Early Retirement, Pension System and Saving Rate in China

Xin Liang[*]

Abstract

This paper uses a life-cycle model to study the role of early retirement and pension system as drivers of China's persistent high savings. In the model, by incorporating the feature of Chinese mixed-pension system and being capable of generating changes in the national saving rate in China, the dominant early retirement effect over the wealth substitution effect can increase household's savings, which results in high savings in China. The findings suggest that the model can explain approximately 44% of the increase in the saving rate between 1995 and 2015.

JEL classification: E21,E27,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

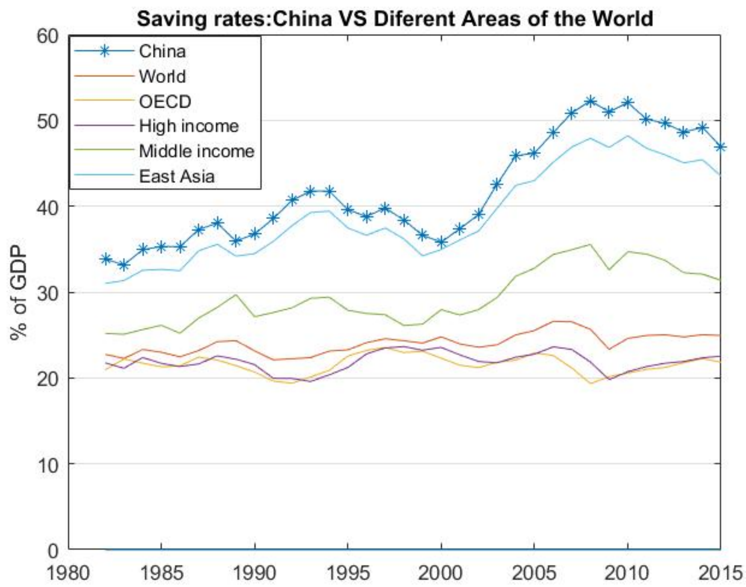


Figure 1: Saving rates: China VS Diferent Areas of the World
Source: World Bank Indicator

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 53 percent in 2008. Since 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 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.

In addition, China has undergone a dramatic economic transformation involving not only fast economic growth and sustained capital accumulation, but also major shifts in different systems, for example, the social security system. 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). 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 income of retirement, the behaviors of consumption, saving and investment of households will change during both

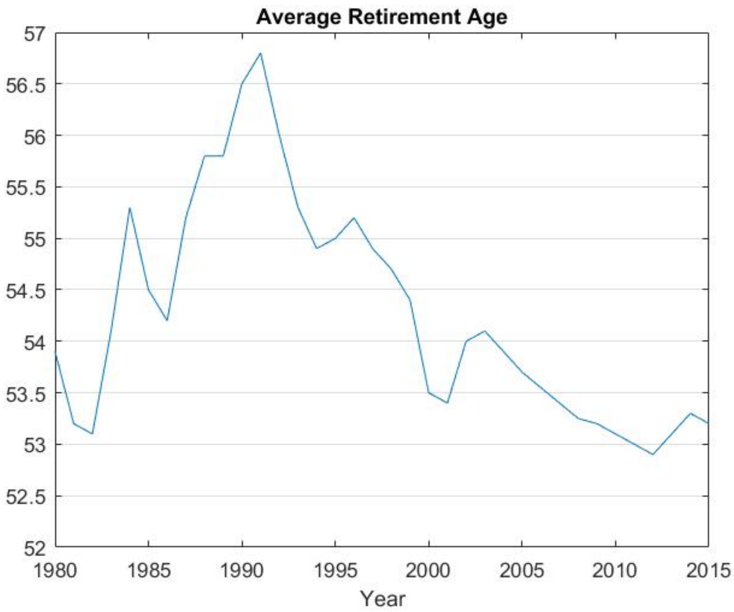


Figure 2: Average retirement age in China
Source: CHNS and China Labor-force Dynamic Survey(CLDS)

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[1] than other countries with the similar life expectancy and allows for early retirement in China.[2] Under this circumstance, what accompanies the process of the pension reform is a noteworthy phenomenon that, Chinese people choose to retire earlier than mandatory retirement age and the average retirement age is trending lower constantly. According to 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 53 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.

While being consistent with salient qualitative and quantitative features of the Chinese experience, this paper suggests that early retirement and the mixed pension system has a significant impact on the saving rates. Given China has an earlier retirement age and also allows for early retirement, the life-cycle model of this paper finds that, first, the early retirement cause agents to increase saving in order to cover the more extended periods of the retirement over which accumulated assets will be spread; second, the increase the pension benefit brought by the pension reform will decrease the saving since there is a wealth substitution effect that the pension benefits can substitute for the saving; third, the positive effect of

[1]60 for male and 55 for female.

[2]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 can retire at age 60, female employees can retire at age 55 and female workers can retire at age 50. In the heavy labor and high-risk industries, for example, mining industry, male can retire at 55 and female can retire at 45. If employees lost the ability to work which is proven by hospitals, male can retire at 50 and female can retire at 45.

the early retirement dominates the negative effect of the wealth substitution effect of pension benefit, which results in the high saving rates in China. In specific, in the benchmark case, the dominant early retirement effect over the wealth substitution effect in the model is capable of accounting for 44% of the rise in the saving rate between 1995 and 2015.

There has already been some well-addressed explanations for this high saving rates puzzle from different perspectives including the One-Child policy, Modigliani and Cao (2004), sex ratio, Wei and Zhang (2011), One-Child policy and long-term care, İmrohoroglu and Zhao (2017), population aging and pension reform, He et al. (2016), uncertainty, Chamon et al. (2013), etc.. However, although greater uncertainty explains why young people save more because they need to build higher buffer-stock savings. However, as individuals age after retirement, 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 elderly. In addition, lower replacement rates raise the precautionary saving of the elderly to prepare for their elderly life, while my focus on pensions exhibits a crucial difference from previous research. First of all, lower replacement rates for the retired are less likely to explain the high saving rates of the elderly because pension payments are a component of income, and saving is defined as income minus expenditure. A lower pension implies lower saving unless consumption decreases by a more considerable amount, which is generally not the case as households attempt to smooth consumption. Secondly, in China, the de facto rate and the de jure rate can be different because of delayed and canceled payments. Even if it is true that the reform has reduced the de jure replacement rate, this does not necessarily imply that the de facto rate will fall as well. Indeed, the simulation results of this paper suggest that in the change of the $defacto$ rate in 1997 pension reform, the pension income is more likely to increase than to decrease.

The main contribution of this paper is to provide an explanation for the persistently high national saving rates in China. Based on the existing literature, I go one more step to look at the effect of early retirement coupled with the social security system. By correlating the early retirement and the change of pension benefits, this paper can not only provide a new angle of investigating the saving rate in the working population through their average retirement age but also solve the potential problem as mentioned above in studying the savings of the retired population through the change of pension benefit. In addition, the model tries to capture the wealth substitution effect and the induced retirement effect proposed by Feldstein, which, to my knowledge, is the first time. The model in this paper is not going to study why people retire earlier by endogenizing the retirement decision to match the data of average retirement age and then try to examine what factor result in the early retirement. In this paper, given the fact of early retirement, I try to find that the early retirement can explain the high saving rates in China and it is the dominant early retirement effect over wealth substitution effect in China 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 presents the calibration of the model. Section 5 shows the results of the static and dynamic analysis. Finally, section 6 concludes.

2 Literature Review

This paper is mainly related to the body of 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 three different strands.

The first strand examines life-cycle considerations and demographic variation. This strand of literature mainly focuses on the impact of One-Child policy on the population and the ageing population in China (Modigliani and Cao (2004); Wei and Zhang (2011);Choukhmane et al. (2013); İmrohoroglu and Zhao (2017); Curtis et al. (2015);He et al. (2016);Bárány et al. (2016)). Modigliani and Cao (2004) attribute the reason for the high household saving to the constant increase in the share of the working population out of the total population, which is a result of the One-Child policy. Wei and Zhang (2011) consider the saving motive from a new perspective of the population structure-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. He et al. (2016) find that although the rapid aging in China puts pressure on the pension system and leads to a shift of age structure in the economy towards the elderly who work less and save less, one needs to save more while working to prepare for a longer retirement period due to the longer life expectancy. This empirical finding results in the high savings.

The second strand investigates the influence of social security on savings rates mainly from the perspective of the underdeveloped PAYG pension system with low pension replacement rate which is hard to sustain the same consumption level after retirement. Chamon et al. (2013) have proposed that the greater uncertainty and the decreased pension ratio constitute the primary explanation for the high savings in China. Feng et al. (2009) also argue that the pension reform resulted in lower replacement rates for the elderly, further motivating them to save more.

The third strand considers the role of uncertainty in the high saving rates. The increase in savings is due to the precautionary savings against uncertainty. Chamon and Prasad (2010) have proposed that the U-shaped pattern in China can be explained by the precautionary against the high educational and medical expenditures. They have observed that the increase in saving rates has been accompanied by a drastic increase in educational expenses and medical expenditures. Educational spending for children create a saving motivation for young households, and medical expenditures generate a saving motivation for elderly households. Blanchard and Giavazzi (2016) have noted the importance of income uncertainty in explaining the high saving rate in China.

Another related and important strand of 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 low-skilled workers tend to retire early and average-skilled workers anticipate retirement. In addition, 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) investigates five different reform proposals by means of an overlapping generations model with endogenous retirement age and heterogeneous individuals for the Norwegian economy. This paper finds that the expansion of their social security systems has discouraged labor market participation in general and induced early retirement. Even if the early retirement subsidy is substituted by an early retirement tax (the Early retirement reform), only households in the middle-income class increase their retirement age. The majority of households still keep early-retiring, resulting in that the pension benefits are reduced, and people increase their savings. Díaz-Giménez and Díaz-Saavedra (2017) studies the 2011 and 2013 reforms of the Spanish public pension system and finds that Spanish pension systems that include critical non-actuarial benefits encourage early retirement. The reforms through delaying the legal retirement ages finally lead to the increase in the duration of the working lives, the aggregate effective labor and savings due to lower retirement pensions. However, the reforms studied in this strand of 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 where penalizes retirement before a normal retirement age by a low pension replacement rate while there are very few 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) 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 detail 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. Let $N_{t,j}$ denote 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

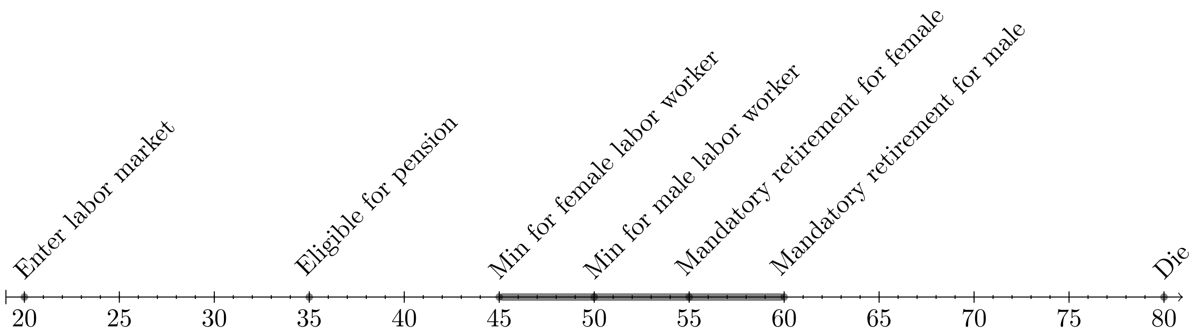
$$\mu_{t,j} = \frac{N_{t,j}}{N_t} = \frac{N_{t,j}}{\sum_{j=1}^{\bar{J}} N_{t,j}} \tag{3}$$

In this case, the population growth rate n and the unconditional survival probability s_j can capture the demographic structure: the larger s_j and smaller n means that the population is aging; the smaller s_j and larger n_t means that the population is becoming younger.

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 for receiving pension benefit if they have worked and paid for the pension tax for 15 years [3] 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 reality and since the mandatory retirement age of female and male are 55 and 60 respectively, in this model, I assume that Chinese households 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. 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 CRRA

[3] These 15 years don't have to be a consecutive time. It can be an accumulative time.

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:

$$SS_j = \theta[\nu \frac{\sum_{j=0}^{R-1} \mu_j w_j \epsilon_j \eta_{j,j} h_j}{\sum_{j=0}^{R-1} \mu_j} + (1-\nu)\frac{\sum_{j=0}^{R-1} w_j \epsilon_j \eta_j h_j}{R-1}] \tag{9}$$

where θ represents the target replacement ratio, i.e., the ratio between pension benefit and average local labor income. The larger the replacement ratio is, the more generous the government is. The first fraction on the right-hand side represents 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. 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 and the representative firm with constant returns to scale, no adjustment costs and exogenous total technological change at period t (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 run 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_{t+j}, of their gross labor income for more than accumulative 15 years in China, workers become eligible for a pension benefit during retirement. The pension can be claimed at any time after the early 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 tau_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 household 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:

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

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 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,

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

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

4. The capital market clear, that is,

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

5. The labor market is clear, that is,

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

6. The social security system is self-financing,i.e.,

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

7. The government budget constraint is satisfied, i.e.,

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

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 should and so on 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 household enters the labor market. In the benchmark, I choose $R = 41$ 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 in World Bank dataset[4] and

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

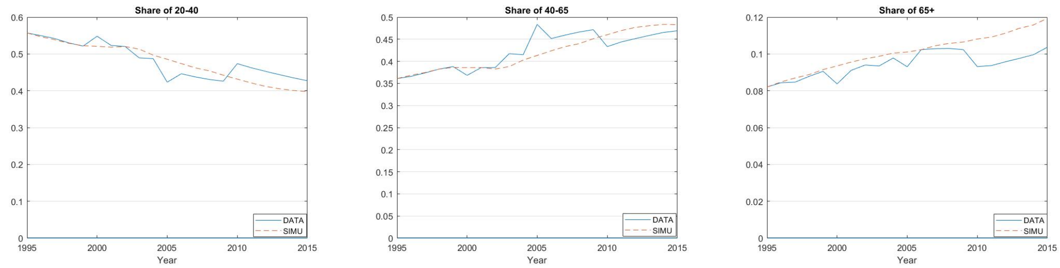


Figure 3: Population share

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 [5].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 (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 2. As we can see in figure 2, 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[6]. Therefore, β is set to 1.007. 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 is set to 5.8% from 1995 to 2050, which is the average value calculated by Ge et al. (2014) using the UHS data. From 2050 to the final steady state, the TFP growth rate is set to 2% as common use in the long-term developed economy.

[5]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#

[6]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.

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

4.4 Labor income

For the age-dependent labor efficiency profile $\{\{\epsilon_{t,j}\}_{j=1}^{\bar{J}}\}_{t=1}^{T}$, I estimate it using the China Household Nutrition Survey (CHNS) data and the method in the appendix of He et al. (2016) to make the age profiles of individual productivity to be 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 İmrohoroglu and Zhao (2017) 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.

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.

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 ages equal to the average retirement age of 1995 in China, i.e., 55. 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.

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 leisure	0.40	Target Ave. working hour
δ	Depreciation rate	0.1	Song et al. (2011)
σ	Relative risk aversion of consumption	2.9	Average of common range
$\bar{J}$	Maximum of life span	61	
R	Age of retirement	36	Data
θ	Pension replacement ratio	0.75	Data in 1995
ν	Share of PSYG	1	Data in 1995
τ_L	Labor income tax	0.175	Liu and Cao (2007)
τ_K	Capital tax	0.175	Liu and Cao (2007)
g	TFP growth rate	0.058	Ge et al. (2014)

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%	14.13%	13.64%

5.1 Initial and Final Steady State

The results in table 2 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 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 probability is fixed to be the same in 2015 after 2015 in the transition path. 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 and the change of pension benefit. In addition, the shorter working period results in the lower labor supply (0.240).

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

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%

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, the PSYG part after 1997 pension reform targets to 35% average monthly local wages while for the Fully Funded part targets 24.2% average monthly local wages. The total replacement is the about 60% ($35\% + 24.2\%$). For the share of PSYG, it is about 60% ($35\%/(35\% + 24.2\%)$) calculated by the law. After 2015, it is fixed on the average retirement age in 2015 forever.

Figure 3 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 3, the saving gradually decreased in the first five years in the 1990s, and then increased substantially from 36.46% of GDP in 1995 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.

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 on in this section.

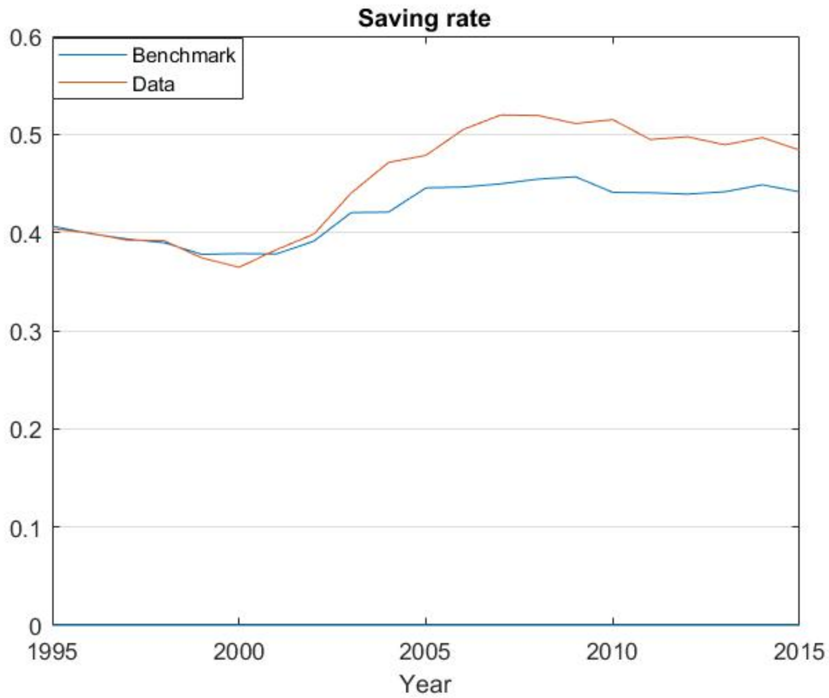


Figure 4: The Chinese Saving Rate: Model vs. Data

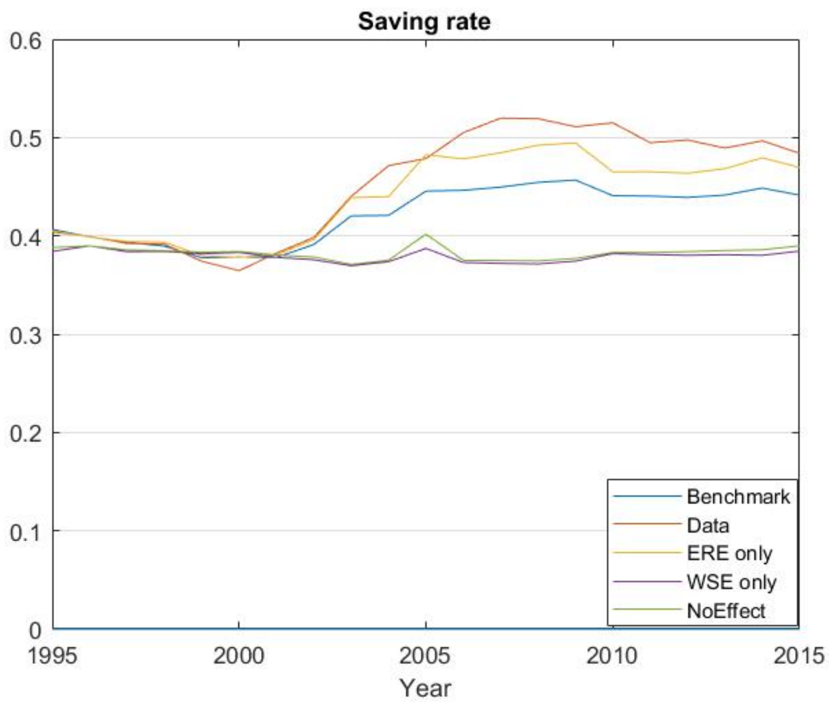


Figure 5: The decomposition of Chinese Saving Rate

In the first experiment, I examine the effect of early retirement by forcing all the agents in my 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 4. 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 3. 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 before her retirement.

In the second experiment, I examine the effect of the change of the social security income by shutting off 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 4. The saving rate moves up to a higher level than the benchmark level- in 2015, it is 46.95% as shown in Table 3. 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. In Table 4 we can see that, after 2001, the social security income along the benchmark transition path is lower than the case where the change brought by the pension reform is shut off. Therefore, if the pension income increases after the reform in the benchmark, the saving rate will decrease compared to the case in the 2nd experiment. This can explain the second mechanism that if the social security can support more in the retirement effect, the social security can substitute for the saving, which will decrease the saving rate. That is, the Wealth Substitution effect can decrease the saving 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 4. As we can see from Table 3, the saving rates along the transition path in the 3rd experiment are slightly higher than those in the 2nd experiment. This proves 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 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 proves that the early retirement effect dominates the wealth substitution effect. And the dominant early retirement effect over 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 (44.14%) is 19.81% while the change of the saving rate in the benchmark model from 1995 (40.66%) to 2015 (44.14%) is

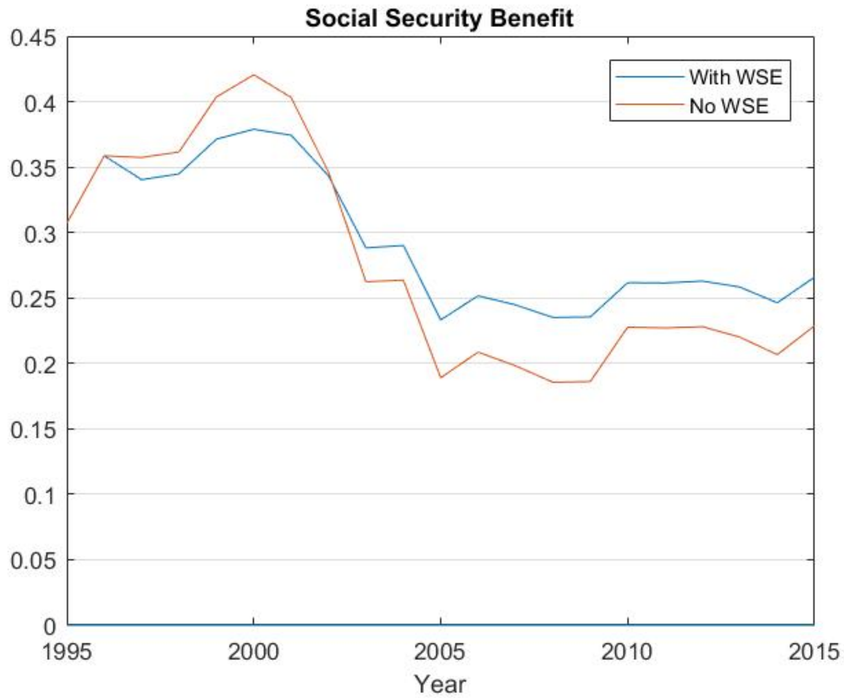


Figure 6: Social Security income

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, calibrate it to the Chinese economy, and examine the role of the average retirement age and the change in pension benefits 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 postpone the mandatory retirement age, the saving rate will likely decline.

References

Bárány, Zsófia, Nicolas Coeurdacier, and Stéphane Guibaud (2016) "Fertility, longevity, and capital flows," in , Reihe Ökonomie / Economics, No. 321, Institut für Höhere Studien.

Blanchard, Olivier and Francesco Giavazzi (2016) "Rebalancing Growth in China: A Three-Handed Approach," in *Seeking Changes*: Joint Imprint with Central Compilation and Translation Press, China, pp. 49–84, URL: http://www.worldscientific.com/doi/abs/10.1142/9789814656306_0003, DOI: http://dx.doi.org/10.1142/9789814656306{_}0003.

Chamon, Marcos D. and Eswar S. Prasad (2010) "Why Are Saving Rates of Urban Households in China Rising?," *American Economic Journal: Macroeconomics*, Vol. 2, pp. 93–130, URL: http://pubs.aeaweb.org/doi/10.1257/mac.2.1.93, DOI: http://dx.doi.org/10.1257/mac.2.1.93.

Chamon, Marcos, Kai Liu, and Eswar Prasad (2013) "Income uncertainty and household savings in China," *Journal of Development Economics*, URL: https://www.sciencedirect.com/science/article/pii/S0304387813001132, DOI: http://dx.doi.org/10.1016/j.jdeveco.2013.07.014.

Choukhmane, T, N Coeurdacier, and K Jin (2013) "The one-child policy and household savings," URL: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2341051.

Conesa, Juan C and Dirk Krueger (1999) "Social Security Reform with Heterogeneous Agents *," *Journal of Economic Literature*, pp. 757–795.

Curtis, Chadwick C., Steven Lugauer, and Nelson C. Mark (2015) "Demographic Patterns and Household Saving in China," *American Economic Journal: Macroeconomics*, Vol. 7, pp. 58–94, URL: http://pubs.aeaweb.org/doi/10.1257/mac.20130105, DOI: http://dx.doi.org/10.1257/mac.20130105.

Díaz-Giménez, Javier and Julián Díaz-Saavedra (2017) "The future of Spanish pensions," *Journal of Pension Economics and Finance*, Vol. 16, pp. 233–265.

Fehr, Hans, Wenche Irén Sterkeby, and Øystein Thøgersen (2003) "Social security reforms and early retirement," *Journal of Population Economics*, Vol. 16, pp. 345–361.

Feng, Jin, Lixin He, and Hiroshi Sato (2009) "Public Pension and Household Saving: Evidence from China," URL: https://www.sciencedirect.com/science/article/pii/S0147596711000035, DOI: http://dx.doi.org/10.2139/ssrn.1379942.

Ge, Suqin, Dennis Tao Yang, and Virginia Tech (2014) "Changes in China' s Wage Structure," *Journal of the European Economic Association*, Vol. 12, pp. 300–336.

Gourinchas, Pierre Olivier and Jonathan A. Parker (2002) "Consumption over the life cycle," *Econometrica*, Vol. 70, pp. 47–89, URL: http://doi.wiley.com/10.1111/1468-0262.00269, DOI: http://dx.doi.org/10.1111/1468-0262.00269.

He, Hui, Lei Ning, and Dongming Zhu (2016) "The Impact of Rapid Aging and Pension Reform on Savings and Labor Supply : The Case of China."

Liu, Xing and Shujun Cao (2007) "Determinants of Corporate Effective Tax Rates Evidence from Listed Companies in China," *The Chinese Economy*, Vol. 40, pp. 100–113, DOI: http://dx.doi.org/10.2753/CES.

Modigliani, Franco and S. L Cao (2004) "The Chinese saving puzzle and the life-cycle hypothesis: A revaluation," *Journal of Economic Literature*, Vol. 42(1), pp. 145–170.

Sánchez Martín, Alfonso R. (2010) "Endogenous retirement and public pension system reform in Spain," *Economic Modelling*, Vol. 27, pp. 336–349.

Song, Z., Kjetil Storesletten, and Fabrizio Zilibotti (2011) "Growing like China," *American Economic Review*, Vol. 101(1), pp. 196–233.

Tauchen, George (1986) "Finite state markov-chain approximations to univariate and vector autoregressions," *Economics Letters*, Vol. 20, pp. 177–181.

Wei, SJ and X Zhang (2011) "The competitive saving motive: Evidence from rising sex ratios and savings rates in China," *Journal of Political Economy*, Vol. 119(3), pp. 511–564.

İmrohoroglu, Ayşe and Kai Zhao (2017) "The Chinese Saving Rate : Long-Term Care Risks , Family."