Population Ageing, Pension System and Retirement Age Extension in China --- an Applied Dynamic General Equilibrium Analysis

1. Introduction

China has experienced remarkable economic growth in the past three decades. Her growing labour force has played an important role in this extraordinary growth phase (World Bank, 2012). However, the situation will change. The growth of the working age population will stop at around 2015 and turn strongly negative afterwards. Meanwhile, the proportion of the old population aged 65 and over will increase dramatically, from 8.2 per cent in 2010 to an estimated 25.6 per cent in 2050 (United Nations, 2010). As a result, the support ratio which is defined as the ratio of working age population to the elderly population will drop significantly from 8.8:1 in 2010 to 2.4:1 in 2050. This poses a significant threat to China's pension system and the sustainability of economic growth. Furthermore, China's low retirement age compounds the ageing problem. Currently the retirement age is 60 for male employees, 55 for female officials and 50 for female workers. Recognition of the current retirement ages would yield an even lower support ratio. To mitigate the negative effects of the shrinking support ratio on economic growth, it is essential to secure an adequate labour force participation among the current working age population (World Bank, 2012). Increasing the official retirement age is one of the strategies to encourage labour force participation.

Using the tools of dynamic CGE modelling, this paper will estimate the effect of retirement age extension on the supply of labour and, therefore, on China's economic growth over the period of 2010 to 2030.

2. Methodology and modelling framework

2.1 CHINAGEM model and its core theory, structure and dynamic mechanism

The model we used in this paper is CHINAGEM – a dynamic computable general equilibrium model of the Chinese economy. The original database of the CHINAGME model includes 142 sectors and its base data reflects the 2012 input-output structure of the Chinese economy. The core CGE structure is based on ORANI, a static CGE model of the Australian economy (Dixon et al 1982). The dynamic mechanism of CHINAGEM is based on the MONASH model of the

Australian economy (Dixon and Rimmer, 2002). The CHINAGEM model captures three types of dynamic links: physical capital accumulation; financial asset/liability accumulation; and lagged adjustment processes in the labour market.

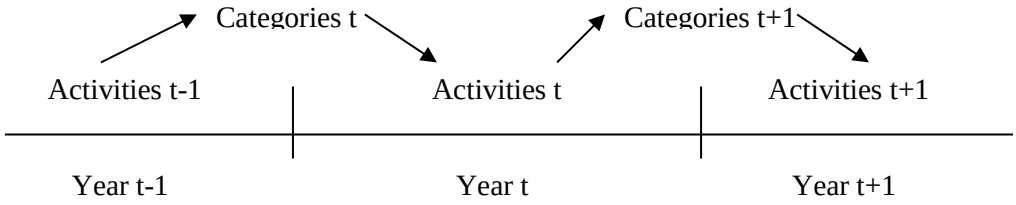
In CHINAGEM, production is modelled using nested constant elasticity of substitution (CES) and Leontief production functions which allow substitution between domestic and imported sources of produced inputs and between labour, capital and land. The production functions are subject to constant returns to scale. Household demand is modelled by the linear expenditure system (ELES). Trade is modelled using the Armington assumption for import demand and a constant elasticity of transformation (CET) for export supply. China is considered as a small open economy in import markets with foreign import prices determined in world markets. Exports are demanded according to constant-elasticity demand curves for most commodities. In the model, capital stock is accumulated through investment activities (net of depreciation). Investors respond to changes in the expected rate of return.

2.2 Extension of CHINAGEM model

2.2.1 Labour market module

The original version of CHINAGEM lacks the capacity to model pension issues in detail. In this version, there is only one type of labour and no pension account and government account. Given that different type of labour in China is eligible to participate in different pension insurance scheme, so it is necessary to have different labour types in the model. In this paper, following Dixon and Maureen (2009) and Mai et.al (2013) we introduced a labour market module into CHINAGEM model. The labour market module is designed to capture China's unique household registration system and other institutional barriers in the labour market. Two crucial concepts in the CHINAGEM labour market module are categories and activities of labour supply. At the start of year t, labour that will be available during the year are allocated to categories of labour supply. The categories are determined mainly on the basis of employment during the preceding year (t-1). Activities in year t are what people do in that year. The relationship between activities and categories is illustrated in Figure 1.

Figure 1: Labour market dynamics



The labour market module contains ten labour supply categories: five employment categories, three unemployment categories, and two new entrant categories (Table 1). The first eight of these categories are associated with corresponding activities. For example, the category AG for year t refers to the number of employment in rural agriculture in year t-1 that is still available for employment in year t. The activity AG for year t refers to the number of labourers actually absorbed in rural agricultural employment in year t. Most of the AG-category labour in year t is employed in activity AG in year t. However, some AG category labour may flow to other activities, and some labour from other categories may flow to the AG activity.

Different categories have different labour supply behaviour and there are different degrees of mobility between categories. We treat the entire rural labour force as unskilled workers and we assume that all rural employment and unemployment categories can only make offers to work in rural activities (AG, RNAG, and RUE) because of China's residential registration (hukou) system. But rural new entrants (NRUR) can make offers to rural as well as urban activities. This is based on the assumption that some urban enterprises recruit new entrants from rural areas and grant them urban residential status. Rural new entrants with university degrees may acquire a job in a skilled urban occupation and obtain urban residential status. For the urban labour force we disaggregate into two employment categories, urban skilled employment (USE) and urban unskilled employment (UUSE); one unemployment category (UU); and one new entrant category (NURB). We assume that urban categories make offers only to urban activities (UUSE and USE). We assume no voluntary unemployment in China. Consequently, no category makes offers to unemployment. We summarize the labour supply categories and activities in Table 4.

The number of persons employed in an activity in the current year is determined by the demand for and supply of that activity. Those who make an offer to an employment activity but do not get a job in that activity will be forced back to their previous employment activity or to the

relevant unemployment activity.

The labour market module of the CHINAGEM model has the following equation blocks:

- demand for and employment of labour by activity;
- supply of labour by category;
- wage adjustment reflecting the gap between demand and supply;
- the determination of everyone's activity in year t; and
- linking the number of people in activity o in year t to the number of people in category c in year t+1.

Please refer to Mai et al (2013) for a formal presentation of the labour market module.

Table 1: Categories and Activities

	Employment categories and activities
AG	**AG**riculture - Person-years of employment in rural agriculture sectors with rural residential status
RNAG	**R**ural **N**on-**AG**riculture – Person-years of employment of rural people in non-agriculture industries within their township of residence, such as in township and village enterprises and private enterprises in rural areas
RUE	**R**ural-**U**rban **E**mployment – Person-years of employment of rural people in non-agriculture industries outside of their township of residence
UUSE	**U**rban **U**n**S**killed **E**mployment – Person-years of employment of urban people in unskilled occupations
USE	**U**rban **S**killed **E**mployment – Person-years of employment of urban people in skilled occupations
	Unemployment categories and activities
RAGU	**R**ural **AG**ricultural **U**nemployment – Person-years spent by rural workers without a job in their township of residence
RUU	**R**ural-**U**rban **U**nemployment – Person-years spent by rural workers without a job outside their township of residence
UU	**U**rban **U**nemployment – Person-years of urban labour force that are not employed
	New entrants categories (no corresponding activities for these categories)
NRUR	**N**ew entrants **RUR**al – Person-years of new entrants into labour force with rural residential status
NURB	**N**ew entrants **URB**an – Person-years of new entrants into labour force with urban residential status

The category of labour supply in the labour market module is consistent with China's pension insurance schemes. Based on the statistical data we assume that all the urban skilled workers (USE) and 80 per cent of the urban unskilled employment (UUSE) workers participate in the Urban Employees' Basic Pension Scheme (Scheme 1). The rest of 20 per cent of UUSE worker participates in the Urban and Rural Residents' Pension Scheme (Scheme 2) (see Table 2). These workers may include some self-employed urban workers and some workers who are

employed in the small private factories or companies.

Table 2: China's current pension system -- coverage of each pension scheme

Labour category	Urban Employees' Basic Pension Scheme (Scheme 1)	Urban and Rural Residents' Basic Pension Scheme (Scheme 2)
USE	100%	---
UUSE	80%	20%
RUE	25%	75%
AG	---	100%
RNAG	---	100%
UU	---	100%
RAGU	---	100%
RUU	---	100%
REST*	---	100%

Please note: REST* includes the urban and rural new entrants (NURB and NRUR) and the rest of all labour force who does not include in the labour categories in Table 1.

For the rural urban migrant workers (RUE), according to China's statistical Yearbook there was around XXX RUE workers in the urban area in 2012. However their participation rate of urban employees' basic pension scheme was very low which is around 25 per cent. There are many reasons for the low participation rate: (1) high contribution rate. Since RUE workers' wage in average is lower than UUSE workers. Contributing the same rate of their wage (20 per cent) to the social pool for most of RUE workers is too high (references); (2) unstable job. The nature of RUE workers implies that their jobs are relatively not very secure. Changing job or moving back to their hometown after a short period of work in the urban area is very common for RUE workers. Therefore, majority of RUE workers are reluctant to participate in the urban employees' basic pension scheme; (3) un-transportable pension account. Based on the currently policy, once a RUE worker move to another province, the worker will lose the contribution paid by his employers to his social pool account. He can only get back his contribution in his private fund but not the contribution in the social pool. The un-transportability of the pension account discourage RUE workers to participate in the urban employees' pension scheme. From XXX government began to remove this policy and in some provinces, pension contribution of

social pool is portable. This reform will encourage RUE workers participation in the pension scheme.

For the agricultural workers (AG) and rural non-agricultural workers (RNAG), we assume they all participate in the Scheme 2.

We assume that all unemployed workers including UU, RAUU and RUU, and the rest of urban and rural residents (REST) participate in the Scheme 2 (Table 2).

2.2.2 Pension module

The pension module we developed for this study captures China's current pension schemes. It includes two parts: first part is about urban employees' basic pension scheme (scheme 1) and the second part is about urban and rural residents basic pension scheme (scheme 2). Scheme 1 includes two pillars: pillar one is the social pool and pillar two is the private fund. Scheme 2 includes two pillars as well. However currently the pension fund of pillar two in scheme 2 is very small in China, so in the current version of pension module, we ignore pillar two and only consider pillar one in scheme 2.

2.2.2.1 Urban Employees' Basic Pension Scheme –Scheme 1

- ***Pillar one***

We first define the contribution by labour category to pillar one:

$$CONTRIBUTION1\_1(o)_t = CRATE1 * Wagelevel(o)_t * Emperson(o)_t * COVERAGE\ (o) * P\_ACON\_P1\_O1_t \quad (1)$$

Where $CONTRIBUTION1\_1(o)_t$ is the contribution made to pillar one, Scheme 1 by labour catogory o at yeat t. Currently only three labour catogories -USE, UUSE and RUE - are participating in this scheme, so o refers to the labour catogory of USE, UUSE and RUE. $CRATE1$ is the contribution rate which is 20 per cent of their wage for these labour catogories. $Wagelevel(o)_t$ is the wage level of catogory o at year t. $Emperson(o)_t$ is the total number of employed persons of catogory o at year t. $COVERAGE\ (o)$ is the coverage (participation) rate of catogory o in this scheme. As we discussed in the last section, the participation rate of USE, UUSE and RUE is 100 per cent, 80 per cent, 25 percent for USE, UUSE and RUE,

respectively. $P\_ACON\_P1\_O1_t$ is the actural participation rate at year t. Some wokrers partipated in the sheme but not regularly pay the contribution or stop paying contrbution after contributing several years. Here the actural participation rate is the real participation rate after excluding those workers. The actural participation rate from 2012 to 2016 is calculated from by using historical data. From 2017 and onwards, we assume that the acutral participation rate remains at the 2016 level.

$$Stock1\_1_t = Stock1\_1_{t-1} + Stock1\_1_{t-1} * IntRate + \sum_o Contribution1\_1(o)_t + Government1\_1_t - \sum_o Payment1\_1(o)_t \quad (2)$$

Equation 2 is the eqaution about the pension stock of pillar one, Scheme 1. It says that the pension stock at year t is last year's stock plus the interest erned, the workers's contribution and government subsidies at year t, then subtract the payment to retired eligible workers at year t. Where $Stock1\_1_t$ and $Stock1\_1_{t-1}$ is the pension stock of pillar one at year t and year t-1, respectively. IntRate is the interest rate of the economy. $\sum_o Contribution1\_1(o)_t$ is the sum of contibution paid by different labour catogory o at year t. $Government1\_1_t$ is the government subsidies to pillar one at year t. $\sum_o Payment1\_1(o)_t$ is the sum of payment to retired workers by labour catogory o at year t.

Based on China's current pension policy, the pension payment is paid to eligible workers based on which year the eligible worker started to work and which year the eligible workers retired. The eligible workers who retired before 1996 is called "old pensioners". Their pension payment at year t is simply the fourty per cent of the average wage level at year t. We did not disaggregate pension payment to the "old" workers by their labour catogory becuase the goverment pays these workers 40 per cent of the current year average wage level regardless of their labour catogory. Furthermore, there is no rural urban migrant workers (RUE) among these "old" workers.

$$Payment\_Old_t = Wagelevel_t * 40\% \quad (3)$$

Where $Payment\_Old_t$ is the payment at year t to eligible "old workers" who were retired before 1996.

For the "new" workers who started working in and after 1996 at labour catogory o, their pension payment for pillar one at year t $Payment\_New(o)_t$ is one per cent of their wage level

at year t-1 time years worked. Every eligible worker may have different years of working when he/she retires (equation 4). In this paper, we use the avegage years of working index for all labour catogorie. The avegage years of working is calabrated in the model from year 2013 to 2016 based on the actutal pension payment data and number of workers who received pension paymnet from this scheme. For the year 2017 and onwards, we assume that years of working remains as the same as the year 2016.

$$Payment\_New(o)_t = Wagelevel(o)_{t-1} * years\ of\ working * 1\% \quad (4)$$

For the "middle" workers who started to work before 1996 and not retired before 1996, their pension payment includeds two parts: the first part is one per cent of wage level of the labour catogory o at year t -1 times years of working; the second part is 0.03 per cent of wage level of the labour catogory o at year t-1 times years of working before 1996.

$$Payment\_Middle(o)_t = Wagelevel(o)_{t-1} * years\ of\ working * 1\% + Wagelevel(o)_{t-1} * (1996 - YearRetired) * 0.03\% \quad (5)$$

- ***Pillar two***

When we define the contribution to pillar two (priave account), we start with the individal contirbution.

$$Con\_PP2\_1(a,o)_t = Crate2\_1 * Wagelevel(o)_t \quad (6)$$

Where $Con\_PP2\_1(o)_t$ is pension contirbution made to pillar two by per worker of labour catogory o and aged a at year t. $Crate2\_1$ is the contribution rate of pillar two, which is curretnly 8 per cent of the wagelevel for all labour catogories. Euation 6 means that contirbution made to pillar two by individual worker at catogory o and aged a is simply 8 per cent of his/her salary.

The stock or accumulated contribution of each worker's private account of labour category o at age a, at the start of year t is the stock accumulated in the last age, a-1 at year t-1, plus the interest earned and the contribution made at age a-1.

$$Stock\_PP2\_1(a,o)_t = Stock\_PP2\_1(a-1,o)_{t-1} + Stock\_PP2\_1(a-1,o)_{t-1} * IntRate + Con\_PP2\_1(a-1,o)_{t-1} \quad where\ a \in 20-58 \quad (7)$$

In China under the current retirement policy, the retirement age is 50 for female workers, 55 for female officers and 60 for male employees. In the CHINAGEM model, we do not have

gender disaggregation, so we calculated the average retirement age of the 2012 labour force, which is 58. We assume that the average retirement age of the labour force is 58 from 2012 and onwards if the Chinese government keeps its current retirement policy. In equation 7, we calculate per worker's pension stock accumulated in pillar two at age a, where age a ranges from 20 to 58.

In equation 7, $Stock\_PP2\_1(a,o)_t$ is the pension stock of pillar two per worker of category o at age a, at the beginning of year t. The pension stock per worker after he/she has retired is calculated using following equation:

$$Stock\_PP2\_1(a,o)_t = Stock\_PP2\_1(a-1,o)_{t-1} + Stock\_PP2\_1(a-1,o)_{t-1} * IntRate + Payment\_PP2\_1(a-1,o)_{t-1} \quad where\ 58 < a < 100 \tag{8}$$

Equation 8 shows that an eligible workers' pension stock at the start of year t after he/she has retired equals his/her pension stock in the previous age at year t-1plus the interest earned, then deduct the pension he/she received in year t-1. Where $Payment\_PP2\_1(a-1,o)$ is the pension received by the eligible worker of labour category o. $Payment\_PP2\_1(a-1,o)$ is calculated in equation 11.

The total pension stock of pillar two for the working age workers (age 20-57) and the first year of retirement age 58, is calculated as follows

$$Stock\_AG2\_1(a,o)_t = Stock\_PP2\_1(a,o)_t * EMPERSON(a,o)_t * COVERAGE(o)_t * P\_ACON\_P2\_1_t \quad \text{where a} \in 20-58 \tag{9}$$

Where $Stock\_AG2\_1(a,o)_t$ is the aggregated pension stock of labour category o at age a in year t. $P_ACON_P2_1_t$is the actural participation rate of the pillar 2, scheme 1 in yeart t. Equation 9 says that total pension stock of pillar two for the working age workers of labour catogory o at age a in year t is per person pension stock of labour catogory o at age a in year t times the total number of employed persons of caogory o at age a at year t indexed by the coverage rate of category o and the actural participation rate in year t.

For the retired wokers (aged 58 above), the total pension stock of pillar 2 is

$$Stock\_AG2\_1(a,o)_t = Stock\_PP2\_1(a,o)_t * PopRetire(a,o)_t * COVERAGE(o)_t * P\_ACON\_P2\_1_t \quad \text{where } 58 < a < 100 \tag{10}$$

Where $PopRetire(a,o)_t$ is the eligible retired workers of category o at age a in year t. The aggregated pension stock of labour category o at age a in year t is per worker's pension stock of category o at age a in year t times the number of retired workers of category o at age a in year t indexed by the coverage of pension scheme and actual participation rate of pension scheme in year t.

The annual pension payment of each eligible retired workers received from pillar two or their private account is simply one fifteenth of their pension stock at age 58 (Equation 11). This means that the government assumes that in average, eligible workers will pass away after 15 years of their retirement. If the eligible worker is still alive after fifteen years of their retirement, then the government will continue to pay his/her pillar two pension even though his/her private account has already become empty.

$$Payment2\_1\ (o)_t = Stock\_PP2\_1("58", o)_t/15 \tag{11}$$

Where $Payment2\_1\ (o)_t$ is the annual payment an eligible worker of category o received from his/her private account. $Stock\_PP2\_1("58", o)_t$ is the pension stock a worker of category o has accumulated when he reaches his retirement age 58.

2.2.2.2 Urban and rural residents' basic pension scheme – Scheme 2

Under China's current pension system, all the residents aged 20 and over should participate either urban employees' basic pension scheme (scheme 1) or urban rural residents' basic pension scheme (scheme 2). If a resident is not eligible for participating in Scheme 1, he/she should contribute to Scheme 2. As we mentioned in last section, Scheme 2 has two pillars as well - pillar one (social pool) and pillar two (private account). Since the participation rate and total pension fund of the pillar 2 are currently very small, so in this study we ignore the pillar two.

- ***Contribution to the scheme***

The pension fund for Scheme 2 includes three parts: government subsidy, individual contribution and interest. Unlike Scheme 1, Scheme 2 is manly funded by central and local governments and individual's contribution is very small. In 2012, individual contribution to Scheme 2 is only 166 Yuan RMB. It increased to 226 yuan RMB in 2016. The total contribution to this scheme is calculated as follows:

$$ContributionAG\_2A(o)_t = Con\_PP\_2_t * Persons\_2\ (o)_t$$

where o belongs to USE,UUSE and RUE (12)

$$Persons_{2(o)_t} = \left(1 - Coverage(o)\right) * \left(\sum_a Emperson(a, o)\right)_t$$

$$where\ a \in 20 - 57 \quad (13)$$

Equation 12 says that for the labour category of USE, UUSE and RUE workers, their contribution to pension fund, $ContributionAG\_2A$ at year t equals contribution paid per person at year t times the total number of workers in each category who participate in the scheme at year t, $Persons\_2(o)$. Equation 13 shows that $Persons\_2(o)$ at year t equals the employed persons summed by age who do not participate in the urban employees' basic pension scheme. As we displayed in Table 2, the coverage rate of scheme 1 for USE, UUSE and RUE workers is 100 per cent, 80 per cent and 25 percent, respectively. Then the coverage rate for scheme 2 for USE, UUSE and RUE workers would be zero, 20 per cent and 75 per cent, respectively.

For the residents who belongs to the rest of labour category listed in Table 2, their contribution to the pension fund at year t equals contribution paid per person Con_PP_2 at year t times total number of persons in each labour category at year t, $Persons\_2(o)$ and then adjusts using the actual participant rate P_ACON_P2 at year t. Here we assume that per person's contribution to the fund is the same for all the labour categories.

$$ContributionAG\_2B(o)_t = Con\_PP\_2_t * Persons\_2\ (o)_t * P\_ACON\_P2_t \quad (14)$$

Where o belongs to the labour category AG, RNAG, UU, RAGU, RUU and REST.

The stock of the pension fund is defined as

$$Stock\_2_t = Stock\_2_{t-1} + Stock\_2_{t-1} * IntRate + \sum_o ContributionAG\_2(o)_t + Goverment\_2_t - PaymentAG\_2_t \quad (15)$$

Equation 15 suggests that the stock of the pension fund at year t is the stock of last year plus the interest earned plus the sum of contribution made at year t by all labour categories and the government subsidy at year t, $PaymentAG\_2_t$, then subtract the payment paid to the eligible residents at year t, $Payment\_2_t$.

- ***Payment received from the scheme***

The eligible residents will receive their pension payment from the scheme after they reach the retirement age which in average is 58 years old. The pension payment is defined as

$$PaymentAG\_2_t = PaymentPP\_2_t * PersonsPay\_2_t \quad (16)$$

Where $PaymentPP\_2_t$ is the pension payment per person from the scheme at year t, which is decided by the government. According to the Yearbook of China Social Security, in 2012 pension payment per person is 880 yuan RMB and it increased to 1408 yuan RMB in 2016. We assume that per person pension payment will increase at the rate of GDP from 2017 and onwards in the baseline scenario. $PersonsPay\_2_t$ is the total number of eligible residents who will receive pension payment from this scheme at year t. It is defined as

$$PersonsPay\_2_t = \{PopRetire_t - \sum_o PopRetire(o)_t\} * EliRate_t$$

where o belongs to USE,UUSE and RUE (17)

The total number of residents who are eligible to get the pension payment from the Scheme 2 at year t is the total retired population at year t subtracts the persons who get the pension payment from scheme one, then adjusts using the actual eligible rate at year t. The eligible rate is calibrated using the historical data from 2012 to 2016. From 2017 and onwards, we assume that the eligible rate remains at its 2016 level.

2.2.3 Government account

In China, central and local governments provide subsidies to both urban employees' basic pension and urban and rural residents' basic pension schemes. According to the statistical data, pillar one- the social pool of the scheme 1 has been running deficit for several years. With the expected rapid ageing, we would like to know if the Chinese government continues the current

pension system, how much the deficit of social pool will accumulated. If the government chooses to finance the deficit how much the government general budget deficit will increase to and what the impact of the huge deficit on the macro economy? In order to answer these questions, we introduce the government account into the CHINAGEM model.

As we know that government general budget balance is defined as government general budget revenue subtracts the general government budget expenditure.

- **General government budget revenue**

In China, general government budget revenue mainly comes from two sources: tax revenue and non-tax revenue. The tax revenue includes 21 different tax revenues. In this study, we aggregate the 21 different tax revenues into three broad groups: (1) income tax revenue which includes corporate income tax and individual tax revenues; (2) tariff revenue and (3) other tax income revenue which includes the rest of 18 tax revenues. Based on 2017 China Statistical Yearbook, we find out that the shares of above three tax income and non-tax income revenues over the GDP from 2012 to 2016 in average is 4.6 per cent, 0.4 per cent, 12.3 per cent and 3.2 per cent of GDP, respectively. In our baseline scenario from 2017 to 2050, we assume that these shares remain at these levels (Figure 3 in section 3).

- **General government budget expenditure**

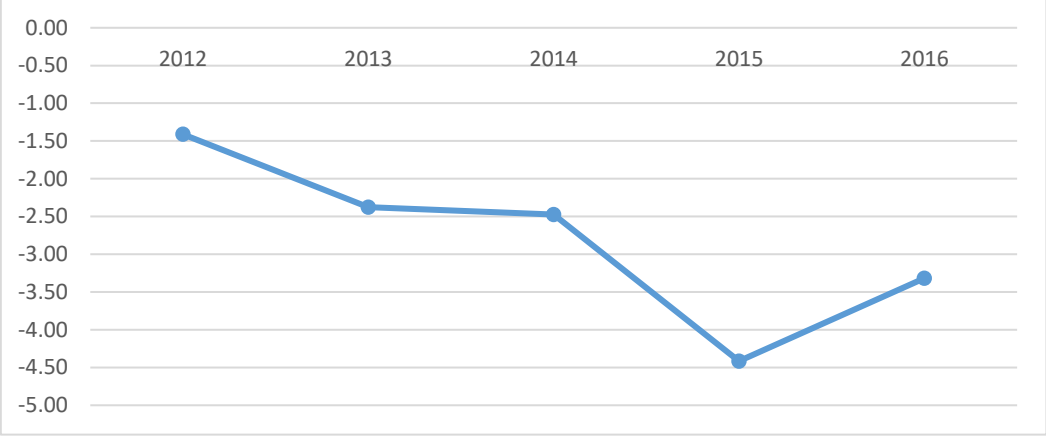
In China, general government budget expenditure mainly includes 23 items. In this study, except the item of "expenditure for social safety net and employment effort", we aggregate the 22 items into the following broad groups: (1) Expenditure for general public service; (2) Expenditure for education; (3) Expenditure for medical and health care and family planning; (4) Expenditure for other services. For the item of "expenditure for social safety net and employment effort", we further disaggregate it into four sub-items: (5.1) Expenditure for urban employees' basic pension scheme; (5.2) Expenditure for urban and rural residents' basic pension scheme; (5.3) Expenditure for health care insurance and (5.4) Expenditure for other insurances. Based on 2017 China Statistical Yearbook, we calculate the shares of above expenditure items over the GDP from 2012 to 2016. We find that the average shares of the first four expenditure groups over GDP from 2012 to 2016 are 5.9 per cent, 3.5 per cent, 1.8 per cent and 9.7 per cent, respectively. The expenditure for urban employees' basic pension scheme only accounted for 0.5 per cent of GDP from 2012 to 2014 and it increased to 0.6 per cent in 2015 and further to 0.8 per cent in 2016. We assume that in our baseline scenario from 2017 to 2050, the share of expenditure for urban employees' basic pension scheme over GDP will

remain at its 2017 level of 0.8 per cent. For the expenditure for urban and rural residents' basic pension scheme, it only accounted for 0.2 per cent of GDP from 2012 to 2016. In our baseline scenario from 2017 to 2050, we also assume that this share will remain its 2016 level of 0.2 per cent. For the expenditure for health care insurance and other insurances, we assume that the share of expenditure for health care insurance and other insurances over GDP will remain its 2016 level of 1.62 per cent in our baseline scenario from 2017 to 2050 (Figure 4 in section 3).

- **General government budget balance**

Based on the 2017 China Statistical Yearbook, China's general government budget balance has been in deficit since 2012. The amount of deficit accounted for 1.4 per cent of GDP in 2012. It increased to 2.4 per cent in 2013 and 2.5 per cent in 2014, further jumped to 4.4 per cent in 2015 and then drop back to 3.3 per cent in 2016. Even though the government general budget balance has been in deficit, its size has been controlled under 5 per cent of GDP (Figure 2).

Figure 2: Change of general government budget balance as share of GDP (%)



Source: China Statistical Yearbook, 2017

3 Development of Baseline scenario and simulation results

To analyse the economic effects of the retirement age extension, we first develop a baseline scenario - a business-as-usual scenario without the implementation of the policy change[1]. Then we conduct a policy simulation, an alternative forecast with the change in the retirement age. The effects of the policy change are measured by deviations of variables in the alternative forecast from their baseline levels.

[1] For more detail about how the business-as-usual scenario is developed for the CHINAGEM model, see Mai 2006.

3.1 Macro variables in the baseline scenario

To develop the baseline scenario, using the data from China Statistical Yearbooks and World Bank Development Indicators database, we first update the model's database to 2016. Then for the forecast period 2017 to 2050 we assume that the growth pattern of the Chinese economy will follow its historical trend but at progressively lower rates. For example, while the average annual growth rate of real GDP between 2012 and 2016 is 7.16 per cent we assume that the average growth rate of real GDP from 2017 to 2020 is 6.76 per cent, 6.5 per cent from 2021 to 2025, 6.0 per cent from 2026 to 2030, 5.5 per cent from 2031 to 2035, 5 per cent from 2036 to 2040, 4.5 per cent from 2041 to 2045 and 4.3 per cent from 2046 to 2050 (Table 3). We further assume that the service sector will increase faster than the industrial sector and that imports will increase faster than exports from 2017 onwards (Table 3). The growth rates of rural migrant workers and other labour categories in the baseline scenario are endogenized and determined by the exogenous macro variables such as investment, consumption and export, and the growth rates of agricultural, industrial and service sectors, and the growth rate of total labour force (refer to Table 3 for the baseline results). The growth rate of the exogenous variable such as total labour force is calculated based on the growth rate of working age population and the aggregate labour force participation rate we will discuss in section 4 (please refer to Figure 11). In the baseline scenario, we assume that the cohort labour force participation rates will remain at their 2010 levels until 2050. The growth rate of working age population is from the medium variant of population projection conducted by Zuo et. al. (2018).

Table 3 shows that China will experience sustained labour force declining in the future. The labour force will decline at a rate of 0.33 per cent in 2020 and further down to 0.64 per cent in 2030. It will further drop at a rate of 1.32 in the middle of the century. The baseline simulation shows that with the continuously declining labour force, China has to reply on the capital stock growth and total factor productivity improvement to sustain its economic growth. China's productivity improvement has to remain at above 2 per cent annually in the forecast period of 2017 to 2050.

Table 3: Summary of baseline calibration*

	2018	2020	2030	2040	2050
Exogenously specified variables					
Annual growth rate (%)					
Investment	6.1	5.84	4.60	3.45	3.1
Consumption	9.35	9.02	7.51	6.26	5.27
Export	7.74	7.42	5.8	4.93	4.05
Real GDP	6.8	6.7	5.77	4.81	4.02
Labour force	-0.4	-0.33	-0.64	-0.93	-1.32
Output of					
Agricultural sectors	5.71	5.25	3.60	2.04	1.41
Industrial sectors	6.24	5.81	4.36	3.14	2.05
Service sectors	9.12	8.67	7.15	5.99	5.06
Calibrated results					
Annual growth rate (%)					
Capital stock	5.60	5.39	4.69	4.31	4.13
TFP	4.26	4.18	3.83	3.19	2.65
Real wage rate	7.59	7.20	6.19	5.52	5.25
Import	9.6	8.22	6.57	6.40	6.18

Source: Baseline simulation results. ***** Only selected years results are displayed in this table.

Table 3 shows that China will experience sustained labour force declining in the future. The labour force will decline at a rate of 0.33 per cent in 2020 and further down to 0.64 per cent in 2030. It will further drop at a rate of 1.32 in the middle of the century. The baseline simulation shows that with the continuously declining labour force, China has to reply on the capital stock growth and total factor productivity improvement to sustain its economic growth. China's productivity improvement has to remain at above 2 per cent annually in the forecast period of 2017 to 2050.

3.2 Variables and data related with Pension module

The data for the variables related with pension module for the historical period 2012 to 2016 are from the Bulletin on the Development of Human Resources and Social Security in China and the Annual Report on the Development of Chinese Social Insurance, various years. Table 4 shows the details of pension account of Scheme 1 (total amount of pillar one and pillar two) from 2012 to 2016. The pensioners who receive the pension payment of Scheme 1 has increase from 7.446 million in 2012 to more than 10 million in 2016. We can see from Table 4 that from 2012 to 2016, the pension fund is in surplus and the pension stock has been increased

(accumulated surplus) from 2394 billion RMB in 2012 to 3858 billion RMB. However, based on the Chinese government ??? (reference), the stock of pension fund of pillar one (social pool) has running out at around 2012 and it has been in deficit since then. The government has to use the money in pillar two (personal account) to pay the pillar one pension for the retired workers. In order to accurately forecast the accumulation of pension fund from 2017 to 2050, we have to split Table 4 and get the pension accounts for pillar one and pillar two, respectively. Please refer to Annex A for the details of how we split the data. The pension accounts for pillar one and pillar two from 2012 to 2016 are displayed in Table A1 and Table A2, respectively. Since pension fund of pillar one has run out in 2012, so the increase of pension stock shown in column 8, Table 4 is actually from pillar two.

Table 4: Pension account of Urban Employees' Basic Pension Scheme (billion RMB)

	Pensioners (million) (1)	Contribution (2)	Government Subsidy (3)	Interest income and other (4)=(5)-(2)-(3)	Total Revenue (5)	Total Expenditure (6)	Annual Surplus (7)=(6)-(5)	Accumulated Surplus (8)
2012	74.46	1646.7	264.8	88.6	2000.1	1556.2	443.9	2394.1
2013	80.41	1863.4	301.9	90.3	2268	1847	408.62	2838.0
2014	85.93	2033.1	359.4	118.0	2531	2175.5	334.92	3246.6
2015	91.42	2301.6	471.6	127.93	2934.1	2581.3	319.83	3581.5
2016	101.03	2676.8	651.1	129.74	3505.8	3185.4	272.245	3901.4

Source: Bulletin on the Development of Human Resources and Social Security in China, 2012, 21013 and 2015; Annual Report on the Development of Chinese Social Insurance, 2014 and 2016.

Table A2 displays the pension account of pillar one, Scheme 1 from 2012 to 2016. We assume that the stock of pension fund of pillar one is 0 in 2012. Since the annual payment to pensioners (expense) in pillar one (column 5, Table A2) is larger than the annual revenue (contribution plus the government subsidy and interest and other income, the sum of column 1, 2 and 3, Table A2) in pillar one, the annual surplus is negative (Column 6, Table A2). As a result, the stock of pension fund is negative since 2013 (Column 7, Table A2).

Table A3 displays the pension account of pillar two, Scheme 1. With the positive annual surplus, the stock of pension fund increased from 2394.1 billion in 2012 to 5436.3 billion in 2016. Given the amount of contribution in Column 1, Table A2, using the equation one, we calibrated

the actual participating rate of pillar one from 2012 to 2016. Our calculation shows that the actual contribution rare is only 42.1 per cent in 2012, 42.4 per cent in 2013 and it increased to 45.5 per cent in 2016. This calibrated number is consistent with many scholars' observation in China. According to the current pension policy in China, if a worker has continuously contributed to pillar one, Scheme 1 for minimum 15 years, he/she will be eligible to get pension from social pool after he/she retires. This policy obviously discourage workers to continue to contribute to the social pool (pillar one) after they have completed their "15 years" compulsory contribution. In order to reduce the heavy burden of pension, government should consider changing this policy. In the forecast period of 2017 to 2050, we assume that the actual participating rate of pillar one, Scheme 1 will remain at the 2016's level, 45.5 per cent.

Based on the contribution data in column 1, Table A3, using the equation 9, we calibrate the actual participating rate of pillar two, Scheme 1. The calculation shows that the actual participating rate is only 38.6 per cent in 2012, 40.5 per cent in 2013 and it increased to 44.7 per cent in 2016. We assume that the actual participating rate of pillar two, Scheme 1 will remain at the 2016's level, 44.7 per cent in the forecast period 2017 to 2050.

Table 5: Pension account of Urban and Rural Residents' Basic Pension Scheme (billion RMB)

	Pensioners (million) (1)	Contribution (2)	Government Subsidy (3)	Interest income and other (4)=(5)-(2)-(3)	Total Revenue (5)	Total Expenditure (6)	Annual Surplus (7)=(6)-(5)	Accumulated Surplus (8)
2012	130.75	59.4	112.65	10.85	182.9	115	67.9	230.2
2013	137.68	63.6	137.03	4.57	205.2	134.8	70.4	300.6
2014	143.13	66.6	149.75	14.65	231	157.1	73.9	384.5
2015	148.00	70	205.33	10.17	285.5	211.7	73.8	459.2
2016	152.70	73.2	207.31	12.79	293.3	215.1	78.2	538.5

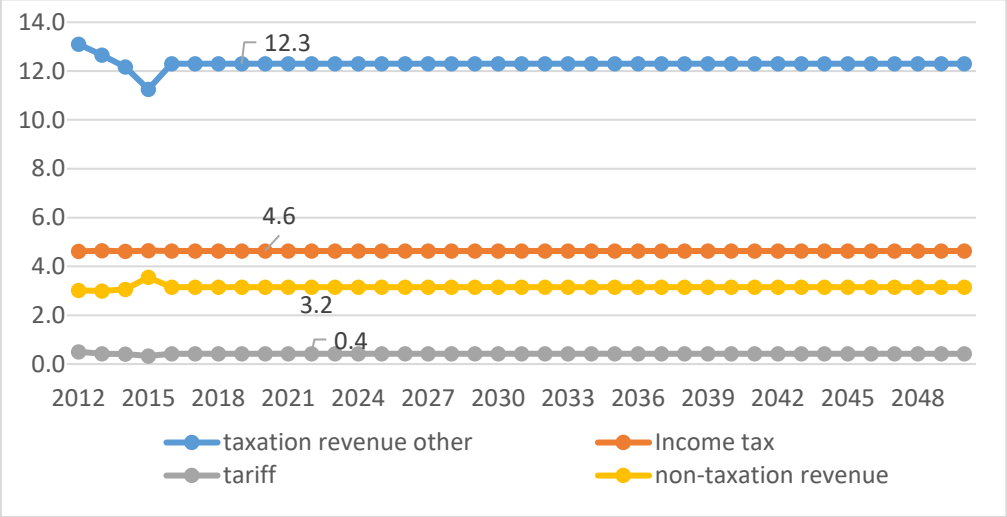
Source: Bulletin on the development of human resources and social security in China, 2012, 21013 and 2015; Annual Report on the Development of Chinese Social Insurance, 2014 and 2016.

Table 5 shows the details of pension account of Urban and Rural Residents' Basic Pension Scheme (Scheme 2). Similarly, based on the contribution data in column 2, Table 5, using the equation 12, we calibrate the actual participating rate of Scheme 2. The calculation results are

displayed in column 8, Table A3. In the forecast period of 2017 to 2050, we assume that the participating rate of Scheme remains at the 2016 level, 61.3 per cent.

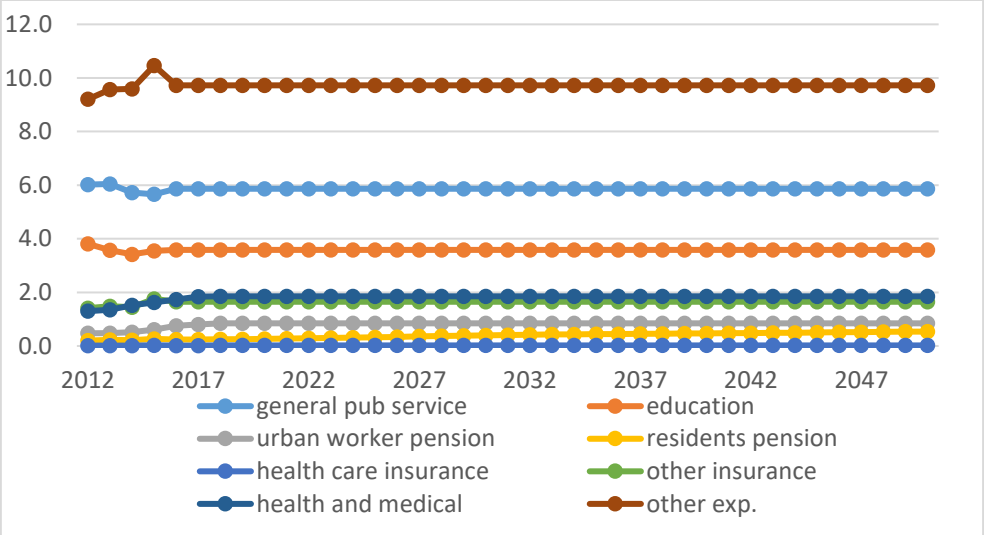
To simulate the change of pension fund in the baseline scenario for the period of 2017 to 2050, we assume that the Chinese government will keep its current pension system and the current contribution rates for each scheme. To simulate the impact of pension payment on government general budget balance, we also assume that the shares of general government revenue over the GDP and the shares of general government expenditure over the GDP keeps their historical pattern over the forecast period. Figures 3 and 4 displays the assumptions of general government budget revenue and expenditure.

Figure 3: Assumption of Government general budget revenue



Source: Data from 2012 to 2016 is from China Statistical Yearbook 2017.

Figure 4: Assumption of Government general budget expenditure



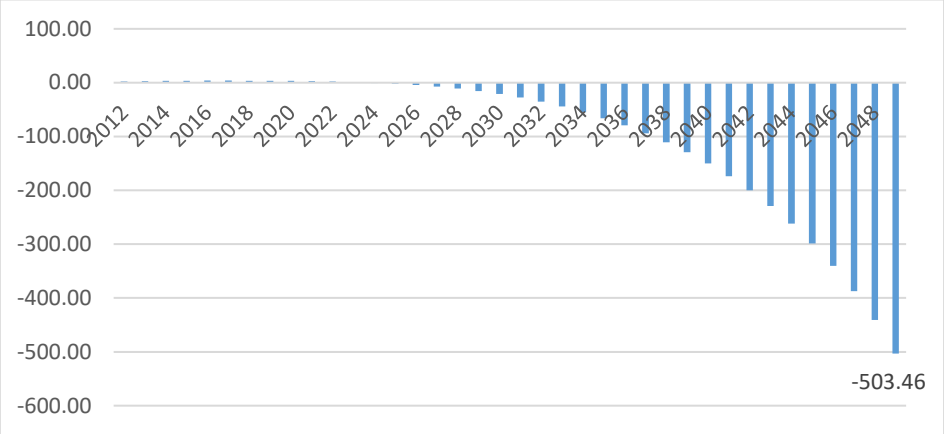
Source: Data from 2012 to 2016 is from China Statistical Yearbook 2017.

3.3 The impact of population ageing on pension fund and government budget balance

Figure 5 displays the change of pension stock of Urban Employees' Basic Pension Scheme (Scheme 1) in the baseline scenario (the sum of pillar one and pillar two). As we discussed in last section, the stock of pillar one is negative and the Chinese government uses the money in pillar two to pay the retired workers their first pillar pensions. Meanwhile the eligible retired workers also receive their pension from their personal account-pillar two. If the current pension system remains in China, then the stock of pension fund will run out of surplus and turn to negative in 2024 and the deficit will accumulate to more than 500 trillion RMB in 2049, which accounts for 47.8 per cent of GDP in 2049 (Figure 6). The main reason of the pension fund becomes negative is the accumulated deficit of pillar one - the annual payment to retired workers is much larger than the annual revenue (the sum of contribution, government subsidy, interests and other income). With the rapid population ageing, the gap between the revenue and pension payment become bigger and bigger because there is less and less labour force to contribute to the pension scheme (the negative growth of labour force) and more and more pensioners to receive pension payment (the rapid growth of old population) as Figures 7 and 8 show. From Figure 7 we can see that by the end of 2049, the labour force will decline to 631 million, which is a 20.4 per cent decline from its 2012 number. Meanwhile, the pensioner who are eligible for receiving pension from Schemes 1 and 2 will increase to 545.7 million, which is a 165 per cent increase from its 2012 number. Among 545.7 million pensioners, there is 217.3 million pensioners who receive pension from Scheme 1 (Figure 8).

Figure 5: Rapid changing pension fund stock (trillion) 2012 to 2049

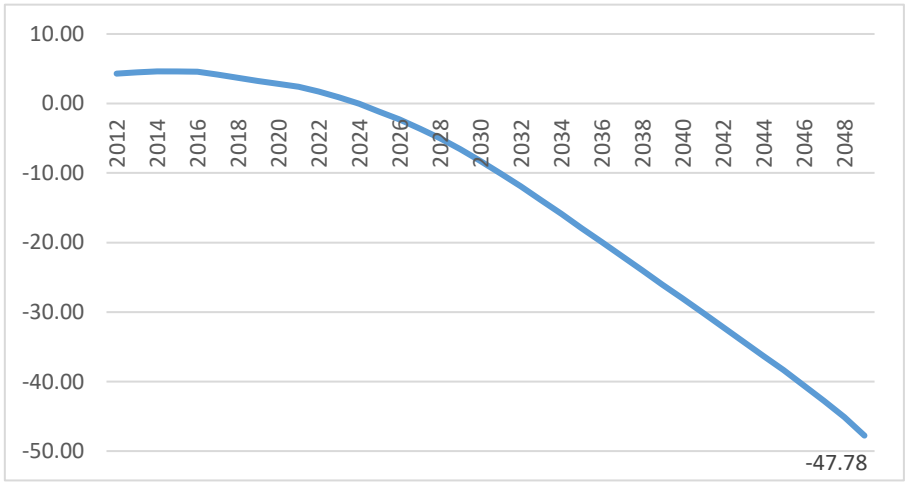
Urban employees' basic pension scheme



Source: baseline simulation results

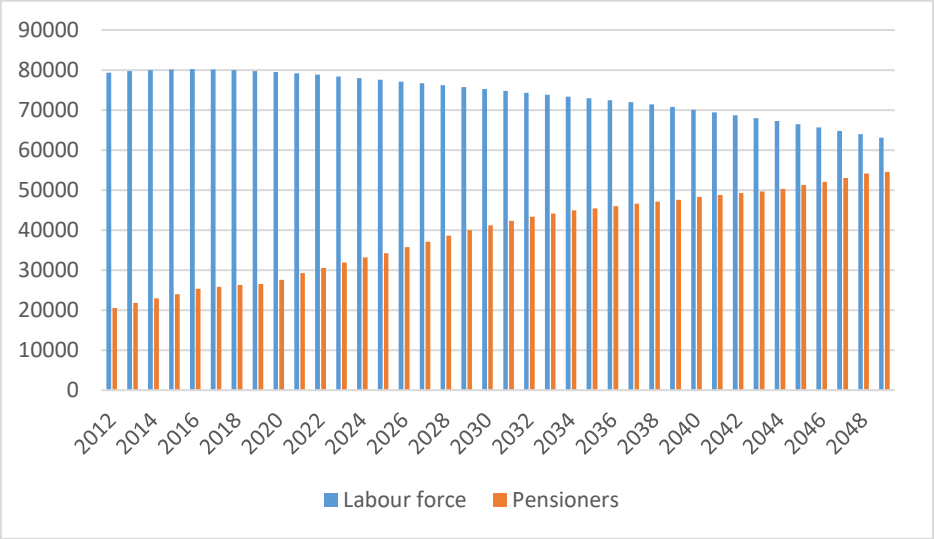
Figure 6: Stock of pension fund as share of GDP, 2012 to 2049 (%)

Urban Employees' Basic Pension Scheme



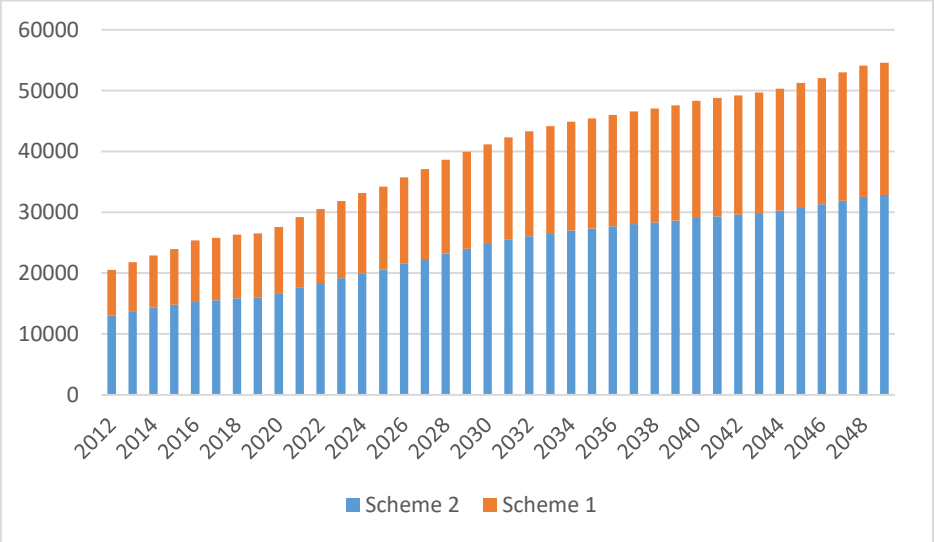
Source: Baseline simulation result

Figure 7: Declining labour force and increasing pensioners, 2012 to 2049 (10,000 persons)



Source: Population projection and baseline simulation result

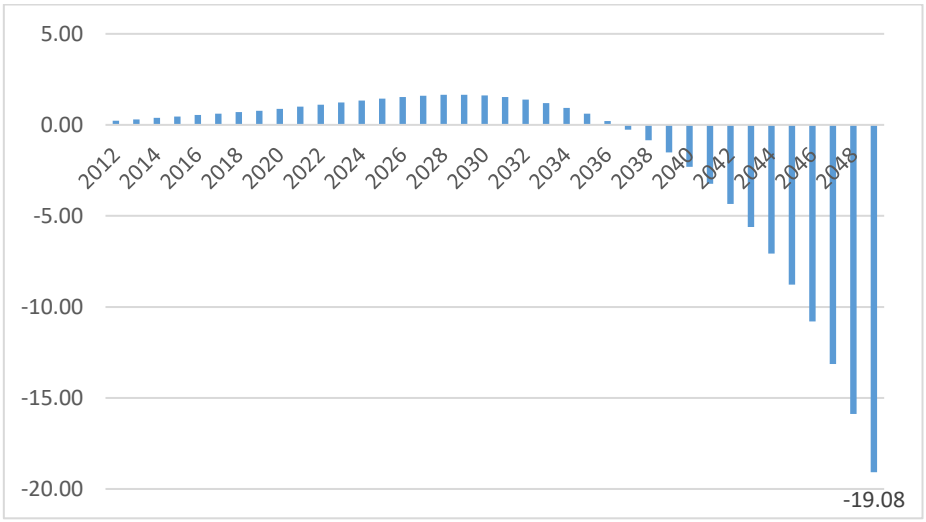
Figure 8: Increasing pensioners of two pension schemes, 2012 to 2049 (10,000 persons)



Source: Population projection and baseline simulation results

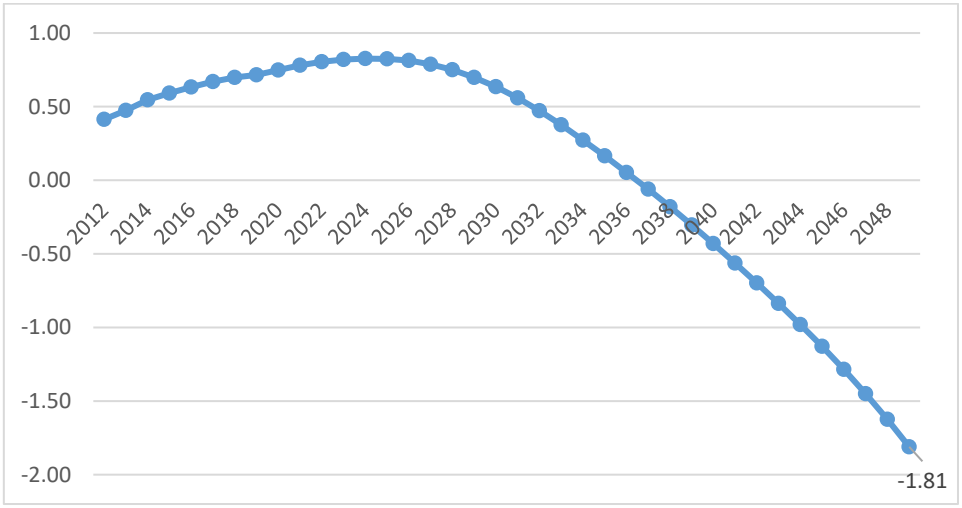
Figure 9 shows the change of stock of pension fund, urban and rural residents' basic pension scheme (Scheme 2). The pension payment to each pensioner is small (only 880 RMB in 2012 and it increased to 1409 RMB in 2016). Even though we assume that its payment will increase at the rate of real GDP annually, the total pension payment comparing with the Scheme 1 is still relatively small. If the government subsidy to this scheme keeps its share of GDP at 0.2 per cent, then the stock of pension fund will become negative in 2035 and its debts will accumulate to 19 trillion RMB in 2049 (Figure 9), which accounts for 1.8 per cent of GDP in 2049 (Figure 10).

Figure 9: Changing stock of pension fund (trillion) 2012 to 2049, Urban and rural residents' basic pension scheme



Source: baseline simulation results

Figure 10: Stock of pension fund as share of GDP, 2012 to 2049 (%) Urban and rural residents' basic pension scheme

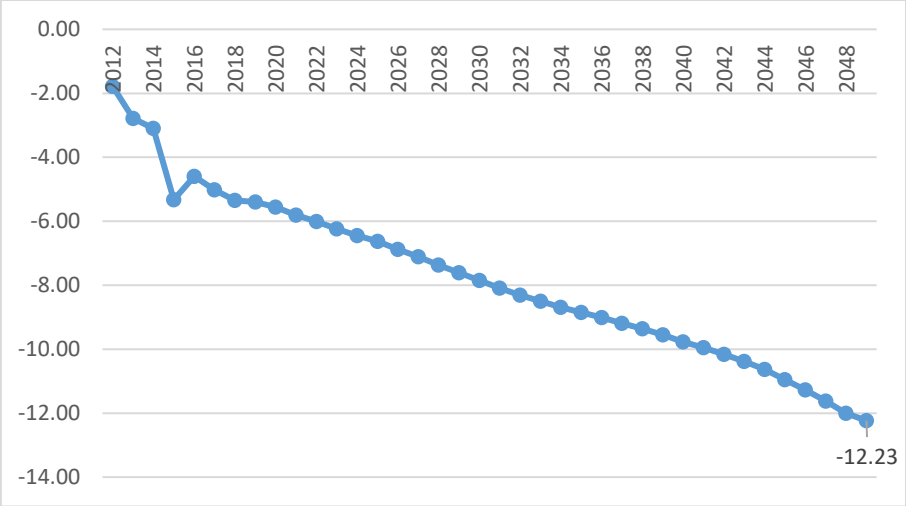


Source: baseline simulation results

If the government chooses to pay the debts of the pension schemes by increasing the government expenditure on the pension insurance, then this will put high pressure on government general budget balance. As we discussed in Section 2.3, the government general budget balance has been in deficit since 2012, however the share of the deficit over GDP has been controlled under 5 per cent. With the rapid accumulation of debts of pension fund, the government general budget deficit will increase very fast. The share of government general budget deficit over GDP will increase to 12.2 per cent in 2049 (Figure 10), which implies that

the economy cannot sustain under such big deficit. The Chinese government has to find ways to reform its current pension system and sustain its economic growth. In this study, we will investigate the impact of increasing retirement age on the economy and pension system. In other words, we would like to know whether increasing the retirement age will help to reduce the pressure on the pension fund meanwhile stimulate the economic growth given the rapid population-aging problem as a backdrop.

Figure 11: Government general budget deficit as share of GDP (%) 2012 to 2049



Source: baseline simulation results

4 The effects of retirement age extension policy

This section contains an analysis of the economic effects of raising the retirement age.

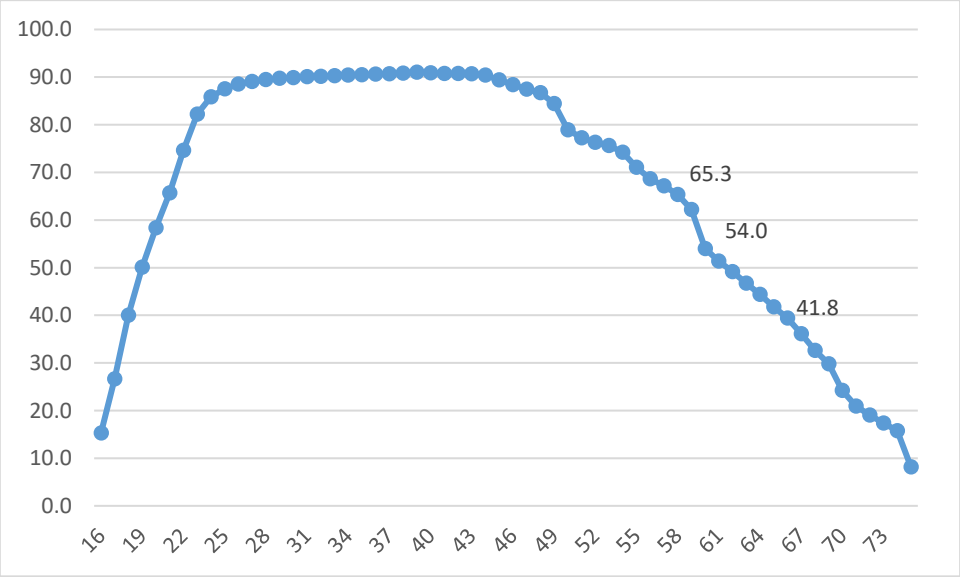
4.1 Retirement age and labour force participation rate

In the baseline scenario we assume that age specific labour force participation rates, therefore aggregate labour force participate rate will remain their 2016 level over the simulation period of 2017 to 2050. The labour force participation rate (LFPR) for the population aged 50 and over has a very close relationship with the official retirement age and pension policy (Peng and Mai, 2013).

Figure 11 shows that in 2016 the labour force participation rate was around 90 per cent for the population aged 28 to 48. It declined below 80 per cent for the population aged 49. It further dropped to 65.3 per cent for the population aged 58 and 54 per cent for the population aged 60. The labour force participation rate for population aged 65 was only 41.8 per cent in 2015. The

main reason for low labour force participation rates for the population aged 55 and over is China's official retirement age. Currently the retirement age is 60 for male employees, 55 for female officials and 50 for female workers. Compared with other countries China's retirement age is very low. For most of developed countries the retirement age is 65 for both men and women. With the expected decline of the working age population in China, an increase in the retirement age will be an effective way to increase the labour force participation rate. Furthermore, China's current retirement policy was introduced in the 1970s when the average life expectancy for both men and women was 65. But during the past 40 years, the life span of Chinese citizens has increased to 75 years (NBS, 2012). A gradual increase in the retirement age will not only help to slow down the reduction of the effective workforce but also lower the expected increase in labour costs. It will also help to reduce the pressure on the pension fund which has been reported in deficit in many provinces (CRIENGLISH, 2012) and the pension fund of pillar one, Scheme 1 in the nation as a total as we discussed in section 3.

Figure 11: Age specific labour force participation rates in 2010 (%)



Source: China Statistical Yearbook (2018)

In the policy scenario, we assume that the Chinese government will gradually increase both male and female workers' retirement age from 2020 onwards. We assume that in 2020, the average retirement age will increase to 59 years old. In 2022, it will further increase one more year to 60 years old. In 2024, it will increase to 61 years old, 62 years old in 2026, 63 years old in 2028, 64 years old in 2030 and 65 years old in 2032. It then remains at 65 years old from 2033 to 2050. The increase of retirement age will result in an increase in the LFPR. To our knowledge, there is no research on the extent to which a one-year increase in the retirement

age will increase the LFPR of the corresponding age group. Based on the corresponding age groups' LFPRs of Japan, Korea, G7 countries and OECD countries in 2016[2], we assume that the LFPRs for population aged 54 will increase from 74.21 per cent to 75 per cent in 2020 and remain at this level till 2050. The LFPA for population aged 55 will increase from 71.09 per cent to 71.87 per cent in 2020 and continue to increase linearly to 75 per cent in 2024 and then remain at 75 per cent till 2050. We assume that the LFPRs of population aged 56 to 58 will linearly increase to 74 per cent, 73 per cent, and 72 per cent in 2025, respectively and remain at these levels till 2050. The LFPR of population aged 59 will start to increase linearly in 2022 and will reach 71 per cent in 2027 and remain at this level till 2050. The LFPR of population aged 60 will start to increase linearly in 2024 and will reach 70 per cent in 2029 and remain at this level till 2050. For the population aged 61, its LFPR will start to increase linearly in 2026 and will reach 69 per cent in 2031 and remain at this level for the simulation period. For the population aged 62 to 64, their LFPRs will start to increase linearly in 2028, 2030 and 2032, respectively and will reach 68 per cent in 2033, 67 per cent in 2035 and 66 per cent in 2037, respectively and remain at these level during the simulation period. Even though the new retirement age is 65, we assume that the LFPR of this age group will also increase but only slightly. Its LFPR will increase linearly from 41.80 per cent in 2031 to 45 per cent in 2037 and remain there during the simulation period. Please refer to Table A3 in Annex 2 for the detailed increase of LFPRs of each age group.

Based on the above assumptions, we calculate the corresponding shocks to the LFPRs of these age groups in the policy scenarios. Meanwhile we shock the retirement age. Therefore, the new retirement age in the policy scenario becomes 59 in 2020, 60 in 2022, 61 in 2024, 62 in 2026, 63 in 2028, 64 in 2030 and 65 in 2032. These shocks mean that comparing with the baseline scenario, in the policy scenario the labour force will be larger from 2020 and the contribution to the pension fund will increase. Meanwhile the size of retired population will be smaller.

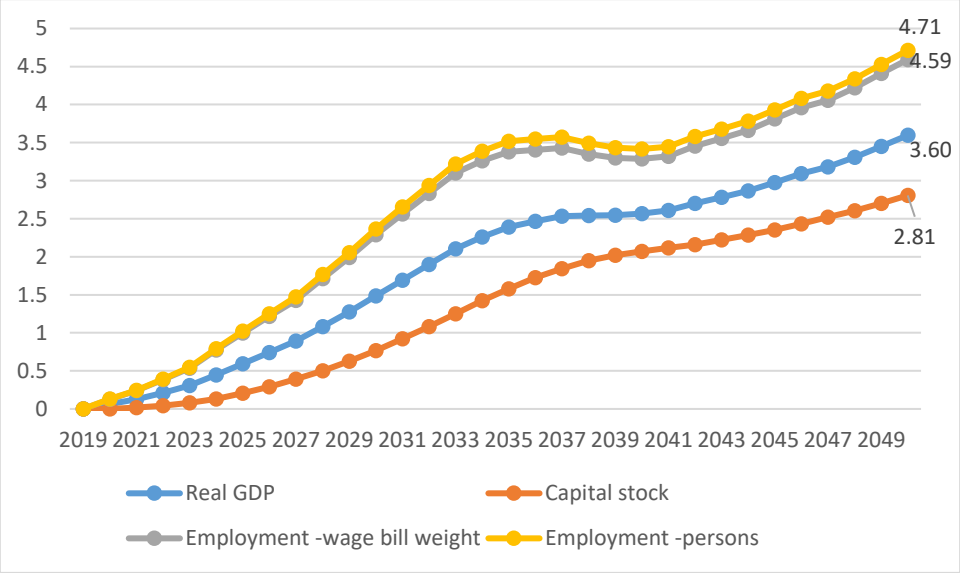
[2] The labour force participation rates (LFPR) for age group of 55 to 64 was 73.7 per cent for Japan, 68 per cent for Korea and 59.6 per cent for OECD countries in 2016. For Japan, the LFPR for age group 55-59 was 83 per cent and 68.1 per cent for age group 60-64 per cent and 45.3 per cent for age group 64-69 in 2017.

4.2 The effects of retirement age extension policy on macro economy

4.2.1 The effects on real GDP

The increase of retirement age will increase labour force and boost China's economy. Figure 12 shows that by the end of simulation period real GDP will be 3.6 per cent higher than in the baseline scenario[3].

Figure 12: The effects of retirement age extension -GDP and other macro variables - Cumulative deviation from baseline scenario (%)



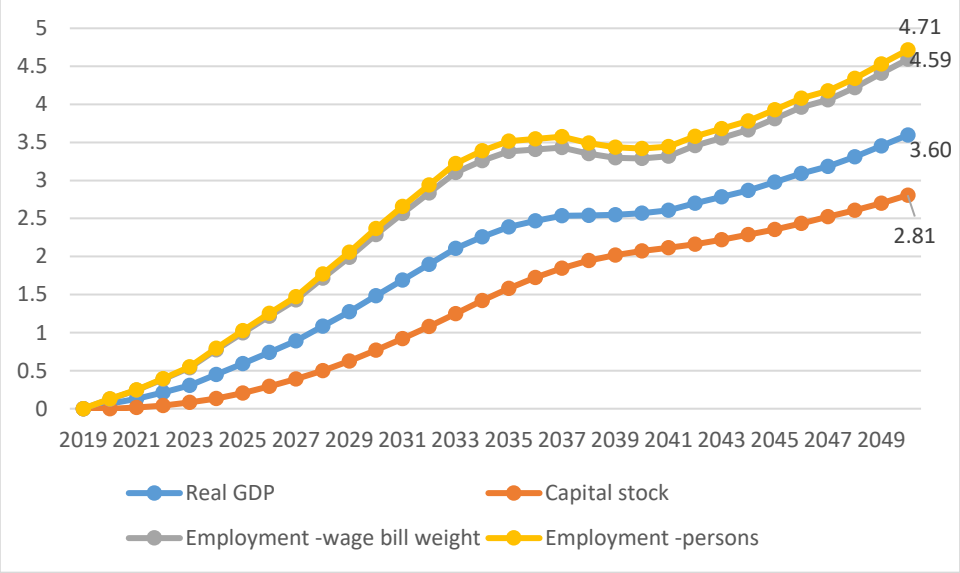
Source: Policy simulation results

There are two reasons for the higher real GDP. First, the increase in the labour supply as a result of the extension of the retirement age contributes to the growth of real GDP. Figure 12 shows that by the end of simulation period, the effective labour input (employment indexed by wage bill weight) will be 4.59 per cent higher than in the baseline scenario. Secondly, a growing capital stock contributes to higher GDP growth. In the long run the total capital stock will be 2.81 per cent higher than in the baseline scenario (Figure 12). The long-run increase in the capital stock relative to baseline is due to the increase in employment. We notice that the deviation of the capital stock from baseline scenario is lower than that of labour input. The reason is that the increase in labour supply will reduce the growth rate of real wages. By the end of the simulation period, the real wage will be 2.52 per cent lower than in the baseline

[3] The shape of growths of GDP and capital stock are consistent with the growth of employment and labour supply. The shape of the growth in the policy simulation period is consistent with the growth of the population aged 54 to 65. Since we increased the LFPRs of population aged 54 to 65 in the policy scenario, the increase of the labour force from these age group will continue during the whole policy simulation period of 2020 to 2050.

scenario. The declining growth rate of real wages compared with the baseline scenario implies that labour is becoming cheaper and employers will have intention to substitute labour for capital, which will reduce the capital –labour ratio of the economy in the long run. The substitution between capital and labour will slow down the growth rate of the capital stock.

Figure 12: The effects of retirement age extension -GDP and other macro variables - Cumulative deviation from baseline scenario (%)



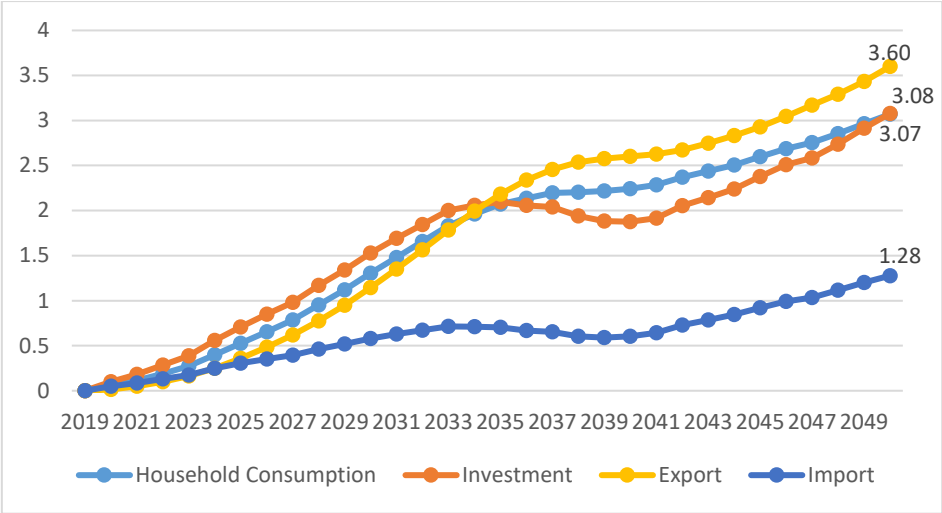
Source: Policy simulation results

4.2.2 The effects on the expenditure side of GDP

Due to the increase in the capital stock, aggregate investment also increases relative to its baseline path (Figure 13).

In the long run the increase in labour supply stimulates the growth of China's exports. As Figure 13 shows, exports will be 3.6 per cent higher than in the baseline scenario. The reason is that with the slower growth of the wage rates of workers, labour cost in export sectors, especially in manufacturing, is reduced. This further increases the competitiveness of Chinese exports in the world market. As a result Chinese exports expand. The expansion of exports implies more employment opportunities, which may further stimulate the development of export-oriented sectors in China.

Figure 13: The effects of retirement age extension – Expenditure side of GDP - Cumulative deviation from baseline scenario (%)



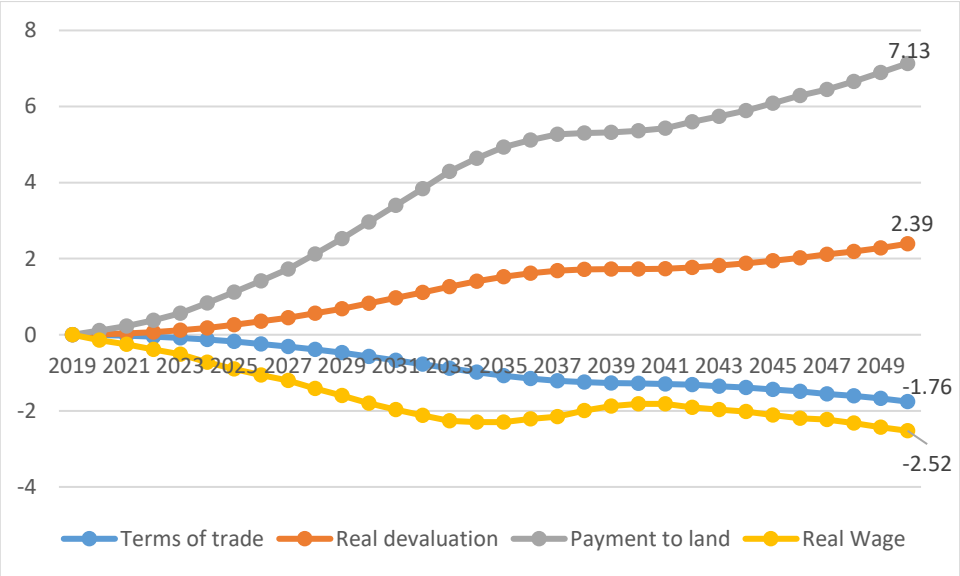
Source: Policy simulation results

The increased labour supply also improves households' living standards measured by real consumption. As Figure 13 shows, real household consumption will be 3.07 per cent higher than in the baseline scenario. We also notice that consumption increases less than real GDP. The reasons include:

- Firstly, the constant expansion of exports requires a deterioration of the terms of trade, which will affect the gains from a given volume of trade adversely. As we just discussed the retirement age extension policy will increase China's export (Figure 13). The expansion of exports drives the terms of trade down because China is a "large country" in her export markets. The price of imports remains unaffected because we assume that China does not exert noticeable market power in her import markets. Figure 14 shows by the end of the simulation period the terms of trade will be 1.76 per cent lower compared with the baseline case.

- Secondly, the higher labour force will reduce the per capita availability of the fixed factor (land). As labour supply increases with the result of increased retirement age, land becomes more scarce and expensive. Figure 14 illustrates that the payments to land will be 7.13 per cent higher than in the baseline scenario. The dramatic increase in the price of land indicates that there is diminishing return to the extra labour and capital. This subdues the increase of income and consumption.

Figure 14: The effects of retirement age extension – other macro variables
- Cumulative deviation from baseline scenario (%)



Source: Policy simulation results

4.2.3 The effects on real wage

Figure 14 shows that the real wage rate will be 2.52 per cent lower at the end of the simulation period compared to the baseline scenario. There are two main reasons for the reduction of real wage rate. First, the deterioration of the terms of trade together with the depreciation of the domestic currency (The expansion of exports requires a real devaluation of RMB relative to the exchange rate path of the baseline scenario. Figure 14 shows that the value of RMB is 2.39 per cent lower than in the baseline case) reduces the real wage rate as the retirement age increases (Figures 14). Secondly, the increase of labour force reduces the relative availability of fixed resource, specifically land, and drives up its price as we discussed in the previous paragraph (Figure 14). The increasing scarcity of land is associated with an increase in the labour intensity of production which in turn reduces the productivity of labour and, thus, depresses the wage rage.

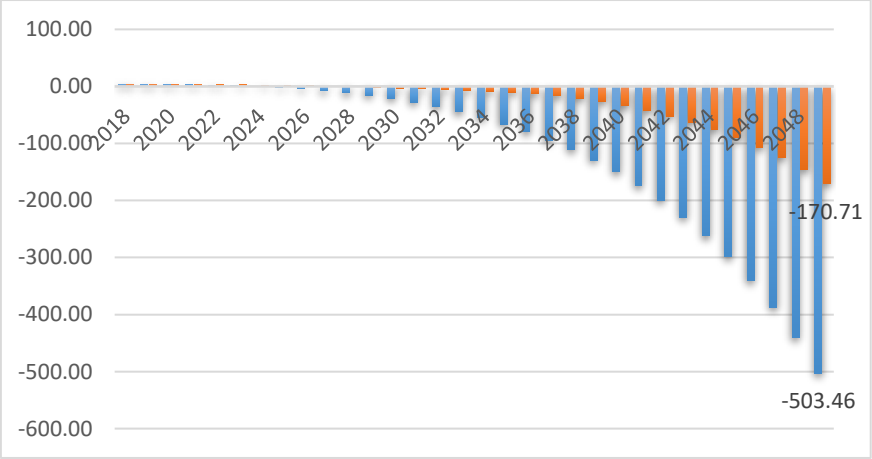
4.2 The effects of retirement age extension policy on pension fund and government budget balance

The increase of the retirement age will affect the pension fund and government budget balance dramatically.

4.2.1 The effects on the pension fund of Scheme 1

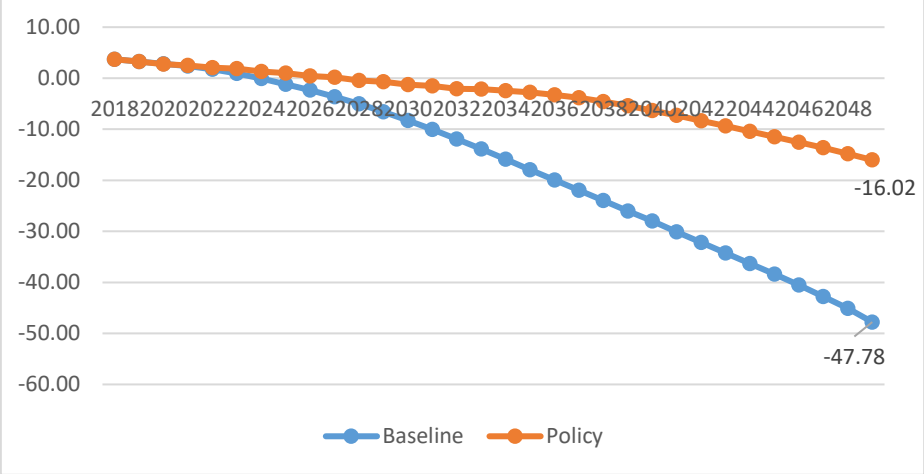
Figure 15 display the values of pension stock of Scheme 1 in baseline and policy scenarios. In the baseline scenario, the pension fund will run out of money and turn to negative in year 2024 while with the increase of the retirement age, the stock of pension fund will turn to negative in year 2028. In the baseline scenario, the debt of pension fund will accumulate to more than 500 trillion RMB by the end of year 2049, which accounts for nearly 48 per cent of GDP (Figure 16), while the increase of retirement age will significantly reduce the debt of the pension fund. By the end of 2049, the total debt of pension fund will be 170 trillion RMB, which is only 16 per cent of GDP (Figure 16).

Figure 15: The effects of retirement age extension –Stocks of pension fund, Scheme 1, baseline and policy scenarios (trillion RMB)



Source: Baseline and policy simulation results

Figure 16: The effects of retirement age extension –Share of stocks of pension fund over GDP, Scheme 1, baseline and policy scenarios (%)

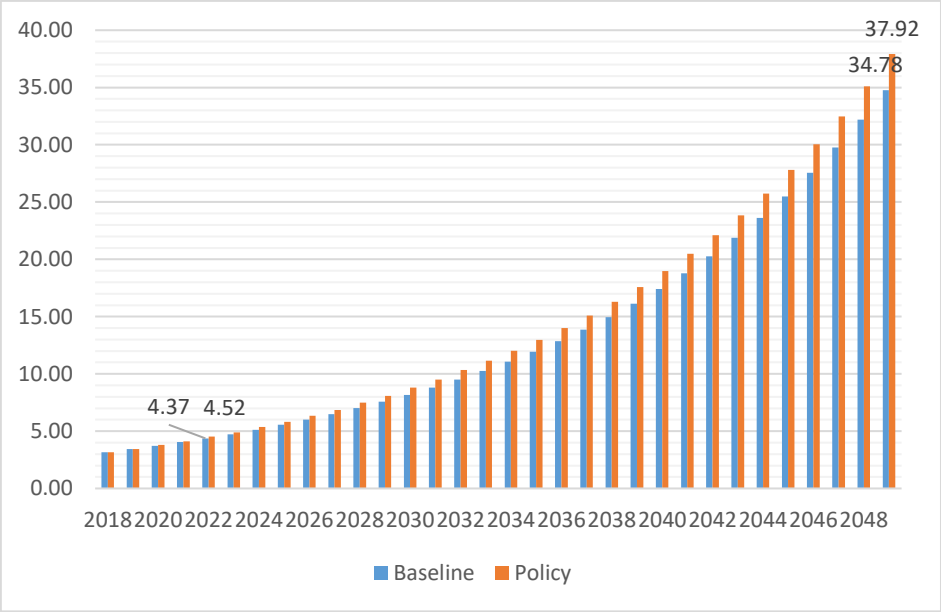


Source: Baseline and policy simulation results

The reasons for the reduction of the pension fund debt include:

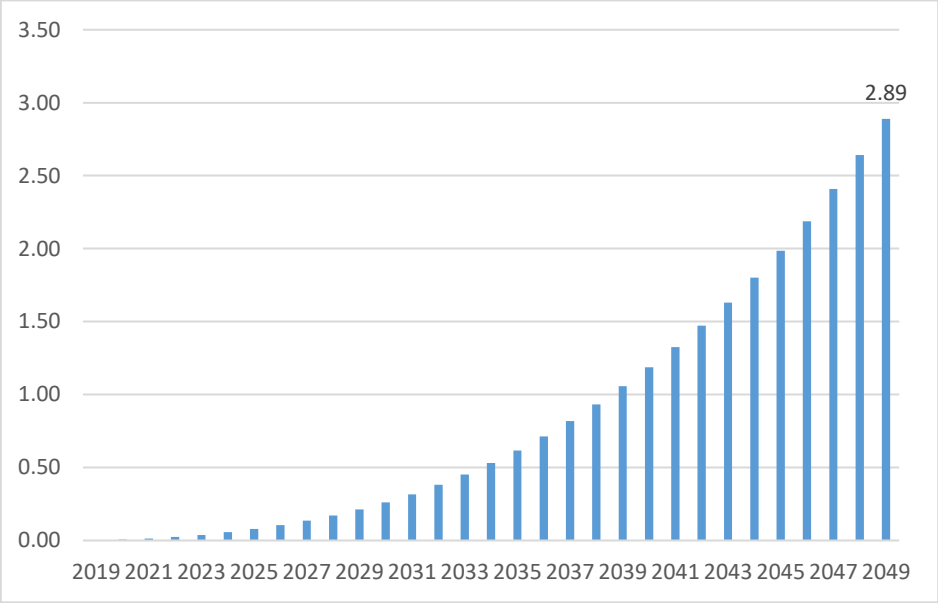
- Firstly, the increased contribution to the pension fund because of increased labour force starting from 2020. Figure 17 shows that the contribution to the pension fund, Scheme 1 is larger in the policy scenario than in the baseline starting from 2020 when the retirement age extension policy starts to implement. The contribution to the pension fund in the policy scenario is 1.77 per cent higher than in the baseline scenario in 2022. With the further increase in the retirement age, the gap of contribution to the pension fund between policy and baseline scenarios becomes larger. In the year 2040, the contribution to the pension fund in the policy scenario is 9 per cent higher than in the baseline and it is 9.05 per cent higher in 2049. Figure 18 shows that by the end of simulation period, the contribution to the pension fund, Scheme 1 is 2.89 trillion higher than the baseline scenario.

Figure 17: Contribution to the pension fund, Scheme 1, baseline and policy scenarios (trillion RMB)



Source: Baseline and policy simulation results

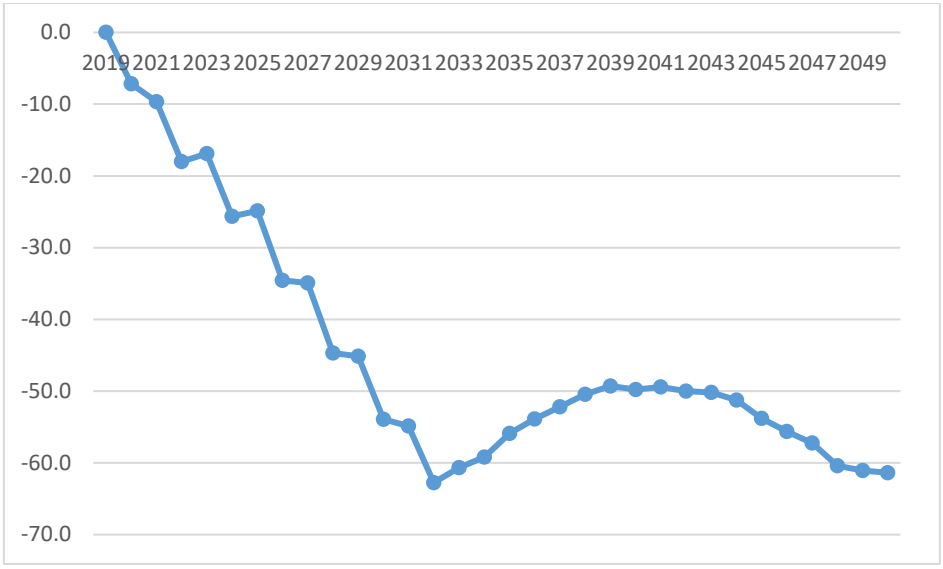
Figure 18: The effects of retirement age extension –Contribution to the pension fund, Scheme 1, cumulative deviation to the baseline (trillion RMB)



Source: policy simulation results

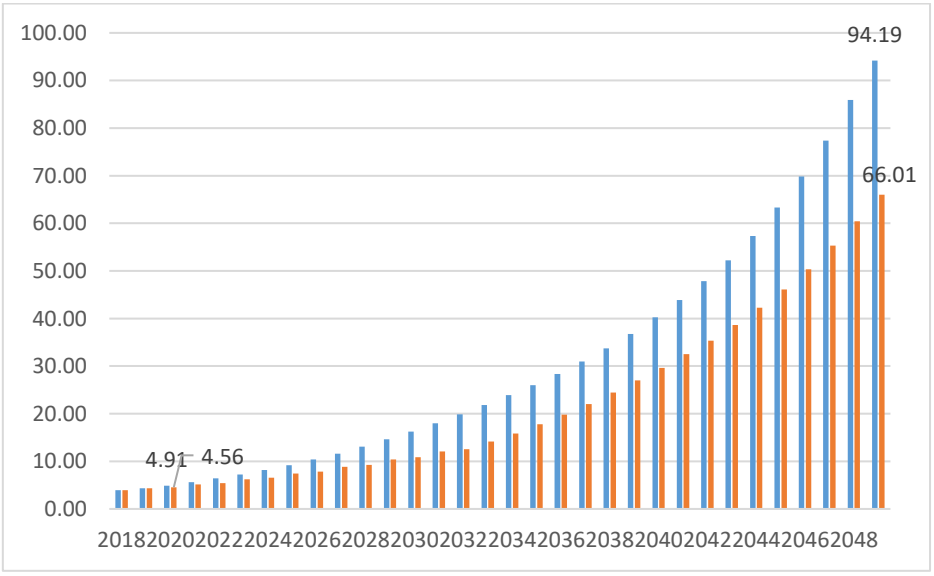
- Secondly, the reduced payment to the retired workers as the size of retired workers become smaller because of the retirement age extension. Figure 19 shows that by the end of simulation period, the size of retired workers who receive the pension fund from Scheme 1 will be 61.4 million smaller in the policy scenario than in the baseline. The reduction of the size of retired workers means decline of the pension payment. Figure 20 shows that the payment to the eligible retired workers is 4.91 trillion in the baseline while it is 4.56 trillion in the policy scenario. The further increase of the retirement age will enlarge the gap of pension payment to the retired workers between policy and baseline scenarios. In year 2049, the pension payment is 94.19 trillion in the baseline scenario while it is only 66.01 trillion in the policy scenario, which is a 30 per cent decrease (Figure 20).

Figure 19: The effects of retirement age extension – size of the retired workers, Scheme 1, cumulative deviation to the baseline (million persons)



Source: policy simulation results

Figure 20: Payment to the retired workers, Scheme 1, baseline and policy scenarios (trillion RMB)



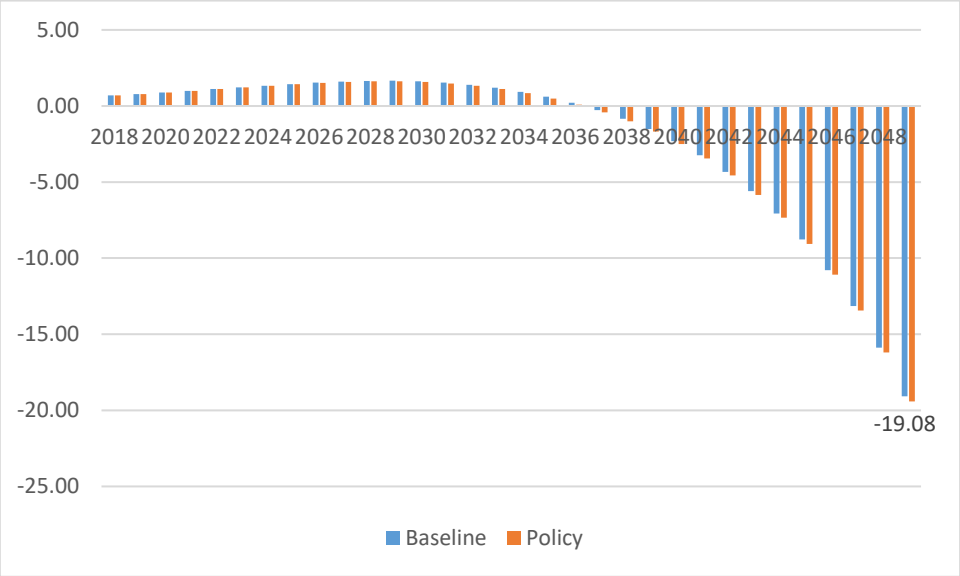
Source: Baseline and policy simulation results

4.2.2 The effects on the pension fund of Scheme 2

The effects of retirement age extension policy on the stock of the pension fund, Scheme 2 is relatively small (Figure 21). The reason is the assumption we made in the model about the

government subsidy to the pension scheme 2. As we know the contribution made by the retired population to the urban and rural residents' basic pension scheme is very small. The pension fund mainly rely on the government subsidies. We assume that the government will subsidy the difference between the pension payment and the contribution. That means if the pension payment in year t is 20 million RMB and the contribution in year t is only 5 million RMB, then the government will subsidy 15 million RMB. Meanwhile we also assume that the share of the government subsidies to the Scheme 2 over the GDP will be fixed at 0.xx per cent of GDP during the simulation period of 2017 to 2050. With the increase of retired population as a result of the rapid ageing, the government subsidies to the Scheme 2 has to increase every year. However, the subsidies cannot be more than 0.22 per cent of GDP. That is why we notice that the stock of pension fund of scheme 2 become negative in year 2037 and the debt of pension fund continue to increase. By the end of 2049, the debt of pension fund, scheme 2 will reach 19 trillion RBM (Figure 9 and baseline, Figure 21).

Figure 21: Stocks of pension fund, Scheme 2, baseline and policy scenarios (trillion RMB)

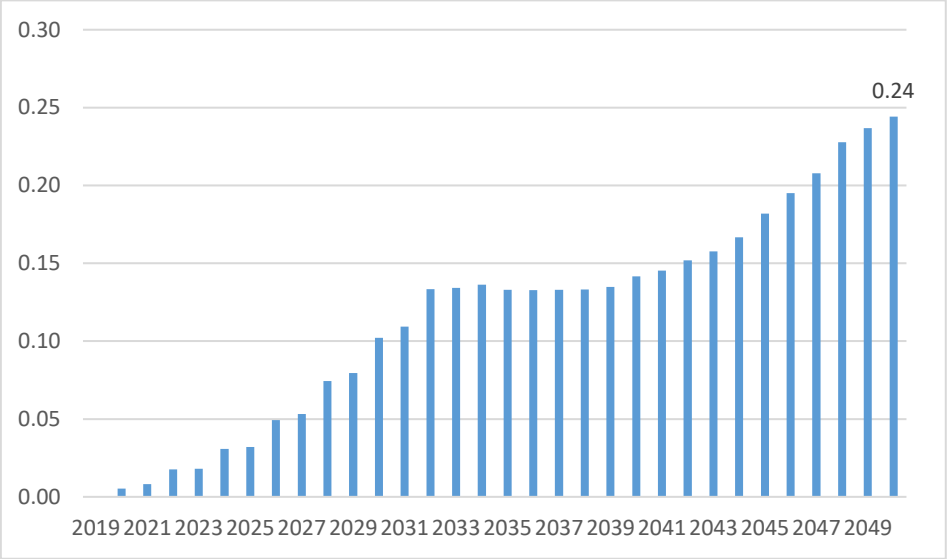


Source: Baseline and policy simulation results

However, in the policy scenario, the share of the government subsidies to the Scheme 2 over the GDP is not fixed anymore. With the assumption of the government funding the difference between the pension payment and the contribution, the increase of the contribution (By the end of the simulation period, the contribution to the pension fund will be 0.24 trillion higher than the baseline (Figure 22)) and the decrease of the pension payment (By the end of the simulation period, the pension payment will be 1.7 trillion lower than the baseline scenario (Figure 23)) because of the increased retirement age will reduce the gap between the pension payment and

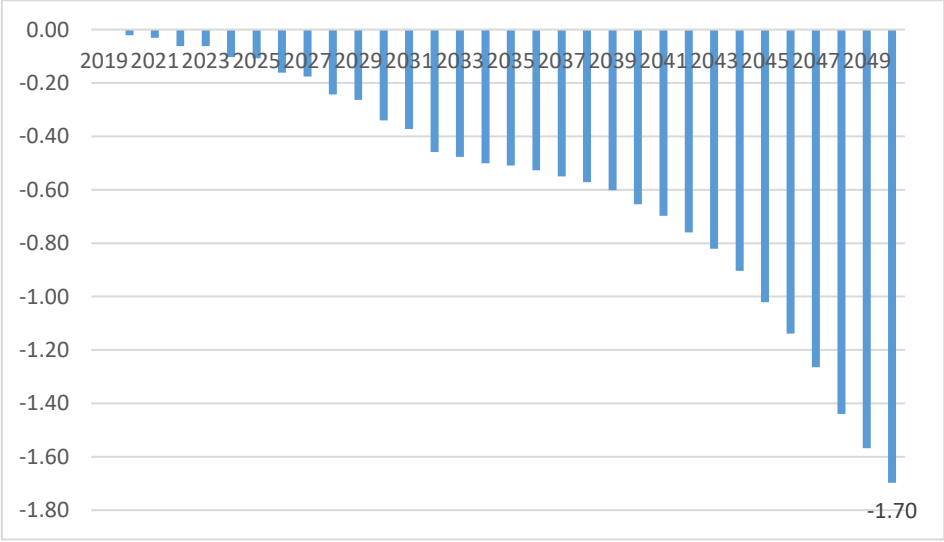
the contribution. Therefore the government subsidies to the pension fund will reduce, which will help the improve of the government general budget balance This is the reason that the effect of retirement age policy on the stock of the pension fund is very small (Figure 21).

Figure 22: The effects of retirement age extension –Contribution to the pension fund, Scheme 2, cumulative deviation to the baseline (trillion RMB)



Source: Policy simulation results

Figure 23: The effects of retirement age extension – Pension payment, Scheme 2, cumulative deviation to the baseline (trillion RMB)

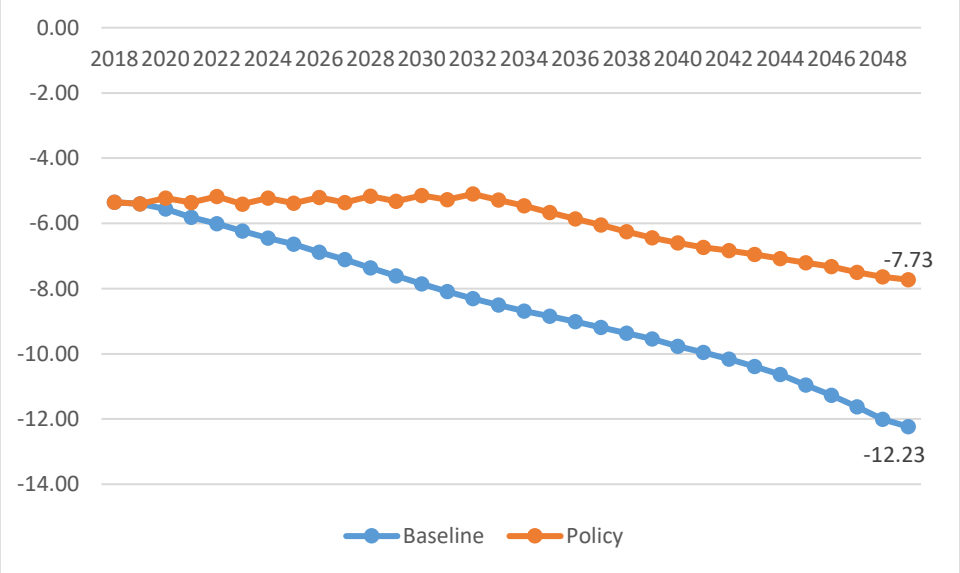


Source: Baseline and policy simulation results

4.2.3 The effects on the general government budget balance

The improvement of the pension fund of both Scheme 1 and Scheme 2 with the implementation of the retirement age extension policy will help general government budget balance. Figure 24 shows that general government deficit will reduce dramatically. By the end of simulation period, the general government deficit as share of GDP will drop from more than 12 per cent to 7.7 per cent, which is a 36.8 per cent decline. The improvement of general government budget balance implies that there is less pressure on the increase of taxes or reduction of government spending and less crowding out effect on investment.

Figure 24: Government general budget deficit as share of GDP (%), baseline and policy scenarios



Source: Baseline and policy simulation results

5. Conclusions and policy implications

China is experiencing rapid population ageing. Using a dynamic computable general equilibrium (CGE) model of the Chinese economy, we investigate the effect of rapid population ageing on the macro economy and the current pension system. The simulation exercise reveals that the rapid population ageing will exert high pressure on the current pension system and make the growth of the economy unsustainable:

- China will experience sustained labour force declining in the future. The labour force will decline at a rate of 0.33 per cent in 2020 and further down to 0.64 per cent in 2030. It will further drop at a rate of 1.32 in the middle of the century.

- China has to reply on the capital stock growth and total factor productivity improvement to sustain its economic growth. China's productivity improvement has to remain at above 2 per cent annually in the forecast period of 2017 to 2050.
- The rapid increase of the old population and decline in the labour force will drive the pension fund into deficit and the deficit will accumulate rapidly. In the middle of the century China's pension deficit will reach more than 520 trillion RMB, which is equivalent around 50 per cent of that year's GDP.
- The huge pension debt will put high pressure on China's general government budget balance. In the middle of the century, the general government deficit will account for more than 12 per cent of GDP.

Thus, reform the current pension system and find ways to deal with the ageing problem become very urgent. Increasing the retirement age has been discussed among the scholars and the Chinese government as a way to mitigate the negative effects of ageing problem on pension system and macro economy. Applying a dynamic CGE modelling approach, we estimate the effect of raising the retirement age on China's macro economy and pension system over the period of 2020 to 2050. We find out that raising the retirement age will

- Boost China's economic growth by increasing employment and capital stock. By the end of simulation period, real GDP will be 3.6 per cent higher than the baseline scenario;
- Improve household living standard measured by real household consumption. By the end of simulation period, real household consumption will be 3.07 per cent higher than the baseline scenario;
- Improve the pension fund dramatically. By the end of simulation period, the pension deficit will reduce from baseline's 520 trillion RMB to 190 trillion RMB, which is equivalent 17.8 per cent of GDP.
- Improve general government budget balance significantly. The retirement age extension will bring the general government deficit back to around 7.7 per cent of GDP.

As a summary, retirement age extension is a powerful policy. It will not only increase the labour force of the economy by increasing the labour force participation of the population, but also reduce the size of retired workers who receive pension by delaying them into the pool of pensioner. China's economy will benefit even more from this policy if the policy could be

implemented soon. Since the simulation results are very sensitive to the assumption of the increase of LFPRs of population aged 54 to 65 when the government increase the retirement age. We know that increase the retirement age will have positive effect on the LFPRs of the age groups which are affected. However, how much the LFPRs will be increased and how many workers will choose to stay in the labour force after the policy becomes effective really depends on how the policy is designed. Carefully design the policy and implement it with cautious will help the country gain the benefit of the policy.

References:

CRIENGLISH (2012), "China to Extend Retirement Age", accessed on 10 April 2013 at http://english.cri.cn/7146/2012/06/11/2702s705429.htm.

Dixon P, Parmenter B. R, Sutton J, Vincent P (1982*) ORANI: A multisectoral model of the Australian economy*, North-Holland, Amsterdam.

Dixon P, Rimmer, M (2002) *Dynamic general equilibrium modelling for forecasting and policy: a practical guide and documentation of MONASH*, North-Holland Publishing Company, Amsterdam.

Mai, Y. Peng, X. Dixon, P. B. and Rimmer, M. (2013), "The economic effects of facilitating the flow of rural workers to urban employment in China", *Papers in Regional Science*.

Annex 1:

Data for pillars one and two, Urban Employees' Basic Pension Scheme (Scheme 1)

The data for the contribution to each pillar in scheme one is not available. However, we have data for contribution to each pillar for the enterprise pension fund. Since the enterprise pension fund accounts for around 90 per cent of fund in the Urban Employees' Basic Pension Scheme (scheme 1) so we use the shares of contribution to each pillar in the enterprise pension fund as the shares of each pillar for Scheme 1.

Table A1: Shares of pillars one and two in Scheme 1 (%)

	Contribution		Payment		Accumulated Surplus (8)	
	Pillar one	Pillar two	Pillar one	Pillar two	Pillar one	Pillar two
2012	62.0	38.0	95.86	4.14	0	100
2013	62.9	37.1	95.71	4.29	--	--
2014	63.3	36.7	95.61	4.39	--	--
2015	63.3	36.7	95.46	4.54	--	--
2016	63.3	36.7	95.30	4.70	--	--

Source: Bulletin on the development of human resources and social security in China, 2015, 2016 and 2017

Table A1 shows that the contribution to pillar one accounted for 62 per cent of total contribution in the scheme 1 in 2012. It slightly increased to 62.9 per cent in 2013 and stayed at 63.3 per cent from 2014 to 2016. We use these shares and the total contribution in Column 2, Table 4 to calculate the amount of contribution of pillar one, Scheme 1. Then the contribution to pillar two is simply using the total contribution to subtract the contribution to pillar one. The results are displayed in Table A2. Similarly, we use the share of payment to pillar one in Table A1 and the total payment in Column 6, Table 4 to calculate the payments to pillar one. The results are also displayed in Table A2. Since pillar one has been running in deficit for several years (Based on the government report XXX (reference) and Chinese scholar's study (reference), we assume that the accumulated surplus of pillar one is 0 in our base year, 2012. Therefore, the accumulated surplus 2394.1 billion RMB in 2012 in Table 4 will be allocated to pillar two, Scheme 1. From 2013 to 2016, the accumulated surplus (Stock) for pillar one is the calculated contribution (Column one, Table A2) plus the government subsidy (column 2, Table A2), then deduct the payment to pensioner (column 4, Table A2). There is no interest in 2013 because of

the empty stock in 2012. We notice that the annual surplus of pillar one in 2013 is negative because the total expenditure (the payment) is larger than the total revenue, which is consistent with the actual situation in China.

Table A2: Pension account of Urban Employees' Basic Pension Scheme, pillar one

(Billion RMB)

	Contribution	Government Subsidy	Interest income and other	Total Revenue	Total Expenditure	Annual Surplus	Accumulated Surplus
	(1)	(2)	(3)	(4)	(5)	(6)=(5)-(4)	(7)
2012	1020.954	264.8	0	1285.754	1491.77	-206.0163	0
2013	1172.079	301.9	-12.3807	1461.598	1767.675	-306.078	-206.0163
2014	1286.924	359.368	-20.575	1625.717	2080.027	-454.3103	-512.0943
2015	1456.914	471.6	-32.97103	1895.542	2464.093	-568.5492	-966.4043
2016	1694.416	651.1	-48.15561	2297.358	3035.748	-738.3889	-1534.954

Source: Authors' calculation based the Bulletin on the Development of Human Resources and Social Security in China, 2012, 21013 and 2015; Annual Report on the Development of Chinese Social Insurance, 2014 and 2016.

Table A3: Pension account of Urban Employees' Basic Pension Scheme, pillar two

(Billion RMB)

	Contribution	Government Subsidy	Interest income and other	Total Revenue	Total Expenditure	Annual Surplus	Accumulated Surplus
	(1)	(2)	(3)	(4)	(5)	(6)=(5)-(4)	(7)
2012	625.746	0	88.6	714.346	64.4283	649.9177	2394.1
2013	691.322	0	102.699	794.021	79.3258	714.6953	3044.018
2014	746.131	0	138.577	884.708	95.4734	789.2346	3758.713
2015	844.688	0	160.9	1005.587	117.2088	888.3792	4547.948
2016	982.387	0	177.9	1160.286	149.6526	1010.634	5436.328

Source: Authors' calculation based the Bulletin on the Development of Human Resources and Social Security in China, 2012, 21013 and 2015; Annual Report on the Development of Chinese Social Insurance, 2014 and 2016.

Annex 2: Table A3: Assumptions of LFPRs of population aged 54 to 65

Age	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038-2049	2050
54	74.21	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75
55	71.09	71.87	72.66	73.44	74.22	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75
56	68.66	69.55	70.44	71.33	72.22	73.11	74.00	74	74	74	74	74	74	74	74	74	74	74	74	74	74
57	67.17	68.14	69.11	70.09	71.06	72.03	73.00	73	73	73	73	73	73	73	73	73	73	73	73	73	73
58	65.35	66.46	67.56	68.67	69.78	70.89	72.00	72	72	72	72	72	72	72	72	72	72	72	72	72	72
59	62.19	62.19	62.19	63.66	65.13	66.60	68.06	69.53	71	71	71	71	71	71	71	71	71	71	71	71	71
60	53.98	53.98	53.98	53.98	53.98	56.65	59.32	61.99	64.66	67.33	70.00	70	70	70	70	70	70	70	70	70	70
61	51.38	51.38	51.38	51.38	51.38	51.38	51.38	54.31	57.25	60.19	63.13	66.06	69	69	69	69	69	69	69	69	69
62	49.14	49.14	49.14	49.14	49.14	49.14	49.14	49.14	49.14	52.28	55.43	58.57	61.71	64.86	68.00	68.00	68.00	68.00	68.00	68.00	68
63	46.73	46.73	46.73	46.73	46.73	46.73	46.73	46.73	46.73	46.73	46.73	50.11	53.49	58.86	60.24	63.62	67.00	67.00	67.00	67.00	67.0
64	44.42	44.42	44.42	44.42	44.42	44.42	44.42	44.42	44.42	44.42	44.42	44.42	44.42	48.01	51.61	55.21	58.81	62.40	66.00	66.00	66.0
65	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80	42.33	42.87	43.40	43.93	44.47	45.00	45.00	45.0

Source: The labour force participation rates in 2019 are the same as in 2010 which is from China Statistical Yearbook, 2017. Data from 2020 to 2050 are authors' assumptions