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The Real Old-Age Dependency Ratio and the Inadequacy of Public Pension Finance in China

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Abstract The old-age dependency ratio and the inadequacy of public pension finance has been a particular focus in theoretical and practical fields. Our paper suggests that the sole use of demographic data to calculate the simple old-age dependency ratio (SOADR) leads to the neglect of some important social factors and the underestimation of the seriousness of the insufficiency of pension funds. We suggest the use of a real old-age dependency ratio (ROADR) that considers students of working age, unemployment, low-income employees and retirees of working age. We use these factors in our new model, which calculates the dependency ratio and the accumulation of pension funds. The results of our simulation are presented in this paper. Comparisons are made between the general and real old-age dependency ratios to indicate the urgent need to adopt the real old-age dependency ratio in analysing pension finance. This is especially important given the assumption that China will extend the current social insurance pension system to the national state pension system covering all rural and urban employees and residents in the near future. Some policies that could be used to address these problems are also suggested in this paper.

Keywords Ageing population · Real old-age dependency ratio · Pension system · Inadequacy of funds

Introductions

Old-age Dependency Ratio in the World and in China

The populations of most industrialised Western nations are ageing. The USA, the EU, Japan, Canada and New Zealand have experienced this phenomenon since the 1970s.

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In the USA, the population aged 65 and over was 16.6 million in 1960, representing 9.9 % of the country's total population. In 1997, the same population in the US numbered 33 million, representing 12.3 % of the total. In 2008, the percentage of elderly people (aged 65 and over) in the USA was 12.7 % (Country statistical profiles: key tables from OECD - ISSN 2075-2288). The same population in Canada increased from 1.3 million or 7.5 % of the country's total in 1961 to 3.7 million or 7.5 % of the country total in 1997 and then to 13.6 % in 2008 (Key tables from the OECD - ISSN 2075-2288). In the UK, the same age group totalled 6.1 million (11.7 % of the total population) in 1961 but grew to 9.3 million (15.8 % of the total) in 1997 (Rosenburg and Everitt 2001) and then to 16.2 % in 2008 (Key tables from OECD - ISSN 2075-2288). A report by the UN (UN 1999) forecasted that the percentage of the world population composed of elderly people will increase even more rapidly during the 2050s and that the percentage of elderly people in the EU in particular will increase from 20 % (as of 1999) to 35 % by 2050. At that time, it is predicted that the percentage of elderly in the USA will be 28 %. Aohiro Yashiro's (1997) analysis of the demographics of Japan suggests that the elderly population will increase to 25.4 % in 2025 and 33 % in 2050.

Dependency ratios are calculated to show the structural changes in a population (Mason and Kinugasa 2008). Rosenburg and Everitt (2001) estimates that the old-age dependency ratio for the USA (the working population divided by the population aged 65 and over) will be 0.36 during its peak year in 2050. It is predicated that the dependency ratio in Canada at that time will be 0.4. One study estimate that the dependency ratio in Europe will be approximately 0.5 in 2050 and that the ratio for all developed countries will also be approximately 0.5 in 2050, indicating that the peak old-age dependency ratio for the entire industrialised countries' population will occur at that time (Tinker 2002). The newest data show that the old-age dependency ratios in Japan, Germany, the UK and the US were 0.35, 0.31, 0.25 and 0.19, respectively, in 2010 (Source: UN Population Division: World Population Prospects: 2008 Revision).

After 30 years of reform and opening up in China, lower population growth rates and longer life expectancy have began to resemble that in Western countries. The male and female life expectancies found by the three national door-to-door censuses in 1982, 1990 and 2000 are shown in Fig. 1. The trends with regard to birth rates, growth rates and death rates over the last 30 years are shown in Fig. 2.[1]

When analysing results regarding population, China's one-child family policy should not be neglected. This policy has been in effect in China's rural and urban areas since the 1970s. As shown in Fig. 3, the population and its growth rate were at relatively high levels from 1952 and then decreased substantially after the late 1970s, which is partly due to the rapid processes of economic development and urbanisation. However, the effect of the one-child family policy could be the main reason for this development.

As we have estimated and will explain in this paper, the working age population, including individuals between the ages of 15 to 64 years, was 968 million in 2009, and the elderly population, including individuals who were 65 years old and above, was 109 million, yielding an ageing population dependency ratio of 0.11 for that year.

[1] The data in Figs. 2 and 3 are from the Statistical Yearbook-2010 of the National Statistic Bureau

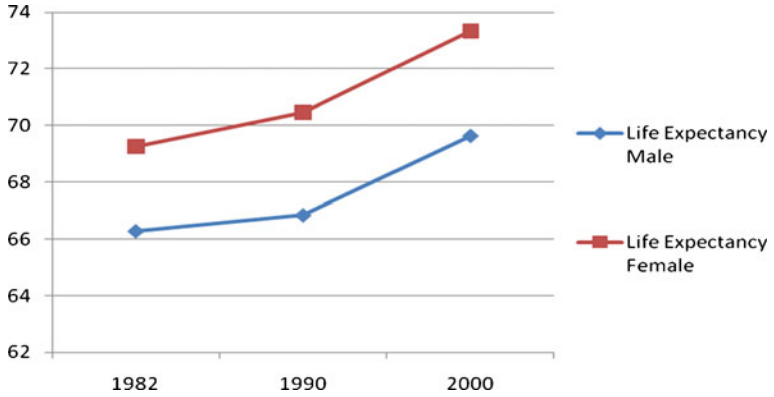

Fig. 1 M&F Life Expectancy in three national door-to-door censuses in 1982,1990 and 2000. Data source: China Statistical Yearbook-2010 of the National Statistic Bureau

In other words, during that year, there were nearly eight working-age people to one elderly person. However, beginning in 2015, the working-age population will begin to decrease in China, and the elderly population will begin to increase. The peak number of elderly people in China will be reached in the year 2038 (Fig. 4). The dependency ratio at that time will be greater than 0.5; in other words, there will be fewer than two working-age people for every elderly person.

Old-age Dependency Ratio and Pension Finance Inadequacy

The old-age dependency ratio will affect the two most influential drivers of the accumulation of pension funds: fund contribution and fund expenditure. A more negative ratio will have a more negative influence on the accumulation of funds and pension management, especially for unfunded pay-as-you-go systems (Leers et al. 2003). These demographic changes will decrease benefits or necessitate other coverage modifications if the system is to be completely self-reliant (Disney 2000). In this paper, only the PAYG public pension system is analysed; private and occupational

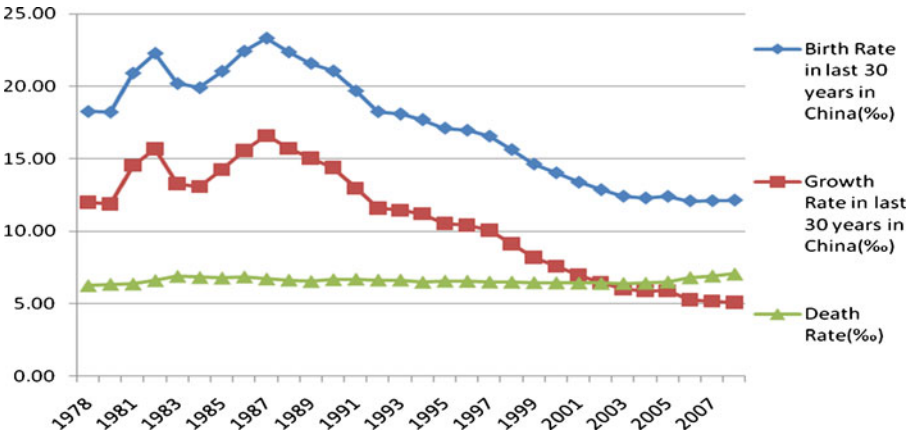

Fig. 2 The birth rate, growth rate and death rate in the last 30 years. Data source: China Statistical Yearbook-2010 of the National Statistic Bureau

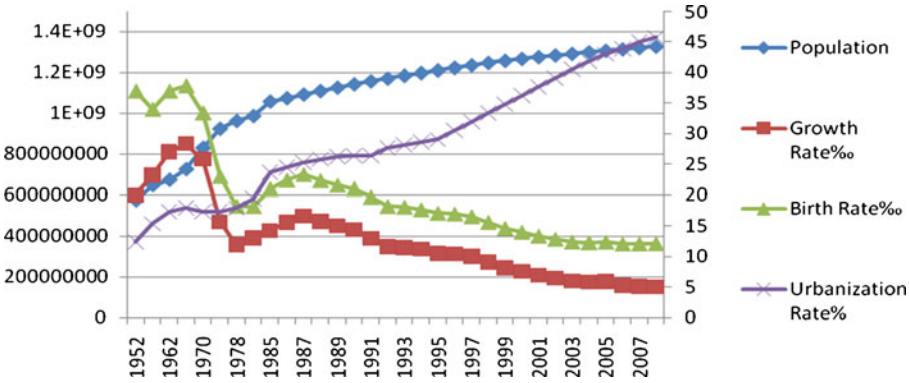

Fig. 3 The population, birth rate, growth rate and urbanisation rate since 1952 in China. Data source: China Statistical Yearbook-2010 of the National Statistic Bureau

pension systems will not be addressed because there is little opportunity for such pension systems in China.

Bao (2010) estimates the financial inadequacy of the urban employee pension social insurance system. Although the ageing of the population and the structural change will affect the system, the contributions from both employers and employees will address the issue of the ageing population. Lin uses the simple dependency ratio and other demographic factors, as well as various economic factors, to forecast the future timing and amounts of the financial shortfall. It is suggested that in response to the future increases in the simple old-age dependency ratio SOADR, the contribution and substitution rates for benefits will need be adjusted to maintain the self-reliance of the urban employee system. This paper tentatively establishes the relationship between the SOADR and the inadequacy of the pension finance system given the idiosyncratic characteristics of China's population and pension system.

The mechanism of China's public pension system will be introduced in the following chapter. The main issue is the possibility that China will extend the insurance system to rural and urban residents, which will lead to further complications within the system.

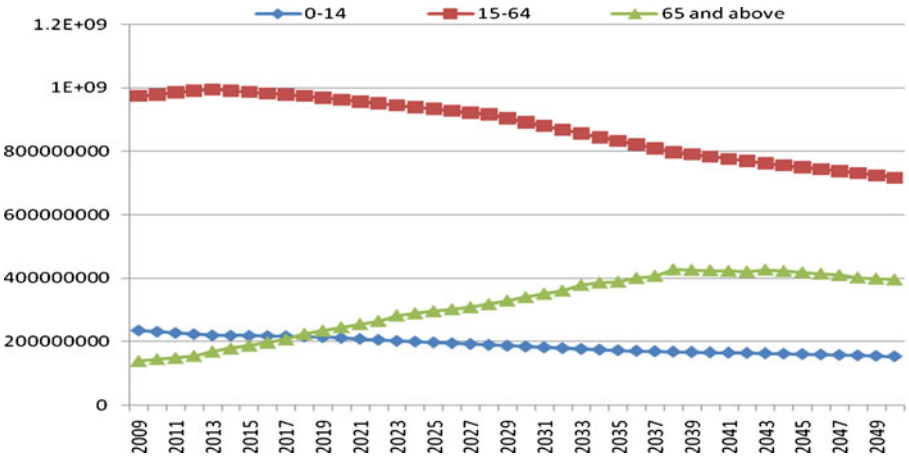

Fig. 4 The prognosis for three age groups during 2009 ~ 2050. Data source: Author's prognosis introduced in more detail in chapter 4

The number of participants will increase from 250 million in the urban employee system to over 1 billion for the working and old-age populations combined. The problem of the relationship between SOADR and the inadequacy of the pension finance system will be far more severe compared with the urban employee system, and the dependency ratio will be more important for analysing the influence factors, as we will see in our model.

From Simple to Real Old-Age Dependency Ratio in China

The Pension System Construction and the Importance of Using ROADR

The pension system in China is currently still in development. The primary pension system is social insurance, which covers employees at urban firms. The Chinese State Council Decision on Improving the Basic Pension System for Enterprise Employees (BPSEE), published in December 2005, created a new round of reforms of the public pension insurance system for urban employees in China. The urban employee system is China's main public pension system, which the government plans to extend to urban and rural citizens.

The BPSEE makes use of a mostly two-account system. Individual accounts contain the accumulated individual contributions, whereas social pooling is used for the employer contributions. Retired employees will claim benefits from both accounts according to a means-tested method of benefit calculation, which was defined in the 2005 decision. Essentially, the IA system is a defined contribution system, whereas the SP system is a defined benefit system. The central and local governments take full responsibility for guaranteeing the level of benefits provided to retired employees.

Although this system combines PAYG social pooling and the funded IA approach, the consistent removal of IA funds to pay for the benefits of the retirees renders the entire system a PAYG system. This keeps the system from being self-reliant. According to the China's 2010 Annual Report of the Ministry of Human Resources and Social Security, the central and local governments provided a total of 195.4 billion Yuan in financial support to guarantee benefits. In 2009, a new plan emerged: China will extend the PAYG and IA integrated system to rural and urban residents, as introduced in Table 1, which will make the accumulation of funds even more austere. The current pension system, including the different contribution and benefit rates, is shown in Table 1. We can see the difference between the contributions to different people, which indicates that the different contribution capacities of both rural and urban areas and both employed and unemployed people are taken into consideration.

There are special retirement income schemes for civil servants, military officers and senior employees in the public sector. The funding for these schemes is not in the form of pension system, and the income is regarded as working income after retirement, though their retired income is more agreeable than the pension insurance income. Young employees in the public sector have already joined the pension insurance system, which means that in the future, pension insurance will cover all urban employees, regardless of whether they are employed in the public or private

Table 1 The Current pension insurance systems in China

Item	Participants	Contribution	Benefit rate	Time of Inception
Basic Pension Insurance System for Urban Employees	Employees in urban enterprises, including all types of employers	Employer: 20 % of the contributory payroll Employees: 8 % of salary to individual account	A certain substitution of the Urban Employees Average Salary	In the 1990s, especially after Order No. 38 of the State Council in 2005
The New Type of Rural Residents Pension Insurance	Rural residents	Contribution with a range of 100 to 500 yuan each person every year	Basic pension benefit of 55 yuan per month and individual account benefit determined by the accumulation	In 2009, Order No. 32 of the State Council
Urban Residents Social Pension Insurance	Urban unemployed residents	Contribution with a range of 100 to 1,000 yuan each person every year	Basic pension benefit of 55 yuan per month and individual account benefit determined by the accumulation	In 2011, Order No. 18 of the State Council

sector. In our analysis, we will not take the civil servant system into account because the system does not follow a funding pattern or a PAYG pattern.

China's central government has increased pension benefits in recent years and has pledged to continue increasing its system's benefits and coverage.

The newest system covering urban and rural residents is a social insurance system, although the premiums paid by the residents are much lower than those paid by urban employees. Given the increases in the level of benefits, the scope of coverage and the plan to provide universal coverage and benefits to all Chinese citizens in the future, the financial sustainability of the system and the contribution capacity of the participants are key issues. Because every citizen will be included in the pension system in the near future, the relationship between the changes in the old-age dependency ratio and the financial inadequacy of the system is becoming increasingly important.

These statistical data on the population in China are misleading on this point. There are more than 975 million people of working age who pay premiums and only 113 million people aged 60 or more to be given pension benefits according to the 2010 statistics. If the SOADR is used, this ratio implies a substantial contribution capacity and little finance burden. There appear to be no concerns regarding affordability, and the issues with the policy are thus underestimated in discussions regarding the extension of the pension insurance system to rural and urban residents.

However, if we consider various factors that will affect the contributions of the working age population, we see that their contribution capacity is much lower than is indicated in the statistics. People of working age do not necessarily have the capacity

to contribute because people earning lower incomes, those who are unemployed, those who are in secondary school and college and those who have retired earlier than the state pension age represent a substantial fraction of the entire working-age population. Thus, the ROADR should be used to forecast real contribution capacity and pension finance adequacy or inadequacy. The resulting data can help to make future policy more suitable to China's demographic and labour market conditions. This characteristic makes the ROADR superior to the SOADR as a means of estimating future pension financial inadequacy. The differing results of the ROADR and SOADR as tools for measuring the financial inadequacy of pensions are illustrated in later sections.

The Four Groups Without Supporting Capacity for the Elderly

It is necessary to exclude the following social groups from the working-age population in the ROADR.

Factor 1: *Working-age students*. Despite being of working age (15~64), most students aged 15–24 are undergraduate students, and the other students are graduate students. This group of people is incapable of supporting others.

Factor 2: *The working-age unemployed*. These people are beneficiaries of the unemployment insurance plan and thus must be removed from the figures for the working-age population.

Factor 3: *The low-income population*. Although these people are of working age, their income is lower than the income tax allowance (which is currently 2,000 yuan per month, although it will increase to 3,000 rmb and beyond in the coming years). Therefore, it is impossible for these people to contribute to the state tax system and pension plan.

Factor 4: *Working-age retirees*. Some calculations indicate that the elderly population is 65 years old and over, whereas in China most employees retire at 60 years of age, with some women retiring at 55 years. Other employees who work under severe working conditions are able to retire at a younger age. Thus, we must remove the population of individuals aged 60–64 years old from the working population until the retiring age increases to 65 years old in China.

Result of the Real Old-Age Dependency Ratio in China

We use software called the China Population Prognosis Software (CPPS) and basic population data for 2009 to simulate the future population and our propositions. When the four groups above are removed from our calculations and estimation, the ODR in 2009 is 0.2, which indicates that there are 5 working-age people to support one elderly person. In fact, the ratio of contributors to pensioners under the social pension insurance plan is 1.7:1 in Shanghai, whose population is ageing more than those of other provinces in China. The RODR in China will be 0.8 in 2038, which indicates that there will be 1.2 working-age people to support one elderly person (Fig. 5). The RODR in 2050 will be 0.86, which indicates that there will be only 1.16 working-age people to support one elderly person.

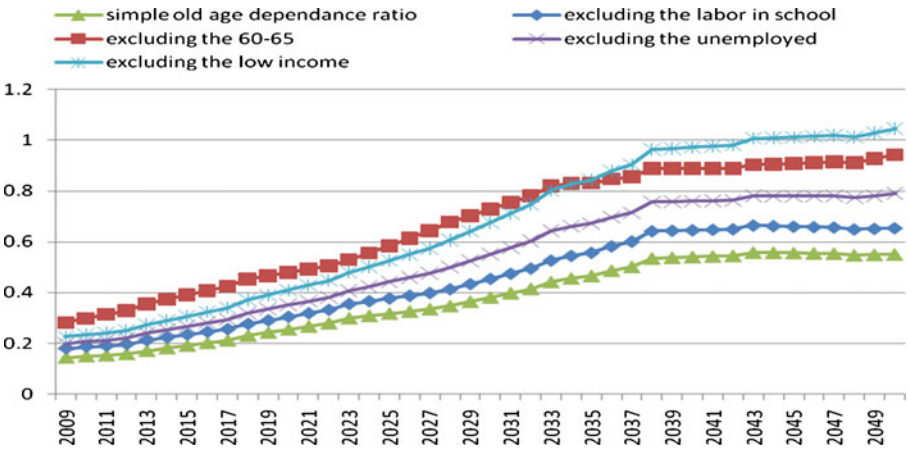

Fig. 5 The simple to effective old-age dependence ratio in 2009 ~ 2050

Compared with the 2050 scenario for Western countries, as indicated in the first part of this paper, China's situation has the following two characteristics:

- First, only 38 (2000~2038) years will pass from the beginning of the increase in the proportion of elderly people (at which point people aged 65 and above represent 7 % of the entire population) to the peak of the trend in ageing, whereas this process will take more than 90 (1950s~2050) years the US, Canada and EU;
- Second, the maximum real old-age dependency ratio in China will be much larger than that of Western countries, which indicates that China will face a much more serious social problem during the 2050s. The main reason for this burden is China's one-child family policy, which reduced the number of children born by 0.4 billion in the last 30 years. This paper calls this phenomenon the Ageing Population Crisis in China.

Models of the Dependency Ratio and Accumulation of Pension Funds

Assumptions of the Model

The assumptions of our model are summarised as follows:

- Universal pension coverage for all rural and urban residents and employees.
- Different contribution rates for working-age people in different groups: urban employees and residents and rural residents. However, we will standardise the contribution rate for working-age people as a whole.
- A single benefit rate: the substitution rate of the social average wage each year. This rate is officially issued by the National Bureau of Statistics for all working-age people regardless of any differences along the urban-rural, employee-resident and public-private axes.
- Universal management methods and pension fund performance, which implies a uniform revenue rate among the pension funds.

- Although the retirement age in China is less than 60 years old, we define the 65 and above as pension age group and the 16–64 age group as the pension contribution age.

The Model of the Dependency Ratio and Insufficiency of the Pension Funds

In our model, we assume that China will construct a basic pension system to universally cover all working-age people and that all elderly people will receive equal levels of pension income after the retirement age, which is 65 years old in our model. The model is as follows:

Let t represent each year with a time interval from 2010 to 2050 and with population and pension data from 2009 as the basis of our calculations.

Let the R_t represent the number of retired people pm each year, L_t the number of working-age people for each year, B_t the pension benefit average, W_t the social average wage during each year, α_t the simple old-age dependency ratio, β_t the contribution rate, s_t the substitution rate for the pension, PF_0 the initial pension funds at time t_0 and r the Average revenue rate of the funds.t_0 Because the first-year pension funds in this system are PF_0, in the yeart_1, the pension funds will be

$$PF_1 = PF_0 \times (1 + r) + L_1 \times W_1 \times \beta_1 - R_1 B_1$$

at time $t, PF_t = PF_{t-1} \times (1 + r) + L_t \times W_t \times (\beta_t - \alpha_t s_t)$ because $R_t = L_t \alpha_t$, $B_t = W_t s_t$, so

$$PF_n = PF_0 \times (1 + r)^{n-1} + \sum_{t=2}^{n} L_t W_t (\beta_t - \alpha_t s_t)(1 + r)^{t-2}$$

This equation indicates the future insufficiency of the pension funds determined by the value of $\beta_t - \alpha_t s_t$ for each year. The future insufficiency of the pension funds will be related to the dependency ratio. If we use the real dependency ratio in our calculations, the future scenario will be very different from that calculated using the simple dependency ratio.

Data and Results

The Current Pension Contribution and Benefit

In our simulation, we assume that the system has been extended to urban residents and rural areas. As a matter of fact, China has instituted pilot projects in some provinces to implement the pension insurance system for urban and rural residents (see Order No.18 of the State Council in 2011). The differences between the system for urban employees and that for residents have to do with contribution and benefit rates, which are the terms used in our model.

In our simulation, we employ the pension funds from the entire system as our measurement. We consider the three systems together because all of these systems and funds are operated by the central and local governments.

Integrating the three systems allows us to identify the standard contribution and benefit rates.

β_{ti} and i=1, 2, 3 show the different contribution rates. Here, the rate is calculated using the contribution level divided by the Urban Employees Average Salary, although the systems for the different residents do not all contribute to the former.

The standard contribution rate for working-age people is as follows:

$$\overline{\beta}_t = \sum_{i=1}^{3} \beta_{ti} \frac{L_{ti}}{L_t}$$

L_{ti} i=1, 2, 3 represents three subdivisions of working-age people: employees in urban areas, unemployed residents in urban areas and residents of rural areas (Fig. 6).

In our simulation, it is assumed that the future basic pension offered by the state will deliver a basic benefit level at a percentage of the Urban Employees Average Salary that is universally applied to the three parties. This is because only after the standardisation of the benefit rate can this system be called a basic state pension system. In this model, the benefit rate is approximately 30 % of the Urban Employees Average Salary.

The Pension Inadequacy Simulation

If the ROADR is used, our simulation yields much more undesirable results than if the SOADR is used, as shown in Fig. 7.

Consequently, the figures indicating the accumulation and inadequacy of the pension funds will also differ if the ROADR is used, as shown in Fig. 8. The projected accumulation of pension funds will be improved if only the SOADR is considered. The accumulation figures will be lower than zero in 2 years according to the ROADR figures, and the degree of insufficiency will be larger, leaving a significant gap between the future extension of the pension system and the actual finance ability of the program based on worker contributions.

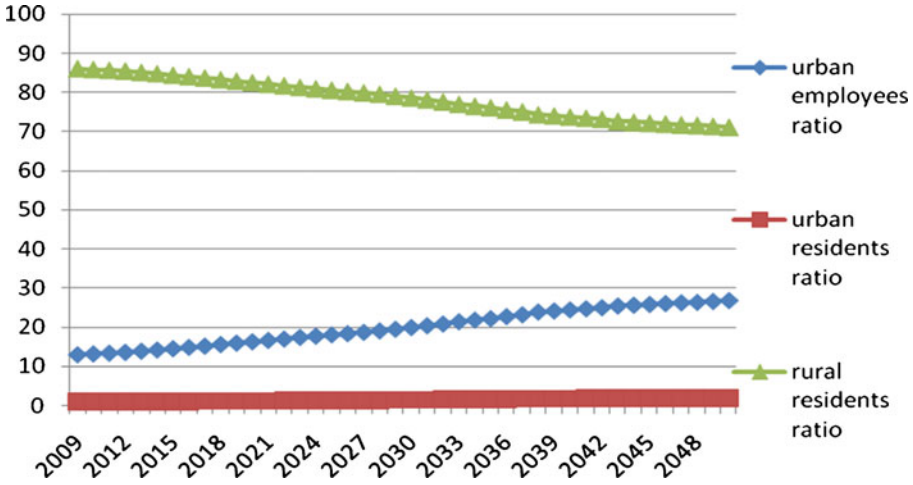

Fig. 6 The future ratios for the three working-age groups

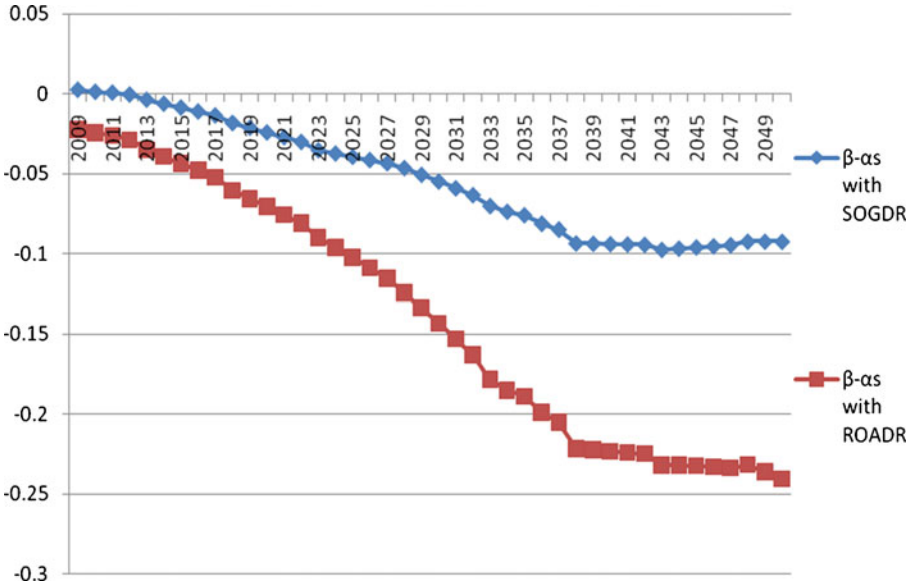

Fig. 7 The $\beta_t - \alpha_t s_t$ in the future using SOADR and ROADR

Conclusions

The pension system in China is still in development. The primary system is the social insurance system, which covers urban employees. This system will be extended to rural and urban residents in the near future. With the country's rapidly ageing population and swift urbanisation, together with the increasing cost of living and rate of inflation, the pension system should take into account all of the factors mentioned in our paper. The population factor is one of the most important considerations. The dependency ratio is used to describe the relationship between the accumulation of pension funds and demographic changes.

This paper presents the novel concept of the real old-age dependency ratio. This ratio is estimated using the CPPS software and basic data. The future insufficiency of

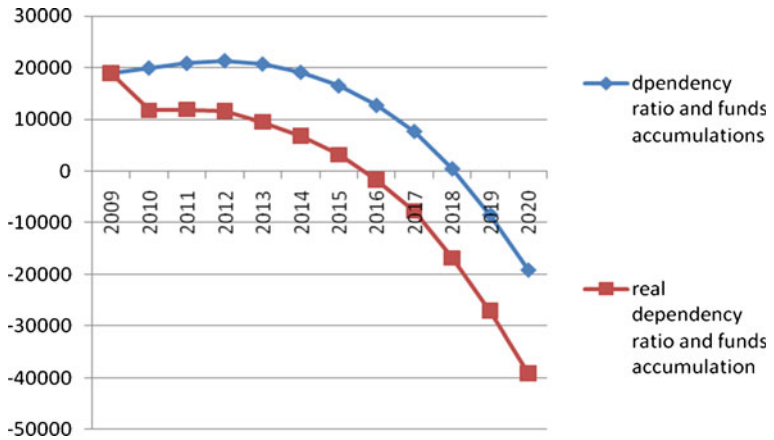

Fig. 8 The pension funds inadequacy in the future using SOADR and ROADR

the pension funds is estimated in this paper, and using the ROADR indicates that this issue is more dire than is sometimes argued. The funding gap will likely occur nearly 3 years earlier than has been projected using the SOADR.

These results have policy implications.

First, these results call for the reform of China's pension structure. On the one hand, the Chinese government should guarantee basic pension benefits, linking them to the CPI to cover all elderly people (especially urban residents) to eliminate elderly poverty. On the other hand, the Chinese government could encourage people to save their pension funds in individual accounts under an EET tax policy (with no taxes on pension savings or pension funds and income taxes levied on pensioners who have the capacity to pay). They could also promote pension trustee governance, pension market funds and prudent investments to increase self-reliance and prudent consumption among elderly people.

The second policy recommendation is that the retirement age for employees and pensioners in China be changed from 55 or 60 to 65 years old and that the retirement age gradually be made the same for women and men. These steps will help decrease the dependence of the elderly on society and increase both employment and social services for the elderly. The channels for investment into pension funds should be enlarged and developed in China in accordance with capital market regulations.

The third policy recommendation is that China develop a population development strategy and improve human resources. It is time to reform the one-child family policy and provide basic birth benefits for mothers and children. It is also very important to develop basic education and occupational training for the younger generations to enhance the capacity of the youth to support the ageing population.

Appendix: Simulation Method and Data for China's ROADR

The Simulation Model

An application called the China Population Prognosis Software (CPPS) is used in our simulation. The simulation employs basic Leslie matrices, which are universally used in other population simulations.

Assuming population P_{t1} at time t_1, then n years later at time t_2, the population will be

$$P_{t2}(x+n) = P_{t1}(x)\frac{\int_{t_2}^{t_2+n} l(x)dx = F(t_1+n)}{\int_{0}^{t_1} l(x)dx = F(t_1)} \tag{1}$$

If the Life Table is used, then

$$\frac{\int_{x}^{x+n} l(x)dx}{\int_{0}^{x} l(x)dx} = \frac{l_{x+n}}{l_x} \tag{2}$$

l_{x1}, l_{x+n} are all taken from the Life Table. The newborn population during this interval must also be calculated. We take the birth rate for women at age x to be b (x);

thus, during the interval used for these calculations, the number of new-born female children is

$$\frac{n}{2}[P_{t1}(x)P_{t2}(x+n)] * b(x) \tag{3}$$

because

$$P_{t2}(x+n) = P_{t1}(x)\frac{\int_{t_2}^{t_2+n} l(x)dx = F(t_1+n)}{\int_{0}^{t_1} l(x)dx = F(t_1)} \tag{4}$$

$$P_{t2}(x+n) = P_{t1}(x)\frac{F(x+n)}{F(x)} \tag{5}$$

We can obtain

$$\frac{n}{2}\left[P_{t1}(x) + P_{t1}(x)\frac{F(x+n)}{F(x)}\right] * b(x) \tag{6}$$

$$P_{t2}(0) = [F(0)/2]\left\{\sum_{x=\alpha}^{\beta}\left[P_{t1}(x) + P_{t1}(x)\frac{F(x+n)}{F(x)}\right]\right\} * b(x) \tag{7}$$

From (5) and (5), together with the population and birth rate in the initial year and the Life Table, we can simulate the future population complexion.

Table 2 The population data and age structure in 2008

Age	Male	Female	Age	Male	Female
0–4	37600901	30503946	50–54	52187147	51485908
5–9	39812852	32793687	55–59	44299887	43134160
10–14	47981961	41394589	60–64	30189402	29232244
15–19	55736189	48848929	65–69	22348365	21827508
20–24	45099210	46091319	70–74	18665163	18879369
25–29	42273957	43878241	75–79	11888387	12903044
30–34	45802705	46674183	80–84	5859075	7316798
35–39	60910935	62310034	85–89	2128523	3257046
40–44	63851183	64342728	90–94	422773	935738.4
45–49	47419391	48072153	95+	87936	214205.2

China Statistical Yearbook-2010 of the National Statistic Bureau

Table 3 The female birth rate at different ages

Age	Birth rate	Age	Birth rate	Age	Birth rate
15	0.001	28	0.9655	41	0.1089
16	0.0025	29	0.8692	42	0.086
17	0.0184	30	0.7233	43	0.1012
18	0.0511	31	0.5999	44	0.0763
19	0.1743	32	0.5463	45	0.0752
20	0.4096	33	0.4786	46	0.0745
21	0.8403	34	0.3793	47	0.0566
22	1.0504	35	0.2966	48	0.0594
23	1.2022	36	0.2631	49	0.0533
24	1.3183	37	0.1973		
25	1.1381	38	0.1991		
26	1.0842	39	0.1521		
27	1.0087	40	0.1229		

China Statistical Yearbook-2010 of the National Statistic Bureau

The Basic Data

The Chinese population data for 2008 are included in the 2009 Annual Statistics of China. The simulated future period is 2009–2050. The 2008 population data are shown in Table 2.

The birth rate data used in our simulation also come from the 2009 Annual Statistics, as shown in Table 3.

China Life's 2009 Life Table, which is used in our simulation, is shown in Table 4.

Other parameters are as follows: the total birth rate is 1.8 in 2000, the female-to-male ratio among newborn children is 1.06, and the urbanisation ratio is 0.46 in 2008.

Table 4 China Life life table (2000–2003)

Age	Male	Female
10	0.000272	0.000147
20	0.00054	0.000246
30	0.000759	0.000351
40	0.001275	0.000615
50	0.002666	0.001393
60	0.006989	0.004272
70	0.020184	0.013337
80	0.056312	0.041241
90	0.149763	0.121107

China Life Insurance Mortality Table (2000 ~ 2003) issued by the China Insurance Regulatory Commission in 2005

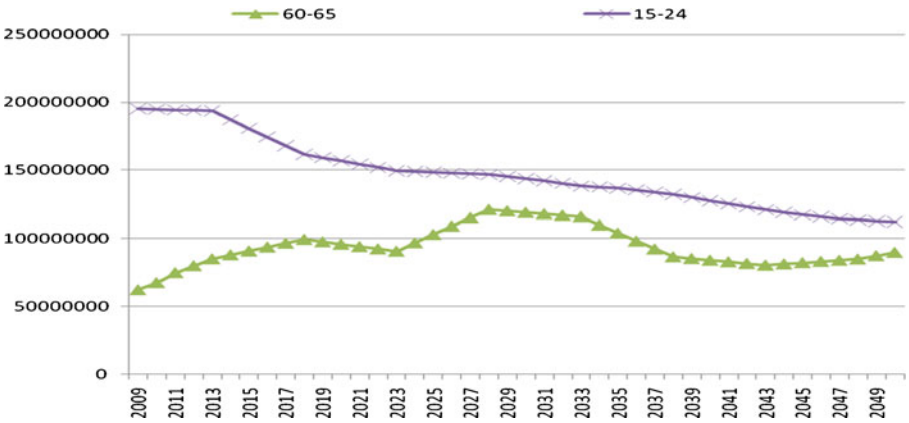

Fig. 9 The 60–65 and 15–24 age populations during 2009~2050

Quantitative Analysis of the Four Factors in our Estimation

For factor 1: *The individuals in the working-age population between 15–24 years of age are defined as working-age students*. In China, students attend primary school from 7–13 years old and middle school from 14 to 16 years old for a total of 9 years of compulsory education. Students attend high school during the 17–18 or 17–19 age range, and the university age range is 19–22 (undergraduate only) or 19–24 (including graduate work). The results of our estimated population within the age range of 15~24 is shown in Fig. 9.

For factor 4: *The population aged 60–64 years old is defined as the population of working-age retirees.* In the future, China may increase the retirement age from 55 or 60 to 65 years old, but there is no formal policy or document stipulating that change as of yet. The population of individuals aged 60 to 64 will be treated as the retired population in advance, so our results obtained using the estimated population in the age range of 60~65 in the next 40 years are shown in Fig. 9.

For factor 2: *Working-age, unemployed individuals*. Calculating the future unemployed population is very difficult due to the imperfect official data. China's

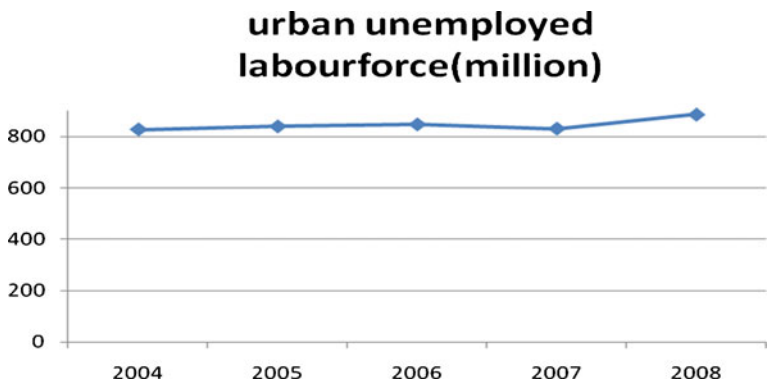

Fig. 10 Urban umemployed labour force population in 2004–2008. Data source: China Statistical Yearbook-2010 of the National Statistic Bureau

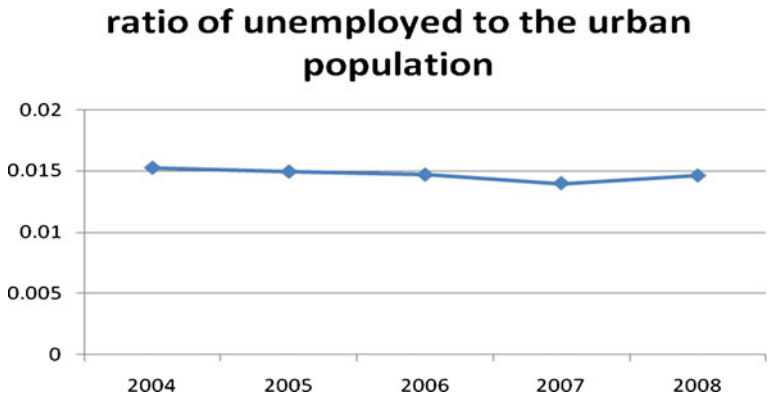

Fig. 11 Ratio of the unemployed population to the urban population. Data source: China Statistical Yearbook-2010 of the National Statistic Bureau

statistical system reflects the figures for only registered urban unemployed people. Thus, the data may not reflect the real unemployment level in the state. The number of registered urban unemployed people since 2004 according to the Annual Statistics of China is shown in Fig. 10.

In our calculations, we use the data from 2004 to 2008 and find that the ratio of the unemployed to the urban population was always approximately 1.5 % during this period, as shown in Fig. 11. Thus, we use the average ratio over these 5 years (0.0146) to predict the future unemployed population in urban areas. This population segment will also be removed from our future projection regarding the working-age population.

There is no formal or official figure for low-income employees, which are defined as those with an income below the Minimum Taxable Income. It is difficult to predict the future size of this population. According to a 2009 research report issued by the Ministry of Finance of China, the number of income tax enlistment is 0.85 billion. If an employee has to pay income tax 12 times a year, then the number of employees whose income is above the Minimum Taxable Income is 70.83 million, which amounts to 30 % of the entire urban

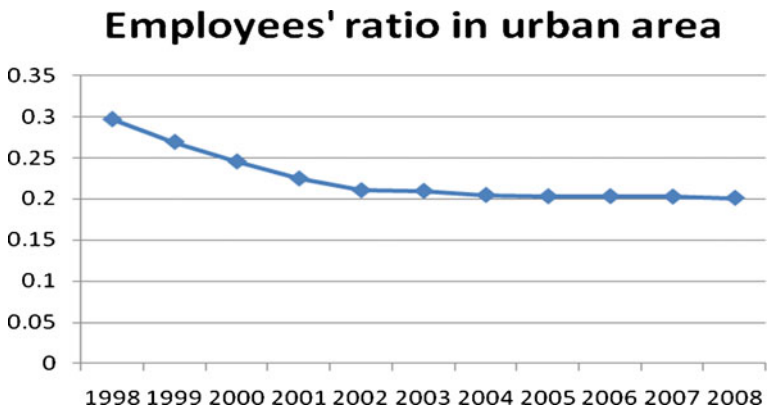

Fig. 12 Employees' ratio in urban areas in last 10 years. Data source: 2010 China Statistical Yearbook of the National Statistic Bureau

employee population. Additionally, according to the statistics for the period from 2004 to 2008, the share of urban employees remained at approximately 20 % of the entire urban population during that period (Fig. 12).

For factor 3: *The low-income population is defined as those whose income is less than the income tax allowance.* The income tax allowance in China is 2,000 rmb per month and will be 3,000 rmb and more in the coming years.

Therefore, the future projections regarding low-income employees can be calculated as follows:

$$P(lowincome)(i) = P(urban)(i) * 20\% * 70\%$$
$$i \in (2009, 2050)$$

We use 20 % of the projected number of urban employees to calculate the number of urban employees and determine that 70 % of future employees will earn below the Minimum Taxable Income.

References

Bao, L. (2010). The influence of the ageing population to the urban employees' pension insurance system in China. *Journal of China's Demographic Science, 1*, 84–92.

Disney, R. (2000). Declining public pensions in an era of demographic ageing: will private provision fill the gap? *European Economic Review, 44*, 957–973.

Leers, T., Meijdam, L., & Verbon, H. A. A. (2003). Ageing, migration and endogenous public pensions. *Journal of Public Economics, 88*, 131–159.

Mason, A., & Kinugasa, T. (2008). East Asian economic development: two demographic dividends. *Journal of Asian Economics. Journal of Asian Economics, 19*, 389–399.

Rosenburg, M., & Everitt, J. (2001). Planning for aging populations: inside or outside the walls. *Process in Planning, 56*, 119–168.

Tinker, A. (2002). The social implications of an ageing population. *Mechanisms of Ageing and Development, 123*, 729–735.

United Nations. (1999). Demographic Yeartiook. http://unstats.un.org/unsd/demographic/products/dyb/1990_round.htm

Yashiro, N. (1997). Aging of the Population in Japan and Its Implications to the other Asian Countries. *Journal of Asian Economics, 8*(2), 245–261.