, creating a gap. According to the recessive debt actuarial model, the pension solvency of urban workers in Zhejiang will be positive through 2022 and negative beginning in 2023. Pension solvency is declining each year, and the funding gap will gradually widen.

(4) Overall, the predetermined interest rate level is inversely correlated with the amount of recessive debt—the higher the interest rate, the smaller the recessive debt. Reducing the pension replacement rate can help reduce the recessive debt, but not significantly. The growth proportion adjustment of pensions is positively correlated with the size of the recessive debt. The size of the recessive debt is related to the annual growth rate of the average wage in society.

### 6.2. Suggestions

Based on current pension income and expenditure in China, we have some recommendations:

(1) Raise the retirement age appropriately. Although the fund's income has gradually increased in China, the funding gap is huge. The government needs to pay more attention to recessive debt. Based on the overall trend of a serious aging problem, the working population in China contributions to pay for a long period after retirement. The pension fund gap is increasing, so the only appropriate and reasonable solution is to raise the retirement age to alleviate some of the pressure of solvency.

(2) Increase the pension replacement rate appropriately. The pension replacement rate is the ratio of retirement wage to income. This is related not only to the vital interests of the retirees, but is also to the operation of the entire basic pension system. Whether the replacement rate is reasonable is a key point of the pension system, and it reflects the organization and policy orientation of the whole system. Undoubtedly, Chinese pension replacement rate is lower than the warning level of reality, which urges us to find a solution for retirement.

(3) Reduce the growth rate of pension adjustments appropriately; expand and consolidate basic pension coverage by law. It is necessary to constantly improve the pension system and to standardize the implementation of the pension payment system. At present in China, according to the enterprise pension fund operation, enterprises are expected to pay about 20% of the total wage ratio, but the actual collection of corporate pensions is far below this number. The weak enforcement of the relevant policies causes the already inadequate pension funds to dwindle further. Therefore, the implementation of pension payment system must be strongly enforced.

(4) Strengthen the supervision of pension insurance and standardize the payment of corporate pension premiums. Gradually increase government financial subsidies on pensions. Adjust the structure of fiscal expenditure, gradually increasing social insurance and other social security expenditures. Each year, cities and counties allocate special budgets to supplement the basic pension fund. The specific amount can be decided based on the ability of local pension expenditures.

(5) Explore various channels to raise pension funds. We can draw lessons from the Chilean model to solve the recessive debt problems during transition. Promoting coordination between increasing the value of pensions and capital market development; issuing special bonds—these channels and others are worth studying and potentially implementing.

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