Early Retirement, Pension System and the High Saving Rate in China

Xin Liang*

Abstract

Since the reform and opening policy, China has maintained remarkable high national saving rates for over 35 years. Especially from 2000 to 2008, the national saving rate in China rose by an unprecedented 40%. This paper studies the role of early retirement and pension system as drivers of China's persistent high savings. The model in this paper is a life-cycle model of homogeneous agents with heterogeneous income shocks. The model incorporates China's fact of early retirement and the feature of the mixed-pension system with both Pay-As-You-Go and Fully Funded. The findings suggest that, qualitatively, the model is capable of generating changes in the national saving rate in China and the dominant positive early retirement effect over the negative wealth substitution effect can increase the agent's savings; quantitatively, the model can explain approximately 44% of the increase in the saving rate between 1995 and 2015.

JEL classification: E21, E2, E62, D91, H55, O1, O16

Keywords: early retirement, saving rate, social security, pension benefit, China

*Department of Economics, University of Connecticut, 341 Mansfield Road, Unit 1063, Storrs, CT 06269-1063; email: xin.liang@uconn.edu

1 Introduction

Over the last 35 years, China, one of the world's largest economies, has experienced a spectacular economic growth which is associated with an equally remarkable high rate of saving. While the gross national saving as a share out of gross domestic product (GDP) hovered around 35 percent in the 1980s, the average yearly rate climbed up to 42 percent in the early 1990s (Figure 1). Since the 21st century, when China entered the World Trade Organization (WTO), the aggregate saving rate started to accelerate, which is surging from 37 percent in 2000 to an unprecedented 52 percent in 2008. After 2000, China's national saving rates have been one of the highest in the world, far outnumbering the average saving rates of the world, the high-income area, the middle-income area, OECD and other East Asian economies during the years of their miracle growth. To be specific, most of China's national saving rates are about 1.5 times of the average saving rates of the middle-income area. And it is about twice of the average saving rates of the high-income area, OECD and world, respectively. Why are the national saving rates so high in China remains a question worths pondering.

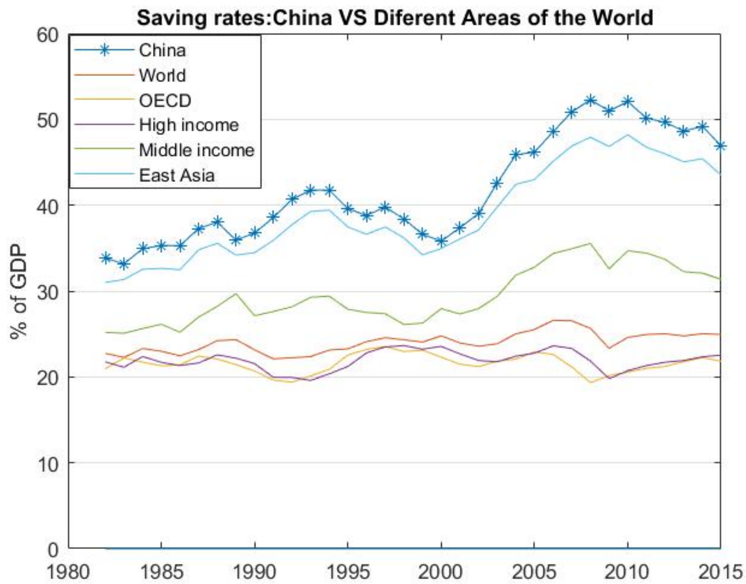


Figure 1: Saving rates: China VS Different Areas of the World
Source: World Bank Indicator

In addition, China has undergone a dramatic economic transformation involving not only fast economic growth and sustained capital accumulation, but also major shifts in social systems. The gradually implemented pension system reform from 1995 to 1997 changed the pension system in China from a pure Pay-As-You-Go (PSYG) to a combination of both PSYG and Fully Funded (FF)[1]. This is almost the very time when China's national saving rate started to soar. It is not coincident. With the reform of the pension system, which is highly related to the pension income, the behaviors of consumption, saving and

[1]For the details about the pension system before and after the pension reform in 1997, see the appendix.

investment of households will change during both the working period and the retirement period, which contributes to the change of the saving rates.

China also sets up a much earlier mandatory retirement age[2] than other countries with the similar life expectancy and allows for early retirement.[3] Under this circumstance, what accompanies the process of the pension reform is a noteworthy phenomenon that Chinese people choose to retire earlier than the mandatory retirement age. In addition, the average retirement age is trending lower constantly. According to China Health and Nutrition Survey (CHNS) and China Labor-force Dynamics Survey (CLDS), the average retirement age surged from 53 to 57 in the 1980s. Afterward, it has decreased from age 57 in 1992 persistently to about 54 in 2004. Finally, the average retirement age remained relatively stable around 53 from 2005 to 2015 (Figure 2). These facts can offer potential channels of the early retirement and pension system to explain the high savings in China.

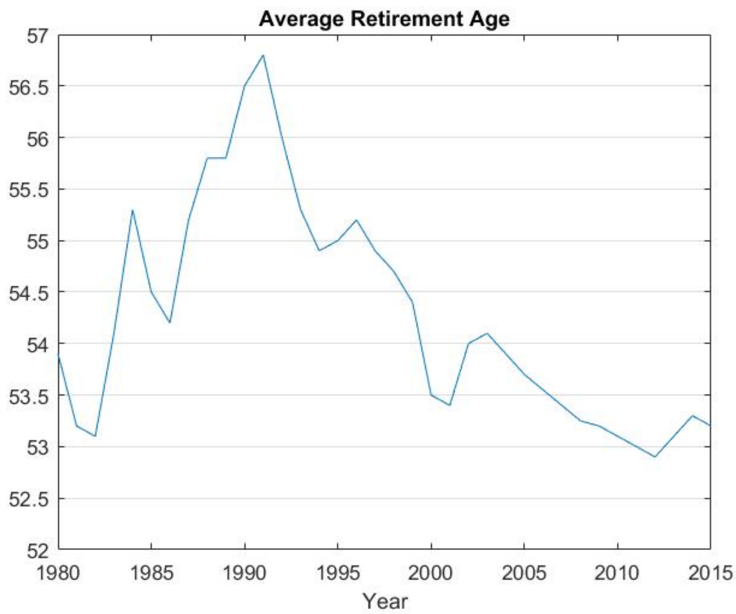


Figure 2: Average retirement age in China
Source: CHNS and China Labor-force Dynamic Survey(CLDS)

There are already some explanations for this high saving rates from different perspectives including consumption-smoothing theory, culture, demographic change, pension system and uncertainties. However, there are different shortcomings and the findings are inconclusive. The details of these imperfections in the existing literature are discussed in the next section.

In investigating the joint impact of the early retirement effect and the change of pension incomes brought by the pension reform on savings, the paper makes three main contributions: (i) a tractable

[2]60 for male and 50 for female.

[3]The retirement policy in China is that, according to the State Council Provisional Regulations on Retirement and Resignation of Workers, if they have worked for more than ten years, male employees should retire at age 60, female employees should retire at age 50 and female cadres should retire at age 55. In the heavy labor and high-risk industries, for example, mining industry, male should retire at 55 and female should retire at 45. If employees lost the ability to work which is proven by hospitals, male should retire at 50 and female should retire at 45.

model linking average retirement age, the change of pension incomes and savings; (ii) its quantitative version calibrated to macro data; (iii) a few decomposition tests to prove the mechanism in this paper.

My theoretical framework incorporates two new elements to the standard life-cycle theory of savings: early retirement effect and wealth substitution effect. Agents retire earlier than the mandatory retirement age. In order to cover the more extended periods of the retirement over which accumulated assets will be spread, agents have to increase their saving rates (early retirement effect). Also, agents' pension incomes change due to the pension reform. If the pension incomes increase, the increment of pension incomes can substitute for the savings for the retirement. This will reduce the saving rates (wealth substitution effect). My model thus sheds light on the impact of the interaction between early retirement effect and wealth substitution effect on savings decisions and saving rates. A stronger policy response of the positive effect of the early retirement compared to the weaker negative effect of wealth substitution between pension incomes and savings, encourages the savings response to a large extent. Also, I propose an explanation that, under certain conditions, the reduced pension replacement rate however results in increased pension incomes, which is inconsistent with the general predictions from a standard overlapping generation (OLG) model.

My second contribution lies in the quantitative exploration of my mechanism. A quantitative version of the model is developed and is calibrated to macro-level Chinese data. I evaluate the quantitative performance of my model through three angles. First, combining both the early retirement effect and the wealth substitution effect, I find that the model imputes 44% of the rise in the national saving rates over 1995-2015. Second, regarding the effect of the change of pension incomes only, the saving rates fall to a lower level. Third, considering the effect of the early retirement only, the saving rates rise to a higher level.

Third, this paper designs three decomposition experiments of savings to emphasize the mechanism. The first test is to force all agents to retire at the mandatory retirement age in China. This can exclude the early retirement effect and allow us to observe the wealth substitution effect only. The second experiment is to shut down the pension reform in the model. Since there is no changes in the pension incomes brought by the pension reform, this allows us to look at the impact of the early retirement effect only. The third trial is to remove both effects in order to examine their joint effect and the interaction between these two effects.

The model in this paper is not going to study why people retire early by endogenizing the retirement decision to match the data of average retirement ages and then try to examine what factors result in the early retirement. In this paper, given the fact of early retirement, I show that the early retirement can explain the high saving rates in China and it is the dominant positive early retirement effect over negative wealth substitution effect that contributes to the high saving rates in China. The model simplifies the reality by not distinguishing the difference between urban and rural population, male and female, households savings and firms savings.

The rest of the paper is organized as follows. Section 2 discusses the related literature. Section 3 presents the model. Section 4 shows the calibration of the model. Section 5 discusses the results of the static and dynamic analysis. Finally, section 6 concludes.

2 Literature Review

This paper is mainly related to the body of the literature which tends to explain the remarkable high saving rates in China. Most of the paper in the literature investigate the interaction between different factors rather them the influence of only one element on saving rates. Therefore, various theories on the explanation can be roughly classified into the following different strands.

Many early studies applied Modigliani-Brumberg's consumption smoothing theory to study the saving behavior in China. The theory argues that people desire to translate their consumption from periods of high income to periods of low income to obtain more stability and predictability. These studies including Chow (1985), Qin (2003) and Modigliani and Cao (2004) tested similar hypotheses but ended up with inconclusive findings for the saving behavior of the Chinese. One challenging fact that hardly reconciles with theories is that, Chinese households continued to save more in anticipation of higher future incomes instead of consuming more to smoothen lifetime consumption. Studies based on household data also could not find evidence showing that the current consumption growth is positively correlated with the past consumption growth in China (Chamon and Prasad (2010)).

Culture is an alternative candidate that can explain the rise in savings. Carroll et al. (1994) argue that the consumption inertia is related to a culture-based explanation to saving behavior. Since thrift has been one of Chinese tradition for thousands of years, their consumption growth could have lagged behind their income growth during the reform period, thus leading to higher household saving. Through the provincial-level empirical work, Horioka and Wan (2007) find that variations in household saving over time and space are influenced by the lagged saving rates, which is a result consistent with the existence of inertia or persistence. However, the empirical evidence is inconclusive. As Modigliani and Cao (2004) argue, the traditional and commonsensical explanation, for example, Chinese people's thrift, counts little. Using the 1988–2003 China Health and Nutrition Surveys, Zhao (2007) finds that younger Chinese cohorts actually have a higher propensity to save than older cohorts after controlling for other saving determinants. Given that older cohorts usually carry more cultural tradition than younger cohorts, these findings show that thrift is not an important determinant of Chinese household saving.

Demographic changes induced by China's one-child policy and the population ageing can also affect the saving rate. Studies from this perspective are often accompanied by the incomplete pension system in China. The primary mechanisms are summarized as follows. First, since the non-working population consists of the young and the old who consumes without earning any income, a rise in their share in the population tends to reduce national household saving. Second, in a developing country without a mature social security system, the older population have to rely on the support (long-term care) from their children. Thus children act as an effective substitute for life-cycle saving. (Choukhmane et al. (2014), He et al. (2016), Imrohoroğlu and Zhao (2018)). In addition, Modigliani and Cao (2004) use the share of the employed population out of the number of minors up to age 15 to approximate demographic change. They find that the decline in the young population dependency between 1953 and 2000 increased Chinese household saving through both effects of “fewer mouths to feed” and old-age security. However, this time series evidence is not confirmed by panel data studies. Neither aggregate dependency ratio (Kraay (2000)) nor separate accounts of the young and the old dependency ratios (Horioka and Wan (2007)) are found to have a significant effect on the household saving rates across Chinese provinces. Applying cohort analysis to data from the Urban Household Survey (UHS), Chamon and Prasad (2010) reach a similar conclusion that demographic structural shifts do not go very far in explaining saving behavior in China. Wei and Zhang (2011) consider the saving motive from the perspective of the sex ratio. They find that Chinese parents with a son competitively raise their savings to improve their son's relative attractiveness for marriage and the pressure on savings spills over to other households. However, they may omit the saving motives in preparing for the education and life expenditure of children as the children grow up. Specifically, this refers to the difference in the expenditure of raising boys and girls which is originated from the traditional culture "Poor Boys, Rich Girls."

Uncertainties including employment, education, health care, and housing services are another important motivation in studying the high saving rates in China. The uncertainty associated with the transition could trigger precautionary motives to save. For the employment, the aggressive reforms of privatization of State Own Enterprises (SOEs) led to mass layoffs in 1997. Given the earnings uncertainty and unemployment risk combined with liquidity constraints and incomplete unemployment insurance, Meng (2003) finds that Chinese urban households that experienced past income uncertainty appeared to have increased their propensity to save in the period of 1995–1999. Blanchard and Giavazzi (2016) have noted the importance of income uncertainty in explaining the high saving rate in China. However, reconciling the findings with the macroeconomic facts is difficult. For example, the employment uncertainty associated with state-sector restructuring continued to rise and reached its peak in the late 1990s. However, the national saving rates did not increase accordingly but rather fell to the bottom of the valley during the second half of the 1990s. In addition, there has been no large employment shock since 2000. Therefore, the precautionary saving motive stemming from employment uncertainty does not seem to explain well the surge in the national saving rate. For the uncertainties in education, health care and housing services, Chamon and Prasad (2010) argue that these rising private financial burdens could induce higher household saving, as younger families accumulate assets for future education spending, older families prepare for uncertain health expenditures, and most people save to prepare for mortgage payments or housing upgrades. Although these are plausible factors, their quantitative effects on savings are difficult to assess. However, intuitively, most of the young adults have already finished their own education, there is no need to save for that purpose. Also, as individuals retire, fewer uncertainties are remaining in their life cycles, and the need for buffer-stock savings shrink. Gourinchas and Parker (2002) have demonstrated that buffer-stock saving occurs mostly at the beginning of the life cycle; therefore, it is unlikely to be a major explanation for the saving of the entire population. Similar compositional effects exist for housing expenditures, as higher costs in housing mortgage tend to reduce the disposable income that can be used in savings.

The last related and important strand of the literature is about the contribution of retirement on savings through the pension system. Sánchez Martín (2010) assesses the pension reform in the Spanish economy whose major policies include delaying legal retirement ages and reducing the generosity of pension benefits. They find that the pension reform extends the length of the averaging period in the pension formula, which reduces the size of pension benefits and finally leads to higer levels of personal savings and capital accumulation. Fehr et al. (2003) investigate five different reform proposals by means of an OLG model with endogenous retirement age for the Norwegian economy. This paper finds that even if the early retirement subsidy is substituted by an early retirement tax, only households in the middle-income class increase their retirement age. The majority of households retire early, resulting in that the pension benefits are reduced, and people increase their savings. Díaz-Giménez and Díaz-Saavedra (2017) study the 2011 and 2013 pension reforms in Spain and find that, through delaying the legal retirement ages, the reforms finally lead to the longer working time. And the lower retirement pensions increase savings, and this increases the stock of physical capital. However, the reforms studied in this strand of the literature manipulate the mandatory retirement age, while the pension reform in China from 1995 to 1997 did not. This difference means that the case of China provides a better opportunity to look at the association between the retirement age and the pension system by excluding the influence of the change of mandatory retirement age. In addition, the existing early retirement literature mainly focuses on the pension system in developed countries which penalizes early retirement by a much lower pension replacement rate. But there are very few studies about China, where there is no penalty for early retirement.

3 Model

This model that incorporates the saving behavior of workers is a closed economy life-cycle model with uninsured idiosyncratic shocks to labor income and mortality. The outline of the model follows İmrohoroglu et al. (1995) and Conesa and Krueger (1999). A period in the model stands for one year of real time, which is denoted by t when referring to calendar time and by j when referring to age. The representative agents enter the labor market at age 20 and live up to age $\bar{J}$. Many cohorts are included in the model. Different cohorts enter in the year 1995 with different starting ages. Each agent begins with a given and same education level, health status and amount of initial assets. The agents earn income together and make consumption decisions together. Each agent faces different labor income risk during her working years, makes exogenous retirement decision before or at the mandatory retirement age and receives social security after she retires. Since there is no insurance market for the income shock and mortality shock, the annuity markets are closed as an assumption. There are no intergeneration transfers. Agents in this economy save because of concerns about the retirement period.

3.1 Demographics

Time is discrete. The economy is populated by agents (individuals[4]) whose ages are denoted by j from 1 to $\bar{J}$. Population in a country at time t consists of two groups of agents: workers and retirees. The population grows at three different exogenous annual rates in three ranges of time, which will be discussed in details in the next section. In each age j at time t, they face an unconditional probability of surviving, $s_{t,j}$, which means that they can live up to age j from the year they were born unconditional on the survival probability of the previous year. It is calculated as $s_{t,j} = \prod_{i=1}^{j} \psi_{t,i}$. $\psi_{t,j}$ is the age-dependent conditional survival probability, i.e., it is a survival probability conditional on the previous year's one. $N_{t,j}$ denotes the number of individuals of age j ($j > 2$) at time t.

$$N_{t,j} = \psi_{t,j} N_{t,j-1}, \quad j > 2 \tag{1}$$

When $j = 1$, in every period t, a new birth cohort enters the economy with cohort size $N_{t,1}$. It grows at an exogenous population growth rate n. Therefore, we have

$$N_{t,1} = (1 + n) N_{t-1,1} \tag{2}$$

The fraction of the age-j cohort in the total population at time t is

$$\mu_{t,j} = \frac{N_{t,j}}{N_t} = \frac{N_{t,j}}{\sum_{j=1}^{\bar{J}} N_{t,j}} \tag{3}$$

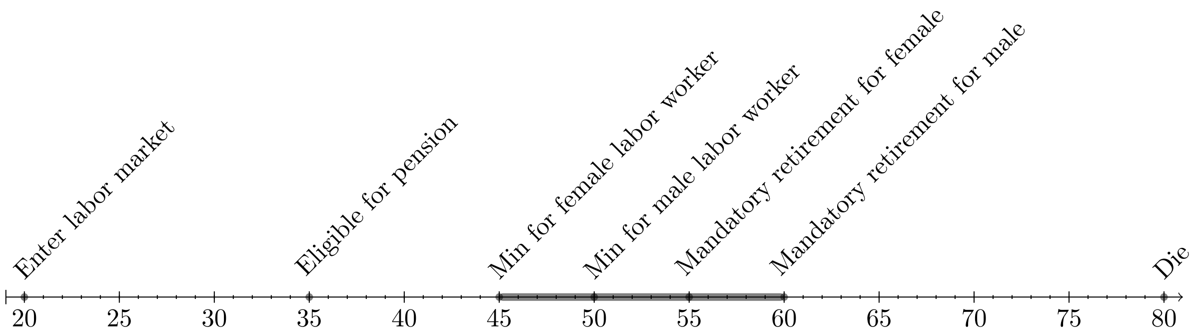
In the following section, for the sake of simplicity, the subscript of years t is omitted. When there is only the subscript of ages j, it represents for the age j for a given year t.

[4]Choosing individual rather than household as the basic unit of this model can better study the effect of the retirement age.

3.2 The Representative Agent

3.2.1 Preference

In this model of China, agents enter the job market at age 20. They are eligible to receive pension benefit if they have worked and paid the pension tax for 15 years[5] when they retire according to the current Social Insurance Law of the People's Republic of China. The minimum legal retirement age of female labor workers is 45, while the minimum legal retirement age of male labor workers is 50. In order to be consistent with China's data and since the mandatory retirement age of female and male are 55 and 60 respectively, in this model, I assume that Chinese agents can choose to retire from age 50 to 60. The timeline is shown as follows.



Agents in the model maximize their expected lifetime utility by choosing optimal paths for consumption, hours worked and an exogenous "once and for all" retirement age[6]. Formally, individuals choose an exogenous retirement age R, and the life-cycle profiles of consumption, hours worked and accumulated wealth, c_j, h_j, a_j, that maximize the sum of expected, discounted utility flows stemming from a period utility function:

$$U = E\{\sum_{j=1}^{R-1} \beta^{j-1} s_j u(c_j, l_j) + \sum_{j=R}^{\bar{J}} \beta^{j-1} s_j u(c_j, 1)\} \tag{4}$$

where β stands for the subjective time discount factor, s_j is the unconditional probability of surviving till age t for an agent and $s_j = \prod_{i=1}^{j} \psi_i$. The individuals are endowed with one unit of discretionary time in a period which can be divided between leisure, l_j and work h_j. Therefore, $l_j = 1 - h_j$ is the fraction of the time endowment allocated to non-market activities, i.e., leisure. For the lifetime utility function, the first summation term represents the total utility of working periods, during which individuals have to make the decision of both consumption and leisure. The second summation term denotes the total utility of retirement periods, during which individuals only have to make the decision of consumption. The leisure decision will become one after the retirement. In particular, the utility function is a Constant

[5]These 15 years don't have to be a consecutive time. It can be an accumulative time.
[6]The retirement ages equal the data.

Relative Risk Aversion (CRRA) function as follows,

$$u(c_j, l_j) = \frac{(c_j^{\gamma} l_j^{1-\gamma})^{1-\sigma}}{1-\sigma} \tag{5}$$

where $\beta, \gamma, \sigma > 0$. γ is the coefficient of relative risk aversion of consumption. σ is the CRRA coefficient.

3.2.2 Working agents

This model does not include intended bequests and assumes that accidental bequests resulting from premature death are taxed away by the government at a confiscatory rate and used for otherwise neutral government consumption. In any period t, a working individual of age j $(1 \leq j \leq R-1)$ faces the following budget constraint,

$$c_j + a_{j+1} = [1 + (1-\tau_K)r]a_j + il_j \tag{6}$$

where τ_K is the capital tax, a_{j+1} is the asset holding for the next period, and r is the interest rate. Labor income at age j il_j is determined as follows,

$$il_j = (1 - \tau_L - \tau_{SS}) w \epsilon_j \eta_j (1 - l_j) \tag{7}$$

where τ_{SS} is the social security payroll tax, τ_L is the labor income tax, and w is the wage, ϵ_j is the deterministic age-dependent productivity at age j, $1 - l_j$ is the fraction of the time endowment allocated to market activities, η_j represents a stochastic idiosyncratic income shock.

3.2.3 Retired agents

Since there is no private insurance market according to the assumption, each agent has to self-insure the risks she faces through asset accumulation. In any period t, a retired individual of age j $(R \leq j \leq \bar{J})$ faces the following budget constraint,

$$c_j + a_{j+1} = [1 + (1-\tau_K)r]a_j + SS_j \tag{8}$$

Following He et al. (2016), SS_j, the defined benefit formula for an age-j retiree is computed as follows:

$$SS_j = \theta[\nu \frac{\sum_{j=1}^{R-1} \mu_j w_j \epsilon_j \eta_j h_j}{\sum_{j=1}^{R-1} \mu_j} + (1-\nu) \frac{\sum_{j=1}^{R-1} w_j \epsilon_j \eta_j h_j}{R-1}] \tag{9}$$

where θ represents the target replacement ratio.[7] The first fraction on the right-hand side represents

[7]The ratio between pension benefit and average local labor income. The larger the replacement ratio is, the more generous the government is.

the average local wage, in which the numerator is the total labor income from the working population at year t and the denominator is the total working population. This term can capture the feature of the PSYG system. The second fraction on the right-hand side represents that average lifetime income for an agent, in which the numerator is the individual's lifetime average wage and the denominator is her total working years. This term can capture the feature of the Fully Funded system, in which the pension incomes come from one's life-time average wages. The weight ν measures the share of PSYG system in the determination of social security benefits. When $\nu = 1$, the pension system becomes a pure PSYG system, which was the system before 1997 in China.

Since Chinese consumers face severe financial constraint, an individual is not allowed to borrow as an assumption. For both working and retired agents, although facing a stochastic income risk in every period, their asset holding always satisfy the constraint $a_{j+1} \geq 0$.

3.3 Firms

Goods market is competitive. The representative firm is constant returns to scale with no adjustment costs. The total technological changes at period t is denoted by A_t. The firm chooses labor, capital to maximize a Cobb-Douglas production function $Y_t = A_t K_t^{\alpha} L_t^{1-\alpha}$. Where α is the capital-labor elasticity, K_t and L_t are the effective capital and labor input at time t, and $A_t = A_0(1+g_t)^t$. g_t is the exogenous growth rate of the TFP. This model assumes that this technology is own by a large number of profit-maximizing, competitive firms.

The capital K follows the law of motion

$$K_{t+1} = (1-\delta)K_t + I_t \tag{10}$$

where I_t denotes capital investment. δ is the constant depreciation rate. The first order conditions that determine net real return to capital and real wage are as follows,

$$r_t = \alpha A_t K_t^{\alpha-1} L_t^{1-\alpha} - \delta \tag{11}$$

$$w_t = (1-\alpha) A_t K_t^{\alpha} L_t^{-\alpha} \tag{12}$$

3.4 Public Sector

The main role played by the public sector is to run a social security system in the spirit of PSYG before 1997 and a mixed pension system with both PSYG and Fully Funded after 1997 in China. After contributing a fixed proportion, τ_{SS}, of their gross labor income for more than accumulative 15 years in China, workers become eligible for a pension benefit in retirement. The pension can be claimed at any time after the retirement age, R, and following a complete withdrawal from the labor force.

In addition, the government taxes both capital and labor income at rates τ_k and τ_L, respectively. The levied tax revenues finance the stream of government consumption expenditures G_t.

3.5 The Competitive Equilibrium

The consumer's utility maximization problem in this model can be represented as a finite-state, finite-horizon discounted dynamic program. The agent is to choose a sequence of consumption, leisure and asset holdings given the set of prices of factors and policy parameters. The state of the agents consists of age j; assets a; leisure l; and the labor income shock faced by the workers η. Let $V_j(X)$ denote the value function of an age-j individual with the set of state variables X where,

$$X = \begin{cases} (a, l, \eta) & 1 \leq j \leq R-1 \\ (a) & R \leq j \leq \bar{J} \end{cases} \tag{13}$$

The dynamic programming problem of the individual's maximization problem is as follows:

$$V_t(X) = \max_{\{a',c,l\}} \{u(c,l) + \beta\psi_{j+1} E V_{t+1}(X')\} \tag{14}$$

subject to

$$\begin{cases} Equation(6)\&(7) & 1 \leq j \leq R-1 \\ Equation(8)\&(9) & R \leq j \leq \bar{J} \end{cases} \tag{15}$$

The formal definition of this stationary recursive competitive equilibrium in the benchmark model as defined in Imrohoroglu (1995) is given as follows:

Definition: In a closed economy, a Stationary Equilibrium for given the policy arrangements $\{\tau_K, \tau_L, \theta, \nu\}$ and age structure $\{\{\mu_{t,j}\}_{j=1}^{\bar{J}}\}_{t=1}^{T}$ consists of a sequence of an individual's consumption, asset holding and leisure, $\{\{c_{t,j}, a_{t,j}, l_{t,j}\}_{j=1}^{\bar{J}}\}_{t=1}^{T}$; a sequence of prices, $\{r_t, w_t\}_{t=1}^{T}$; a sequence of pension benefits, $(SS_t)_{t=1}^{T}$; a sequence of pension tax, $(\tau_{SS})_{t=1}^{T}$; a sequence of government expenditure, $(G_t)_{t=1}^{T}$; a sequence of factors of production, $(K_t, L_t)_{t=1}^{T}$; and a sequence of time-variant age-dependent distribution of individuals $\{\{\lambda_{t,j}(X)\}_{j=1}^{\bar{J}}\}_{t=1}^{T}$ with the set of state variables $X = (a, l, \eta)$ when $1 \leq j \leq R-1$ and $X = (a)$ when $R \leq j \leq \bar{J}$ such that:

1. Given the prices $\{(r_t, w_t)_{t=1}^{\infty}\}$, the individual's decision rule (c_t, a_t, l_t) solves the individual's dynamic problems (14)-(15).

2. The factor prices are determined by Equation (11) and (12).

3. The time-variant age-dependent distribution of individuals follows the law of motion,

$$\lambda_{j+1,t+1}(X') = \begin{cases} \sum_{\{a,l,\eta:a'\}} \lambda_{j,t}(X) & 1 \leq j \leq R-1 \\ \sum_{\{a:a'\}} \lambda_{j,t}(X) & R \leq j \leq \bar{J} \end{cases} \tag{16}$$

where a' is the optimal assets in the next period.

4. The capital market clears:

$$K_t = \sum_{j=1}^{\bar{J}} \mu_{t,j} \lambda_t(X) a_{t,j} \tag{17}$$

5. The labor market clears:

$$L_t = \sum_{j=1}^{R-1} \mu_{t,j} (1 - l_{t,j}) \lambda_t(X) \epsilon_{t,j} \tag{18}$$

6. The social security system is self-financing:

$$\sum_{j=R}^{\bar{J}} \mu_{t,j} SS_t = \tau_{SS} \sum_{j=1}^{R-1} \mu_{t,j} w_t \epsilon_{t,j} \eta_{t,j} (1 - l_{t,j}) \tag{19}$$

7. The government budget constraint is satisfied:

$$G_t = \tau_K r_t K_t + \tau_L w_t L_t \tag{20}$$

4 Calibration

Since the reform of China's pension system from a pure PSYG to a mixed pension system with both PSYG and fully funded was gradually implemented from 1995 to 1997, this paper calibrates the model to match the Chinese economy of 1995 as the initial steady state, the time when the pension reform began. The calibration strategy is to choose common parameters that are widely used in the literature and estimate others using micro-level survey data. The target of calibration is to match the following critical features and variables in the Chinese economy in 1995. First, the equation of pension income should capture the characteristics of China's pension system regulations before and after the reform. Second, the aggregate performance of the model regarding saving rate, consumption ratio, government expenditure ratio, the average working hour, etc., should be consistent with China's data during the calibrated period.

4.1 Demographics

For the demographic structure, $j = 1$ corresponds to age 20 in real life, the time when an agent enters the labor market. In the benchmark, I choose $R = 36$ corresponds to age 55 in real life, which is the average retirement age in the CHNS data of 1995 in China. I set $\bar{J} = 61$ in order to correspond to age 80 in real life, which is chosen to fit in the projection of China's future life expectancy in World Bank dataset[8] and the transition path in the following sections. The population of each cohort from age 20 to age 80 and the conditional survival probabilities $\{\{\psi_{t,j}\}_{j=1}^{\bar{J}}\}_{t=1}^{T}$ are taken from the Chinese Census for the initial steady state, 1995, and the year from 1995 to 2015. In the transition path after 2015, the population growth rate is chosen to be $n = 2.0\%$ from 2015 to 2028 and $n = -2.0\%$ from 2028 to 2095, which is the final steady state. This can match the average population growth rate calculated from the population estimates and projections in the World Bank dataset[9].In order to show that this method of choosing population growth rate is capable of matching the data, I first use the average population growth rate ($n = 0.62\%$) which is calculated from 1995-2015 to simulate the following three different shares of population, the share of 20-40, the share of 40-65 and the share of 65+. The result is shown in figure 3. As we can see in figure 3, this method can capture these three shares of population structure well.

4.2 Preference

For the parameters in the utility function, the value of σ is set to 2.9, which is in the range of the values in the common macroeconomics literature. β is calibrated to match the aggregate saving rate in the initial steady state. γ is calibrated to match the average working hours ratio[10]. Therefore, β is set to 1.007[11] in order to target the saving rate in 1995, which is 40.39%. γ is set to 0.40.

4.3 Technology

For the technology, Following Song et al. (2011), the capital income share of China is set to be 0.5 and the capital depreciation rate δ is set to 0.1. The growth rate of the TFP g_t is set to 5.8% from 1995 to 2050, which is the average value calculated by Ge et al. (2014) using the Urban Household Survey (UHS) data. From 2051 to the final steady state, the TFP growth rate is set to 2% as common use in the long-term developed economy.

4.4 Labor income

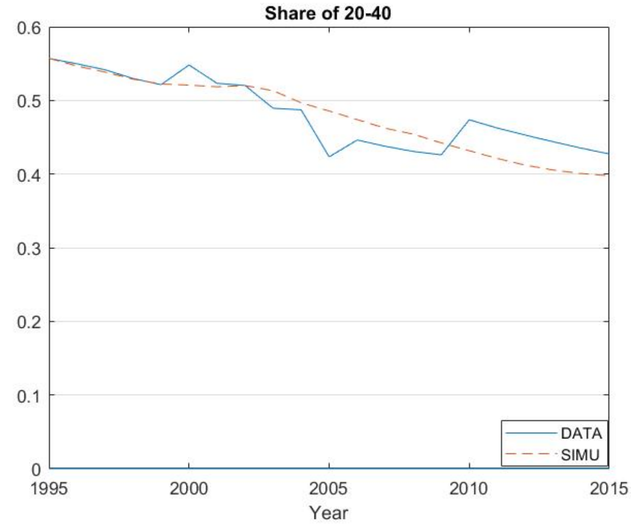
For the age-dependent labor efficiency profile $\{\{\epsilon_{t,j}\}_{j=1}^{\bar{J}}\}_{t=1}^{T}$, I estimate it using the CHNS data and the method in the appendix of He et al. (2016) to make the age profiles of individual productivity to be

[8]The long-term projection of life expectancy of China in World Bank Indicator dataset is 78.

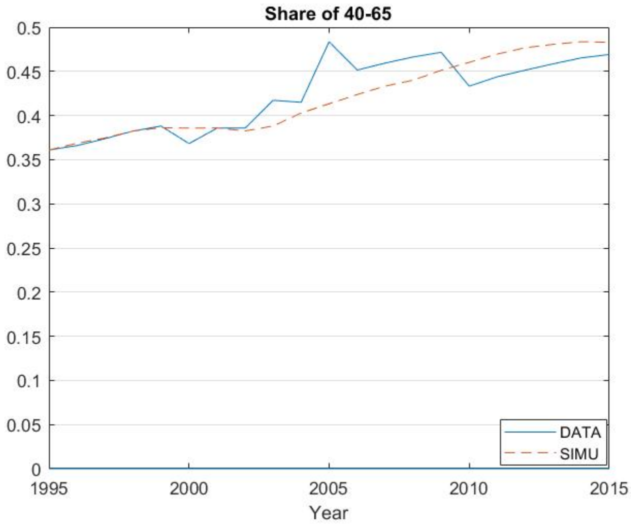
[9]The population estimates and projections data from 2015-2050 can be found at the following webpage: http://databank.worldbank.org/data/reports.aspx?Report_Name=China-Population-Projection-15-50&Id=61621b1c#

[10]Since there is no only wave of 1995 in CHNS, the closest wave is the one of 1997. In 1997 CHNS data, the average weekly working hour per person is 42.15 hours. The share of working hours over total available hours is 42.15/(24*7)=0.251.

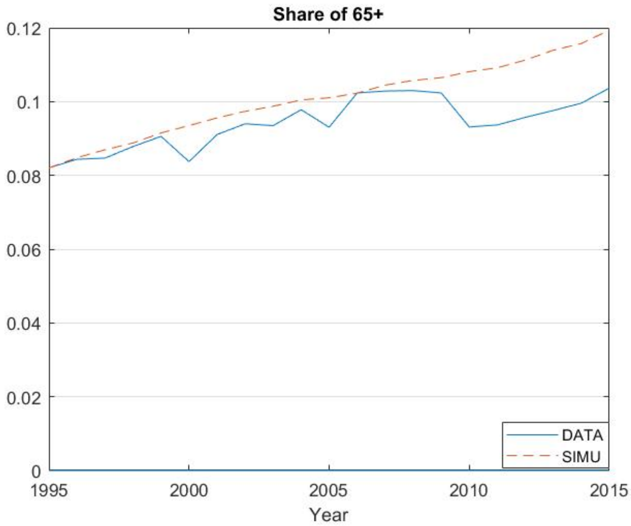
[11]In He et al. (2016) and He (2012), they both choose $\beta \geq 1$. He et al. (2016) set $\beta = 1.044$ to target China's saving rate in 1997. He (2012) set $\beta = 1.027$ to target US's saving rate in pre-1951 economy.



(a)



(b)



(c)

Figure 3: Population share

consistent with the empirical evidence on gross labor earnings. The labor income tax τ_L and the capital income tax τ_K are set to 17.5% according to Liu and Cao (2007).

Labor income risk is an AR(1) process with an i.i.d. innovation as described below

$$\phi_{t,j} = \rho\phi_{t,j-1} + \varepsilon_{t,j}, \varepsilon \sim N(0, \sigma_\varepsilon^2) \tag{21}$$

Based on the finding in Imrohoroğlu and Zhao (2018) and He et al. (2016), I choose $\rho = 0.85$ and the variance $\sigma_\varepsilon^2 = 0.055$. I then discretize the AR(1) process into a three-state Markov chain using the Tauchen (1986) method. The resulting values for are {0.26,1.00,3.80} and the transition matrix is given in Table 1. S1, S2, S3 represents for the low income shock, middle income shock and high income shock for the current period respectively. $S1', S2', S3'$ represents for the low income shock, middle income shock and high income shock for the next period respectively.

Table 1: The Transitional Matrix Income Shock

	$S1'$	$S2'$	$S3'$
S1	0.9769	0.0022	0
S2	0.0231	0.9956	0.0231
S3	0	0.0022	0.9769

4.5 Pension system

Before 1997, the pension replacement rate is high and about 75% in He et al. (2016) and 80% in Sin (2000). For the parameters in China's pension system, to be consistent with the system in 1995, I set the replacement ratio $\theta = 75\%$. Since the pension system before 1997 was a pure PSYG system, there was no Fully Funded system. Therefore, the share of PSYG ν is set to be 100%. Table 2 summarizes all parameter values mentioned.

Table 2: Parameters values in the benchmark model

Variable	Description	Value	Source
α	Capital labor elasticity	0.5	Song et al. (2011)
β	Subjective time discount factor	1.007	Target saving rate
γ	Relative risk aversion of consumption	0.40	Target Ave. working hour
δ	Depreciation rate	0.1	Song et al. (2011)
σ	CRRA coefficient	2.9	Average of common range
$\bar{J}$	Maximum of life span	61	
R	Age of retirement	36	CHNS
θ	Pension replacement ratio	0.75	Data in 1995
ν	Share of PSYG	1	Regulation before 1997
τ_L	Labor income tax	0.175	Liu and Cao (2007)
τ_K	Capital tax	0.175	Liu and Cao (2007)
g_t	TFP growth rate	0.058	Ge et al. (2014)

5 Quantitative result

In this section, I first examine the key aggregate variables in the initial steady state of the calibrated economy where the retirement age equal to the average retirement age of 55 in 1995 in China. The initial steady state is simulating the economic condition in 1995 in China. And the final steady state is 100 years later. For the final steady state, the retirement age is set to be 53, which is the average retirement age in 2015. Next, I examine the transition paths of the aggregate saving rate.

5.1 Initial and Final Steady State

The results in table 3 show that the initial steady state in the simulated model can match the key variables of China in 1995. The gross saving rate is 40.39% in the data, while in my initial steady state it is 40.66%. The gross consumption ratio is 45.77% in the data, while in my initial steady state it is 45.21%. The government expenditure ratio is 13.97% in my model while the data is 13.25%. The government expenditure ratio is 13.97% in my model while the data is 13.25%. The working hour share in the data is 0.251 while in my model it is 0.258. The return to capital is 14.9% while the same variable in the simulated model is 15.96%. The results are quite consistent with the data.

The final steady state is generated by simply changing the population structure of each cohort to the projected level in the year 2095 and the growth rate of TFP factor from 5.8% to 2%, while the survival probabilities equal the survival probabilities in 2015 and are fixed to be the same since 2015 in the transition path. The retirement age is fixed to 53 after 2015. The rest of the parameters are the same as those in the initial steady state. The gross saving rate (43.38%) is higher than the initial steady state mainly due to the earlier retirement age (53) and the change of pension benefit. In addition, the shorter working period results in the lower labor supply (0.240).

Table 3: Comparison between the simulated moments versus data

Variable	Initial Steady State		Final Steady State
	Data	Model	Model
Capital output ratio (K/Y)	2	1.95	2.21
Gross Saving rate (S/Y)	40.39%	40.66%	43.38%
Working hour share (L)	0.251	0.258	0.240
Consumption ratio (C/Y)	45.77%	45.21%	42.98%
Return to capital (r)	14.9%	15.96%	12.67%
Government expenditure (G/Y)	13.25%	13.97%	13.64%

5.2 Transition Path

This section presents the main results of the saving rate starting from the initial steady state and along the transition path to the new steady state. The transition is assumed to take 100 years. As mentioned above, the population of each cohort from age 20 to age 80 and the conditional survival probabilities

$\{\{\psi_{t,j}\}_{j=1}^{\bar{J}}\}_{t=1}^{T}$ are taken from the Chinese Census from 1995 to 2015. And after 2015, the population growth rate is chosen to be $n = 2.0\%$ from 2015 to 2028 and $n = -2.0\%$ from 2028 to 2095, which can match the average population growth rate calculated from the population estimates and projections in the World Bank dataset. The retirement ages equal to the average retirement ages in data from 1995 to 2015 in China. For the parameters in the social security income equation, the pension replacement rate (θ) changes from 0.75 to 0.6 and the share of PSYG (ν) changes from 1 to 0.6 according to the regulation in 1997 and remain unchanged since then. The reason is that, according to Social Insurance Law of the People's Republic of China in Table 5 in the appendix, the PSYG part after 1997 pension reform targets to 35% average monthly local wages while the Fully Funded part targets 24.2% average monthly local wages. The total replacement is about 60% ($35\% + 24.2\%$). For the share of PSYG, it is about 60% ($35\%/(35\% + 24.2\%)$) calculated by the law. After 2015, the retirement age is fixed on the average retirement age (53) in 2015 forever.

Figure 4 displays the saving rate generated by the benchmark economy versus the data for the first 20 years along the transition path starting in 1995. Overall, the time series path of the saving rate generated by the model tracks the data until 2005 reasonably well. After 2005, the saving rate in the model is slightly lower than the data. Overall, the time series path of the saving rate generated by the model mimics the data remarkably well. The model not only accounts for the decrease in the saving rate from 1995 to 2000 but also captures the major increase and fluctuation in the saving rate in the 21st century. In the data, as summarized in Table 4, the saving rate gradually decreased in the first five years in the 1990s, and then increased substantially from 36.46% of GDP in 2000 to 51.92% in 2008. In the benchmark economy, the saving rate was also decreasing in the first five years in the 1990s and then increased from 37.85% in 2000 to 45.44% in 2008.

Table 4: The Saving Rates Along the Transition Path

	1995	2000	2005	2008	2015
Benchmark model	40.66%	37.85%	44.55%	45.44%	44.14%
Data	40.39%	36.46%	47.86%	51.92%	48.39%
Decomposition experiment					
1. WSE only	38.42%	38.31%	38.72%	37.14%	38.45%
2. ERE only	40.5%	37.82%	48.25%	49.22%	46.95%
3. No effect	38.81%	38.4%	40.17%	37.45%	38.99%

5.3 Saving rate decomposition experiments

In order to examine the effect of early retirement and the change in pension income (Wealth Substitution Effect) on the gross saving rate, a few experiments are carried out in this section.

In the first experiment, I examine the effect of early retirement by forcing all the agents in my

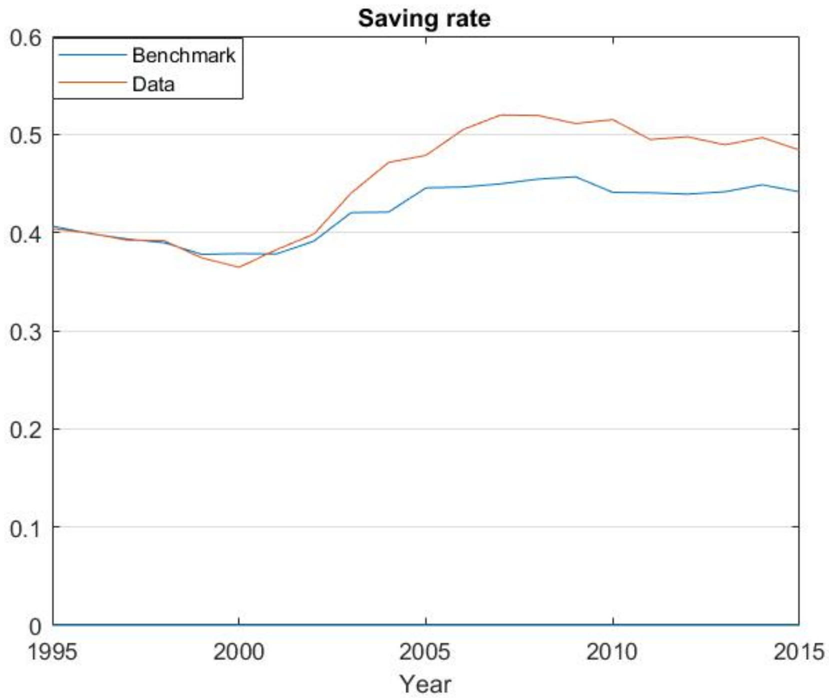


Figure 4: The Chinese Saving Rate: Model vs. Data

calibrated economy to retire at age 60 rather than the average retirement ages in the data. The result is shown in the Wealth Substitution Effect (WSE) only curve in figure 5. The WSE curve falls a lot and can no longer capture the change and fluctuation of the saving rate. The saving rate in 2015 becomes 38.45% as shown in Table 4. The decline in the saving rate is mainly due to the later retirement age and the shorter retirement period than the case in the benchmark economy. This explains the first important mechanism that drives up the saving rate since 1995. If the agent retires earlier, in order to cover the longer time in the retirement period without labor income, she has to save more.

In the second experiment, I examine the effect of the change of the social security income by shutting down the change of the social security income equation brought by the 1997 pension reform, i.e., keeping the pension replacement rate $\theta = 0.75$ and the share of PSYG $\nu = 1$ for the entire transition path. The result is shown in the Early Retirement Effect (ERE) only curve in figure 5. The saving rate moves up to a higher level than the benchmark level - in 2015, it is 46.95% as shown in Table 4. This indicates that the Wealth Substitution effect can dampen the positive effect of Early Retirement effect on saving rate. Without the negative effect brought by the Wealth Substitution effect, China's saving rate could have gone to a higher level. For a deeper study of this result, I show the social security income with and without wealth substitution effect (pension reform) in Figure 6. In Figure 6 we can see that, after 2002, the social security income along the benchmark transition path (With WSE) is higher than the case where the change brought by the pension reform is shut down (No WSE). Therefore, if the pension income increases after the reform in the benchmark, the saving rate will decrease compared to the case in

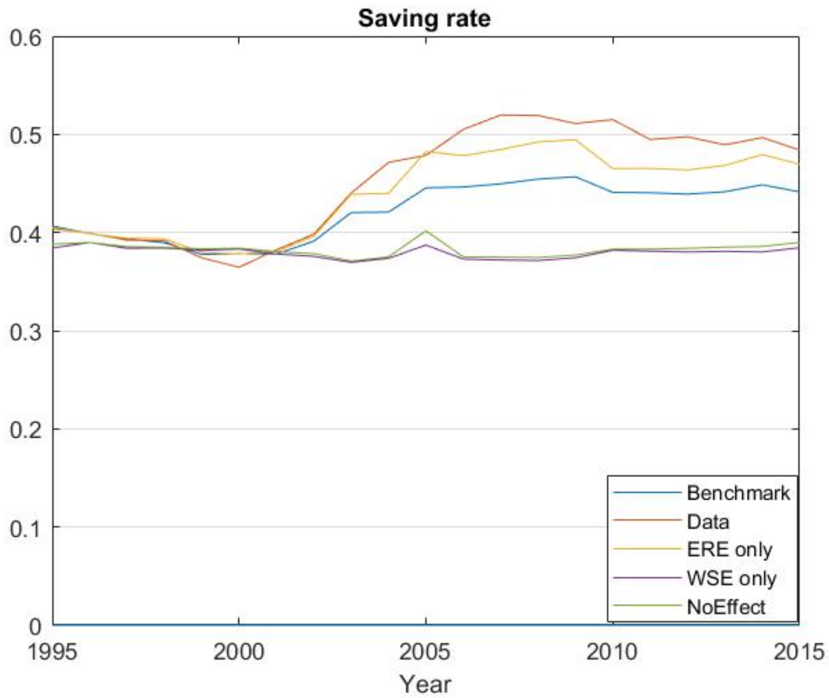


Figure 5: The decomposition of Chinese Saving Rate

the 2nd experiment. This can explain the second mechanism that if the social security can support more in the retirement period, the social security can substitute more for the saving, which will decrease the saving rate. That is, the Wealth Substitution effect can reduce the saving rate. However, it is contrary to economic common sense that a lower pension replacement rate after the pension reform results in a higher pension benefit. The explanation for this paradox is that, when China's government decides the value of the pension replacement rate and the share of PSYG, they take the mandatory retirement age (60) as the retirement age for all agents. However, the actual average retirement age is smaller than the mandatory retirement age, for example, 55 in 1995, which results in a smaller denominator in Equation (9) in Section 3. Therefore, the fraction in the second term in Equation (9) in Section 3 using the actual average retirement age in the benchmark model is greater than what China's government envisions using the mandatory retirement age. The difference between the actual average retirement age and the mandatory retirement age results in a higher pension benefit under a lower pension replacement rate. In addition, the increasing difference between the social security income can also explain the gap between the benchmark and the ERE only curve.

The last experiment is to remove the change of pension reform and the agent has to retire at age 60. The saving rate becomes very low as shown in the NoEffect curve in figure 5. As we can see from Table 4, the saving rates along the transition path in the 3rd experiment are slightly higher than those in the 1st experiment. This shows the negative effect of the Wealth Substitution effect on saving rate. In the previous experiments, we learn that the early retirement effect can increase the saving rate while

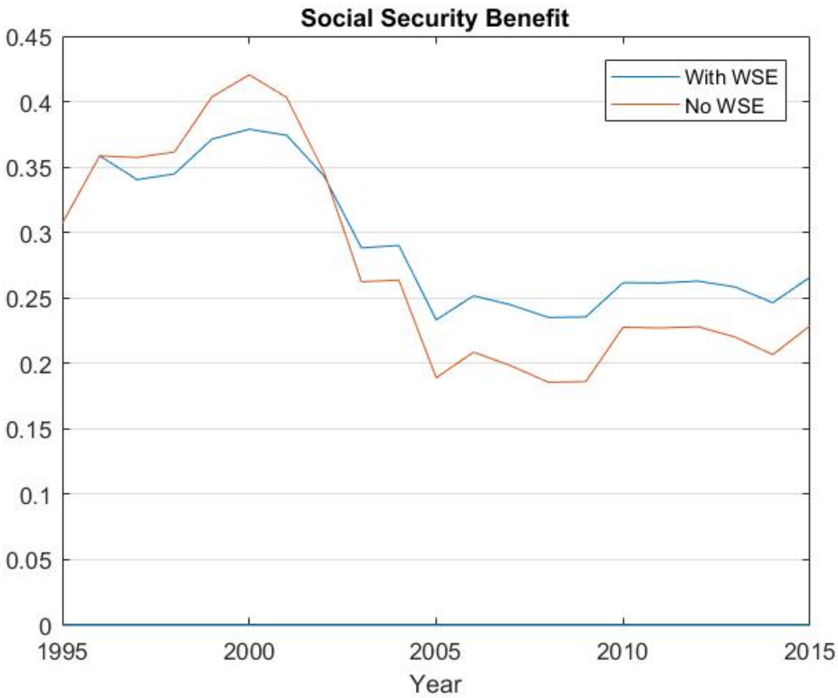


Figure 6: Social Security Benefit

the wealth substitution effect can decrease the saving rate. Therefore, the third experiment shows that even there is a negative effect in the saving rate brought by the wealth substitution effect, the early retirement effect still raise the saving rate to the benchmark level, which shows that the early retirement effect dominates the wealth substitution effect. And the positive dominant early retirement effect over the negative wealth substitution effect contributes to the high saving rate in China since 1995. For the explanatory power of this model, the change of the saving rate in data from 1995 (40.39%) to 2015 (48.39%) is 19.81% while the change of the saving rate in the benchmark model from 1995 (40.66%) to 2015 (44.14%) is 8.56%. Therefore, combining the opposite effects brought by the early retirement effect and the wealth substitution effect in China, this model can explain 43.21% (8.56%/19.81%) of the change of the saving rate in China between 1995-2015.

6 Conclusion

In this paper, I use a model economy that is populated with homogeneous agents with heterogeneous income shock and calibrate it to the Chinese economy. Then I examine the role of early retirement effect and wealth substitution effect in generating changes in the saving rate. My results indicate that the interaction between the average retirement age and the change in pension benefits plays an important role in the increase in the saving rate especially after 1997 as the 1995-1997 gradual pension reform is completed. I find that the saving rate would have increased from 40.66% in 1995 to around 47% in 2015 in the absence of wealth substitution effect. The presence of these facts, on the other hand, results in the saving rate to decline to around 44% in 2010. My experiments reveal that the dominant early retirement effect over the wealth substitution effect is capable of generating significant increases in the saving rate from 1995-2015 in China. Going forward, as the Chinese government enacts measures to delay the mandatory retirement age, the saving rate will likely decline.

Appendix

China's Pension Reform

Since 1995, China has successively carried out reforms of the social security system in various provinces. The core content is the implementation of the integration of social pooling and personal accounts in social security for enterprise employees. At the end of 1997, the State Council promulgated the "The State Council Document No. 26: Decisions of the State Council on Establishing a Unified Basic Pension Insurance System for Enterprise Employees" ("Decision 1997"). This reform sets the goal that the new social security system implements the partial accumulation system through implementation of the "the integration of social pooling and personal accounts in the pension insurance system." Besides, it unifies the conditions for the calculation and payment of pensions.

The specific provisions are as follows: the employees who retired before the implementation of the "Decision 1997" (the Old) still receive pensions according to the old regulations before the reform, that is, according to the seniority, they receive 60% to 90% of their standard wages at the time they retire. And the pension adjustment method is implemented at the same time. For the employees who participated in the work after the implementation of the "Decision 1997" (the New), if the individual payment period has accumulated for 15 years, the pension will be paid monthly after retirement. The pension incomes consist of basic pensions and individual account pension. The monthly standard of the basic pension is 20% of the average monthly wages of local employees in the previous year. The monthly standard of individual account pension is the amount of personal savings divided by 120. For the employees who participated in the work before the implementation of the "Decision 1997" and retired after the "Decision 1997" (the Middle), if the individual payment period has accumulated for 15 years or can be considered as that the individual payment period has accumulated for 15 years, their pension incomes consist of three parts: basic pensions, individual account pensions, and transitional pensions. Therefore, under the new system, according to the individual's employment status when the Decision 1997 implemented (retired, employed, unemployed), the calculation and payment methods of pensions for enterprise employees are different, so do the pension benefits. On the other hand, the pension benefits of employees of government agencies and institutions still follow the previous system regulations without adjustment. Table 5 concludes the main contents of the pension calculation and payment regulations of the enterprise employees before and after the reform according to the "Decision 1997".

Table 5: The pension calculation and payment regulations before and after the 1997 reform

	Pension Benefits	Pension Tax Rate
Before reform	60% to 90% of their standard government wages at the time they retire	According to total wages and local regulation (Firm); Gradually imple -mented, less than 3% of wages (Individual)
After reform		
The New	Basic pensions (Target to 35% of the average monthly wages of local employees in the previous year) + Individual account pensions (balance in the account divided by 120; target to 24.2%)	Firm: 20% of employees' total wages Individual: 4% of personal wages (1997), 8% of personal wages after 1997; 11% of personal wages goes to individual account
The Middle	Basic pensions (same as the New) + Individual account pensions (same as the New) + Transitional pensions (Indexation of monthly average wages × Coefficient × Number of years with -out individual account)	Same as the New
The Old	Same as "Before reform" Pension adjustment method is implemented	None

After 1997, there are several other pension reforms. But these reforms are a merely slight improvement which is based on the reform in 1997. The primary concerns of these reforms are to widen the coverage of the pension system and adjust the pension tax rate for the individual account. For example, in "The State Council Document No. 38: Decisions of the State Council on Improving the Basic Pension Insurance System for Enterprise Employees" ("Decision 2005"), the pension system includes industrial and commercial individual and flexible employment personnel. Besides, it reduces the tax rate that goes to individual account from 11% to 8%. Taxes paid by firm's do not enter the individual account any further.

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