Never Too Old to Save - Explaining the High Saving Rates of the Chinese Elderly*

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January 27, 2016

Abstract

The high saving rate of China has attracted global attention. Furthermore, the saving rates of the Chinese elderly are especially high. Understanding why the elderly in China save at high rates is important for two reasons: (1) it partially explains the high aggregate saving rate in China, and (2) the fact that the elderly save more than the middle-aged contradicts the predictions of the life-cycle model. In this paper, I present evidence that pension income is the primary explanation for the high saving rates of elderly Chinese households. I provide this evidence in three steps. First, I document three stylized facts that are consistent with this hypothesis: (1) saving rates are higher in years with higher pensions, (2) saving rates are higher for those with more generous pension plans, and (3) policy reforms that exogenously increase

*First draft: September, 2014. I would like to give special thanks to Maurizio Mazzocco, Adriana Lleras-Muney and Maria Casanova. Thanks also to Edward Kung, Kathleen McGarry, Aprajit Mahajan, Sarah Reber, and Till von Wachter. The paper has been presented at UCLA, Central University of Finance and Economics, National School of Development (Peking University), international conference on "Institutions, Reforms and Economic Development" (Peking University) and the 15th China Economics Annual Conference. All remaining errors are mine, of course.

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pensions also increase saving rates. However, a higher pension income on its own cannot explain the entire pattern because a household can simultaneously adjust its consumption. Therefore, in the second step, I demonstrate that concerns regarding future medical expenditures and bequest motives can explain why households do not increase their consumption commensurate with increases in pension income. Finally, I build and estimate a life-cycle model that accounts for all empirically observed features. Using this model, I find that pension income, in the presence of medical expenditures and bequest motives, can explain the high saving rates of the elderly. Meanwhile, the economic growth rate in China can also affect the saving rates of the elderly.

1 Introduction

The Chinese saving rate is currently one of the highest in the world (World Bank 2010), and the high saving rate in China has important global impacts. Because Chinese savings are not invested solely in China's own expenditures, Chinese saving has also become an important financial resource for many developed countries. For example, since 2008, China has been the largest holder of US treasury bonds. In February 2014, China held 21.6% of all US treasury bonds (National Bureau of Statistics of China 2014). Chen, Mazzocco, and Személy (2014) show that the rise in the Chinese saving rate partially helps to fund the decline in the household saving rate in the United States (Parker 1999). Greenspan (2009) and Obstfeld and Rogoff (2009) argue that China's high saving has contributed to a global imbalance since 2000, which was directly related to the 2008 global financial crisis.

Among the three components of national saving - household saving, corporate saving and government saving - household saving has been the most important component of Chinese saving over the past two decades (Yang, Zhang, and Zhou 2011). This paper focuses on household saving. Despite the importance of the high household saving rate in China, no clear explanation for this high saving rate has been proposed, and it remains a puzzle (Modigliani and Cao 2004).

To understand the high household saving rate, it is important to understand the answer to the following question: what groups of people maintain the highest saving rates? Figure 1 plots the age profile of saving rates in 2002 based on Chinese Household Income Project (CHIP) data. Surprisingly, elderly households maintain the highest saving rates. For households aged 40-50[1], households maintain an average saving rate of approximately 6%. From that point, saving rates grow quickly as households age, reaching 15% at age 65. Chamon and Prasad (2010) and Yang,

[1]Household age is defined by the age of the household head.

Zhang, and Zhou (2011) have also plotted the age profile of the saving rates in China using data from the Urban Household Survey (UHS), and they obtained similar results.[2] These authors have also noted that this pattern is especially strong after 2000. Therefore, understanding why the elderly save so much is of crucial importance. First of all, understanding why the elderly save so much will contribute to the understanding of the high household saving rate in China and will therefore help to explain the high aggregate saving rate. Second, the life-cycle model predicts that individuals should save the most during middle age, when they have the highest income, and begin to dissave after retirement. The empirical pattern in China is the opposite of this prediction. The standard life-cycle model was constructed to apply to developed countries whose economies are stationary. Understanding the counterintuitive pattern observed in China will help to apply the life-cycle model to countries with rapidly developing economies, such as China.

The major contribution of this paper is to provide an explanation for the high saving rates of the Chinese elderly. I provide evidence that pension income in China, in combination with bequest motives and medical expenditures, can explain the high saving rates of the Chinese elderly.

I provide this evidence in three stages. First, I provide descriptive evidence that the high saving rates of the Chinese elderly are closely related to the pension scheme in China. I present three pieces of evidence that is consistent with the hypothesis. The first such piece of evidence is the time variation of saving rates. I demonstrate that during periods when pension incomes are higher, saving rates are also higher. Compared with the year 1995, the average pension income in

[2]Compared with the saving rates obtained by Chamon and Prasad (2010) and Yang, Zhang, and Zhou (2011), the saving rates presented in this paper are lower. The primary reason for this difference is that in the aforementioned papers, transfers to relatives outside the household are treated as saving. In this paper, such transactions are treated as expenditures instead. If the data presented here were to be treated using the same definition used in these previous papers, the numbers would be of similar magnitude. However, I argue that transfers to relatives outside the household should be defined as expenditures. Transfers from relatives outside the household are treated as household income; therefore, if transfers to those outside the household were to be treated as saving, it would result in double counting and an overestimation of the saving rate.

2002 was higher, both in absolute value and relative to disposable income. At the same time, in 2002, the elderly maintained higher saving rates, and the increase in saving rates after retirement was greater. Moreover, the starting point of this increase in saving rates coincided with the age at which Chinese workers gradually begin to retire.

The second piece of evidence is cross-sectional variation. I find that those who enjoy more generous pension payments also save more and that this difference becomes more prominent as retirees age. Employees of the Chinese government enjoy more generous pension plans than their non-government counterparts. Saving rates are correspondingly higher for government employees. More interestingly, before the age of retirement, there is no significant difference between these two groups. The saving rates only begin to diverge after workers begin to retire.

To provide better causal inference, as the third piece of evidence, I investigate the effect of pension on saving using pension reform as a natural experiment, as time series and cross-sectional variations may be subject to endogeneity problems. The reform I use for this purpose is China's transition from a PAYG (pay-as-you-go) pension system to a mixed three-tier pension system. This reform has been implemented in different provinces with different policies since the early 1990s. As a result, prior to 1997, difference provinces implemented pension systems with different replacement rates.[3] In 1997, China defined a new unified national pension system. As a result, there was an exogenous convergence in replacement rates. Retirees in provinces with originally low replacement rates experienced a greater increase in pensions during the reform. I find that households who received higher pensions as a result of the reform did not increase their consumption to a commensurate degree, resulting in higher saving rates.

The aforementioned evidence, however, presents another puzzle: why do higher pensions lead

[3]Replacement rate can be defined as pension income received after retirement divided by the wage received before retirement.

to higher saving instead of higher consumption? If households were to increase their consumption by a sufficient amount in the case of an increase in income, there would be no increase in saving rates. Therefore, as the second step, I investigate the factors that prevent households from further increasing expenditures. First, I find evidence that concerns regarding future medical expenditures and bequest motives may be potential explanations for why the elderly do not increase their consumption in such a scenario. I find that during the process of Chinese market reform, the government slowly scaled back its provision of national free public medical insurance. As a result, it became necessary for households to be able to afford a larger share of their medical expenditures. Elderly households are more strongly affected by such changes because their medical expenditures will rise by a greater extent. Therefore, they may need to maintain higher saving rates until the end of their life cycles to prepare for potential medical expenditures. Secondly, I provide two pieces of suggestive evidence that bequest motives may be pertinent in China. First of all, 62% of the elderly explicitly claim in a survey question that they have bequest motives. Moreover, most elderly individuals claim that they rely on an annual flow of pension income instead of accumulated assets for their old-age support, which suggests that the annual flow of pension income is typically sufficient to cover their expenditures of elderly life and that the wealth they save is more likely to be intended for their children than for themselves. Second, I find evidence that households with no children save significantly less compared to households with children. Therefore, the elderly may save for bequest purposes.

The documented empirical evidence suggests that pension income, in combination with medical expenditures and bequest motives, may be important drivers of the high saving rates of the Chinese elderly. However, based on a descriptive analysis alone, it is difficult to quantify the importance of pension income in determining their saving behavior.

To address this concern, as a third step, I build and estimate a dynamic life-cycle model that accounts for all related factors identified in the previous two steps. In this model, a representative household will face four types of shock: income shock, health shock, medical expenditure shock and mortality shock. Other factors that may contribute to saving-consumption decisions are also included, such as leisure, education and bequests. In the process of estimating income and medical expenditure profiles, one key feature of this paper is that I carefully distinguish between the "life-cycle profile" and the "cross-sectional profile." In a developed country whose economy is relatively stable, the cross-sectional profile serves as a good proxy for the life-cycle profile. However, in a country such as China whose economy is growing quickly, these two profiles may differ tremendously, which may lead to contradictory theoretical implications. This difference is also one the major differences between my study and previous studies of Chinese saving rates using the life-cycle model.

The model is estimated by using the Method of Simulated Moments (MSM) to match the key features of the empirical patterns. The model achieves good matching to the following features: (1) elderly households maintain positive saving rates, (2) saving rates continue to increase after retirement, (3) households saved more in 2002, (4) educated households save more, and (5) healthy households save more. The model also successfully predicts the difference in saving rates between government and non-government employees, which is intentionally left unmatched in the MSM to perform an out-of-sample test. Moreover, the estimated degree of risk aversion for China is similar to the estimated number for the number for the United States. This result implies that the patterns of saving in China can be explained well in the framework of a life-cycle model. It is not necessary that the Chinese elderly be highly risk-averse in order for us to explain their high saving rates.

After the estimation, I run simulations to test whether the influence of pension income is sufficiently strong to explain the high saving rates of the Chinese elderly when combined with bequest motives and medical expenditures. I individually close one of the following three channels at a time: pension income, bequest motives and medical expenditures. I find that pension income, in combination with bequest motives, best explains the high saving rates of the Chinese elderly. Medical expenditures, however, have only a modest effect. The simulation results also indicate that the current saving pattern in China is related to the country's rapid economic growth. As the pension income in China is indexed to the current average wage of workers, economic growth directly affects the increase in pension income. I find that in cases of economic slowdown, elderly households will decrease their saving rates to a larger extent. If the economic growth rate is sufficiently low, then elderly households will save less than middle-aged households.

With the model, I can also run interesting counterfactual simulations. For example, at the moment, pensions in China are indexed to the current average wage of workers. What would happen if the pension income is instead indexed to CPI, similar to many other countries around the world? Moreover, there is no inheritance tax in China. What would happen if China imposes a 50% inheritance tax, similar to the United States? The simulation results suggest that the saving rates of the elderly would drop by $5\% - 10\%$ and the rates are lower than those of the middle-aged if pensions are indexed to CPI. In the case that inheritance taxes are imposed, the elderly would reduce their saving rates by 4%.

This paper contributes to the previous literature in the following respects. First of all, the paper treats pension reform as an exogenous shock to test the causal relationship between pension income and saving. Second, the paper builds and estimates a dynamic life-cycle model that takes relevant factors into account. Finally, using this model, I am able to test the importance of

pension income in determining saving behavior and to understand how economic growth in China is related to the saving rates of the elderly.

The remainder of the paper is organized as follows. In Section 2, I introduce background information regarding the Chinese retirement system and pension system. I also introduce previous literature concerning the Chinese saving rate. The datasets used throughout this paper are introduced in Section 3. Section 4 presents empirical evidence that pension income is related to saving. Section 5 explains why more pension income leads to more saving instead of more consumption. In Section 6, I build and estimate a life-cycle model based on the observed empirical facts. Various simulations are performed in Section 7. Section 8 presents the conclusions of the study.

2 Background and Existing Literature

2.1 Background of the Pension Scheme in China

The retirement age in China has remained stable since the early 1950s. Males are expected to retire at age 60. Female workers are expected to retire at age 50, and female officers are expected to retire at age 55. Exceptions include early retirement because of work injuries or disability and late retirement as requested by employers because of special skills (professors and experienced doctors, for example). In both cases, individual decisions are not important. Thus, in China, retirement is mostly assumed to be exogenous (Banerjee, Meng, and Qian 2010). Pension payments begin when the worker retires, and they are indexed to the average worker's wage. As a result, it is possible for pension income in China to continuously increase after retirement because of economic growth.

The retirement age has remained constant since the early 1950s. However, the pension system has changed considerably in the past 50 years. Before the implementation of *Reform and Opening-Up* policies in 1978, when China was a planned economy, the pension system was simple

and straightforward. State-owned enterprises provided cradle-to-grave social security, which guaranteed lifetime employment, along with housing, health care, and pensions after retirement. If an enterprise did not have sufficient funds, the state budget would cover the necessary payments. Therefore, during this period, the pension system was considered to be an "iron bowl," although the average wage and pension were low because of low levels of economic development.

With the 1978 reforms, China began to transition from a planned economy into a market economy. With the approach of market reforms, firms themselves began to assume increasing responsibility for the welfare of their employees. Meanwhile, unprofitable enterprises were no longer supported by the government. As a result, unprofitable firms canceled or delayed pension payments to their retirees. Therefore, during that time, despite the high *de jure* replacement rate that retirees were supposed to receive (85%), the *de facto* rate that retirees actually received was much lower, and millions of retired workers were thrown into poverty.

To resolve this issue, China began to experiment with a new pension scheme beginning in the early 1990s. The new plan replaced the existing PAYG system with a three-tier system. The first tier consists of public pensions for all retirees that are jointly financed by the government, enterprises and workers. The second tier consists of occupational pensions funded by enterprises. The third tier consists of voluntary pension savings originating from individual accounts. It is estimated that the *de jure* replacement rate under the new scheme is lower than that under the old system (approximately 75%). However, the new system is supported by the state budget in the first tier, pension payments are more effectively guaranteed, and the *de facto* replacement rate can be higher than that under the old system, and, indeed, the data suggest that this is the case. Figure 2 plots the total pension payments from the government and the pension pool relative to total fiscal expenditures and GDP. Both shares have approximately tripled in 15 years, suggesting

that the government is spending more to ensure the pension payments of retirees. In the following sections, I will present a household survey that also suggests that pensions increased during this period.

The experiment of the new pension scheme first began as State-Owned Enterprises (SOEs) in certain provinces. Initially, different provinces implemented different pension policies and different target replacement rates. In 1997, a national reform was undertaken. There were two major features of this reform. First, it expanded the coverage of the new scheme into the private sector. Second, it unified the previous pension systems of different provinces with different target replacement rates. As a result, there are two possible exogenous variations that can be used to describe this reform. First is the comparison of SOE workers and private-sector workers. This approach, however, is problematic because most elderly retirees work in SOEs before retirement.[4] Retirees from the private sectors alone represent a small sample size, and that sample is likely to be highly selective. In this paper, I exploit the second possible approach - the convergence of replacement rates after the national reform for workers in SOEs. Further details about the identification strategy using the reform will be discussed in later sections.

2.2 Existing Literature

Recent literature has documented the high saving rates of Chinese households (Modigliani and Cao 2004; Chamon and Prasad 2010; Wei and Zhang 2011; Yang, Zhang, and Zhou 2011), and this phenomenon cannot be explained simply in terms of culture because in the years before 1978, the Chinese saving rate was only approximately five percent (Modigliani and Cao 2004). Carroll, Rhee, and Rhee (1994) have examined data concerning migrants in Canada from various source

[4]In 1995, 78.28% of retirees worked in SOEs. The number is 75.3% in 2002.

countries and have found no evidence of cultural effects on saving. The high saving rate in China is therefore known as "the Chinese saving puzzle."

More recently, economists have attempted to exploit household survey data in addition to aggregate data to gain further insight into this puzzle. Instead of providing an explanation, however, this research has identified a more interesting pattern. In contrast to the hump-shaped age profile of saving rates that is predicted by the standard life-cycle model, the Chinese profile turns out to be U-shaped: young households and elderly households maintain higher saving rates than the middle-aged (Chamon and Prasad 2010; Yang, Zhang, and Zhou 2011). More interestingly, this shape only appears after the year 2000. Yang, Zhang, and Zhou (2011) have plotted two separate profiles of saving rates: for 1988-1990 and 2005-2007. The 1988-1990 profile still appears hump-shaped, but that corresponding to 2005-2007 becomes U-shaped.

Therefore, the Chinese saving puzzle can be summarized into two categories. The time-series puzzle can be summarized as follows: why is the current saving rate so high, and why has the saving rate risen so tremendously since 1978? The cross-sectional puzzle can be summarized as follows: why is the current age profile U-shaped? Although the time-series puzzle has already been widely discussed in the literature,[5] and several plausible explanations have been proposed (for example, family programming (Banerjee, Meng, and Qian 2010), the biased sex ratio (Wei and Zhang 2011), demographic transitions (Modigliani and Cao 2004) and greater uncertainty (Chamon and Prasad 2010)), the cross-sectional puzzle is far from being as well-addressed. This paper contributes to one aspect of this puzzle: why the saving rates are so high for the Chinese elderly.

The existing explanations for the U-shaped pattern focus on two factors: the expenditure bur-

[5]This puzzle has been addressed using aggregate data (Modigliani and Cao 2004), provincial data (HORIOKA and WAN 2007) and household data (Chamon and Prasad 2010).

den and income pattern. Chamon and Prasad (2010) have proposed that the U-shaped pattern can be explained by the influence of high educational and medical expenditures. They have observed that the increase in saving rates has been accompanied by a drastic increase in educational expenditures and medical expenditures. Educational expenditures for children create a saving motivation for young households, and medical expenditures create a saving motivation for elderly households.

Song and Yang (2010) attribute the recent change toward the U-shaped profile to a flatter income profile. Using an overlapping-generation model, they have demonstrated that a flatter income profile predicts higher saving rates for both young and elderly individuals. Blanchard and Giavazzi (2006) have noted the importance of income uncertainty in explaining the high saving rate in China. Chamon, Liu, and Prasad (2013) have proposed that this greater uncertainty and the decreased pension ratio constitute the primary explanation for the U-shaped profile. Feng, He, and Sato (2011) have also argued that the pension reform resulted in lower replacement rates for the elderly, further motivating them to save more.

However, although these explanations of the U-shaped pattern are successful in explaining the high saving rates of the youth, they are not as successful for the elderly. For example, educational expenditures are highest in middle age for parents of children who are attending college. To prepare for these high expenditures, young families will save in advance before these expenditures arise. However, medical expenditures increase quickly as individuals age. By definition, high expenditures will suppress saving instead of increasing it because saving is defined as income minus expenditures. Similarly, greater uncertainty explains why young people save more because they need to build higher buffer-stock savings. However, as individuals age after retirement, there are fewer uncertainties remaining in their life cycles, and the need for buffer-stock savings shrinks.

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.

Although the pension program has previously been considered as an explanation for the high saving rates of the elderly (Chamon, Liu, and Prasad 2013; Feng, He, and Sato 2011), who proposed lower replacement rates raises precautionary saving of the elderly to prepare for their elderly life, my focus on pensions exhibits a crucial difference from previous research. First of all, lower replacement rates for the retired are unlikely to provide an explanation for 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 greater 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. As discussed in the previous subsection, although 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 data suggest that if there is any change in the *de facto* rate, it is more likely to increase than to decrease. Therefore, Chamon, Liu, and Prasad (2013) and Feng, He, and Sato (2011) have only been able to predict the increase in the saving rate before age 60, prior to the time when male workers have retired. These authors do not explain why the saving rate continues to increase after retirement, as shown in the data.

Other explanations, such as the one-child policy (Banerjee, Meng, and Qian 2010), migration and housing tenure (Brugiavini, Weber, and Wu 2013), and co-residence selection (Rosenzweig and Zhang 2014), also cannot explain the high saving rates of the elderly. Banerjee, Meng, and Qian (2010) have noted that children and savings are important substitutes for parents' old-age

support. A decrease in the fertility rate will imply an increase in saving rates. However, according to the one-child policy, the younger cohort is more strongly affected because older cohort may already give birth to more than one child before the implementation of the policy. This implies that the one-child policy should suggest that older households will maintain lower saving rates because, on average, they have more children; however, this trend is opposite to that observed in the data. Brugiavini, Weber, and Wu (2013) have argued that China is experiencing massive rural-to-urban migration. Rural migrants immediately receive higher income, but they cannot quickly adjust their consumption because of habit formation. Therefore, their income has been increased to the urban level, but their consumption remains at the rural level, resulting in high saving. However, most migrants are young people, and if they are elderly, it is likely that they have already lived in an urban environment for a long time, meaning that their consumption habits should have already become adapted to the urban level. Housing may also be a potential explanation for the high saving rates of the youth, but not for the elderly, as the elderly have generally already acquired their houses. One alternative argument is that elderly households save for their children's housing after marriage. However, the timing of such saving does not match the data. In China, parents typically have children before age 25, implying that if they are preparing for their children's housing, they should be prepared for this expenditure before age 50. However, the data indicate that saving rates continue to rise after this age. Rosenzweig and Zhang (2014) have noted there is selection bias in the plotting of the age profile of saving rates. Young people with higher income are more likely to leave their parents and form new households. Therefore, households with young heads of household are selectively richer, resulting in higher saving rates. Later in this paper, I will present evidence that similar arguments do not hold for the elderly.

3 Data

This paper uses three different datasets: the Chinese Household Income Project (CHIP), the China Health and Nutrition Survey (CHNS) and the China Health and Retirement Longitudinal Study (CHARLS). I use only urban samples from all three datasets. In rural China, it is common to have large families with multiple generations living in the same household. Therefore, the decisions of the household can be complicated, and it can be difficult to assign an "age" to a household in rural China that contains multiple generations.

The primary data used in this paper are from the CHIP, which is conducted by the Institute of Economics of the Chinese Academy of Sciences. Three waves are currently publicly available: 1988, 1995, and 2002. I focus on the latter two waves because consumption information is incomplete for 1988. The CHIP collects detailed information on both the income and expenditures of each household.

I collapse the dataset at the household level to compute the age profiles of saving rates, household income and expenditures. To maximize the comparability among households of the same age, I focus only on "nuclear families" - families composed only of a husband, a wife and children under age 25. The sample is further restricted to households with positive income and expenditures with heads of household aged between 25 and 80. I also eliminate households in the top or bottom 1% in terms of income, expenditures or assets to mitigate the possible effects of measurement error and extreme values. I assume that there are two types of families - high and low - defined by whether either the husband or the wife holds a degree equivalent to or above the senior high school level. These requirements restrict the dataset to $5,111$ observations for the 1995 wave and $4,727$ observations for the 2002 wave. For the 1995 wave, $2,072$ of the observations are of the high type and $3,039$ are of the low type. For the 2002 wave, the number of high-type

observations is 2,280, and the number of low-type observations is 2,447.

The income consists of individual-level income and household-level income. Individual-level income includes wages, bonus pension payments and subsidies. Household-level income includes property income (interest, dividends, rent, et al.) and transfer income (pension payments, payments from the government, and payment from other family members). For the 1995 data, the mean household income is 12,766 RMB (Chinese yuan),[6] with a standard deviation of 5,497 and a median of 11,733. For the 2002 data, the real average household income increases by nearly 50% to 18,538 yuan, with a standard deviation of 9,394 and a median of 16,668. Moreover, although the CHIP does not collect panel data, information about income history for the past five years is available. Therefore, it is possible to estimate income shocks based on this income history information. Expenditures include food, clothing, communication, medication, education, appliance purchases, transfers and other miscellaneous items (such as interest payments). Assets include housing, financial assets (cash, savings, stock, etc.) and durable goods (cars, pianos, etc.). Appendix A provides definitions of the variables and summary statistics of the CHIP.

However, there are two limitations to the CHIP data. The first is the lack of longitudinal health information, which prevents the estimation of important factors, such as health transition probability. To overcome this issue, I use another dataset: the CHNS. The CHNS (1997, 2000, 2004, and 2006) is mainly used to estimate health transition shock. The CHNS is a household panel survey that offers a rich cross-section of information concerning individual health status; therefore, it can be used to estimate the probability of transition in health status. However, the CHNS contains no detailed information regarding expenditures and therefore cannot be used as the main dataset.

[6]Currently, 1 USD $\approx$ 6.1 RMB. All income, expenditures and assets are adjusted to the price level in 1995.

The second limitation of the CHIP is that it does not contain fertility history information. The number of children in the household is an important factor in understanding saving behavior in China (Banerjee, Meng, and Qian 2010). Without fertility information, the CHIP can capture only children who live together with their parents. To overcome this issue, I use the CHARLS, which contains both fertility history and information related to income and expenditures. The CHARLS (2011) is the most recently released dataset that focuses on aging and retirement study in China. The design of the CHARLS is very similar to that of the Health and Retirement Survey (HRS) in the United States. Currently, however, only one wave is available. Moreover, the CHARLS spans a broad range of subjective questions, thereby informing a detailed understanding of the saving motivations of the Chinese elderly.

4 Empirical Relationships Between Pension Income and Saving

In this section, I will provide empirical evidence that higher pension income is related to higher saving. I provide three pieces of evidence. First of all, I compare the patterns between the 1995 and 2002 waves. I note that in 2002, the pension income was higher, and the saving rate of the elderly was also higher. Second, I compare two different types of employees: government workers and non-government workers. Government workers enjoy more generous pension plans compared to non-government workers. They also maintain higher saving rates, and this discrepancy becomes larger after retirement. Finally, to overcome the potential endogeneity problem, I treat the pension reform that occurred during this period as an exogenous change in pension income to verify the causal relationship between pension income and saving. The reform exogenously induced a convergence of replacement rates among different provinces; therefore, retirees in provinces with originally lower replacement rates became relatively better off. I provide evidence that these

retirees correspondingly increased their saving.

4.1 Changes in Saving Rates Over Time

Figure 3 plots the compositions of disposable income in 1995 and 2002. Labor income and pension income are the two most important components of income for Chinese households. On average, these two components accounted for approximately 91.7% of disposable income in 1995 and 95.5% in 2002. Figure 3 also shows that in 2002, as the population aged, the increase in pension income better compensated for the decrease in labor income. As indicated by the dashed line in Figure 3, in 1995, a household of age 60 earned an average of 84.4% of the income of a household of age 50. This value drops to 78.2% for a household of age 65. For 2002, these two values increase to 97.1% and 88.4%, respectively. This finding implies that in 2002, an elderly household did not earn considerably less than a middle-aged household. This empirical fact is consistent with Song and Yang (2010)'s observation of a "flattening income profile." The difference between two waves can be primarily attributed to the fact that the new pension scheme better guarantees pension payments, meaning that there are fewer delayed and canceled payments, as introduced in the background section.

Another important fact that can be inferred from this graph is that in urban China, older households are mostly financially dependent. Over 90% of their income originates from either wages or pensions. Transfers from children account for only a small proportion of household income, which implies that the role of children in old-age support is not as important as expected.

There is also a sharp difference in the patterns of saving rates between 1995 and 2002, as seen in Figure 4. The U-shaped pattern observed in Figure 4 for the 2002 data has also been observed by Chamon and Prasad (2010) and by Yang, Zhang, and Zhou (2011), although I use a different

dataset (they used the Urban Household Survey (UHS)) and a slightly different definition of the average saving rate for a specific age.[7] As demonstrated by Chamon and Prasad (2010) and by Yang, Zhang, and Zhou (2011), Figure 4 illustrates that the age profile of saving rates in 2002 exhibits a much stronger U-shaped pattern, with older households and younger households saving more compared to the middle-aged. In both the 1995 and 2002 waves, households maintained an average saving rate of approximately 5% at age 45. In 1995, the rate rose only modestly to 7.5% for households of age 65, whereas in 2002, it rose sharply to 15% at the same age. Figure 4 also plots the percentage of retirement as individuals age, as indicated by the dashed line.[8] More interestingly, the start of the increase in saving rates occurs right near the point at which individuals begin to retire. The discrepancy becomes larger as more workers retire. The trend in the percentage of retirees corresponds well to the rise in saving rates. To test whether the difference is statistically significant, I performed the following regression for each year separately:

$$rate_i = \alpha + \sum_s \beta_s Age\_Group_{i,s} + \gamma X_i + \varepsilon_i \tag{1}$$

where the outcome variable $rate_i$ is the household saving rate of the ith household. I ran this regression for households aged over 45 and grouped them into five-year increments. The coefficient β_s can be used to test whether the increase in saving rates is statistically significant. X_i includes

[7]There are two ways to define the average saving rate for a specific age. The first is the average of all saving rates corresponding to that age:

$$\Sigma_{i=1}^{n} rate_i/n$$

The second is the difference between the average income and the average expenditure divided by the average income:

$$(\overline{income_i} - \overline{expenditure_i})/\overline{income_i}$$

In this paper, I use the second definition because it matches the definition of the national saving rate, whereas the other two papers use the first definition.

[8]It is possible to draw two different lines for the two years individually. However, the patterns of retirement for both years were similar. Therefore, for simplicity, I combine both years and draw only a single line.

control variables such as education, employer type and province dummies. Columns (1) and (2) in Table 1 report the regression results for the 1995 and 2002 waves, respectively. The regression results reveal that the change in saving rates with household age in 1995 was not significant. Compared with ages 45-49, the other age groups varied little in saving rates (from -0.1% to 2.5%, and all coefficients in front of age are statistically insignificant) after controlling for certain key variables. However, the age gradient became significant in 2002. Starting at age 50, on average, saving rates rose by 3.9% for every five years of age.

Might this pattern be simply the result of a cohort effect? Is it merely because these particular older cohorts happened to save at high rates? To address this concern, Figure 5 plots the changes in saving rates between the two waves for certain select cohorts. Figure 5 shows that the younger cohorts increased their saving rates by approximately $2-3\%$ between the two waves, whereas the older cohorts increased their saving rates by nearly 10%. There is clear evidence that all cohorts increased their saving rates; therefore, the cohort effect alone is not sufficient to explain why older households maintain a high saving rate.

Might selection bias have contributed to this pattern? For example, to properly define the age of a household, I restricted the samples to nuclear households. This implies that older couples living with their children are excluded from this analysis. If richer parents have a higher tendency to live on their own and richer households typically maintain higher saving rates (Friedman 1957; Gustman and Steinmeier 1999; Venti and Wise 1999), then the selection of nuclear households will necessarily lead to higher saving rates as households age. This is also the reason given by Rosenzweig and Zhang (2014) for the high saving rates of young Chinese households. To address this issue, in Figure 6, I plot age profiles calculated for 2002 without any sampling restrictions. To address the possibility of multiple generations living together in the same household, I tested

two definitions of household age: the age of the head of household and the age of the oldest household member. The first definition is intuitive because the head of household is expected to be the most influential household member in decision-making. The second definition attempts to capture families that include older individuals living with younger relatives. The graph indicates that even when no selection is applied, the saving rates still increase quickly for older households. Through a comparison of the two plots corresponding to data restricted and not restricted to nuclear households, I conclude that selection bias alone cannot explain why older households save so much.

4.2 Changes in Saving Rates Across Groups

In addition to variation over time, there is also variation in pension income across groups. In China, government employees enjoy better welfare treatment, including more generous pension plans. Unlike non-government employees, whose pension payments were not secured in the old region-based regime and are only partially secured by province budgets in the new regime, government employees receive fully secured pension payments. In the old regime, the pension plans of non-government workers were financed solely from the profits of the enterprises for which they worked before retirement. In the new regime, although the first tier is financed from the pension pool at the province level, the second tier is still financed by enterprises. Government employees, by contrast, enjoy fully secured, generous pension plans that are supported by the budget of the central government.

Figure 7 plots the difference in income between government employees and non-government employees in the 2002 wave. The results were similar for the 1995 wave. On average, at age 60, non-government workers earned 87.7% of the amount earned by those who were age 50 at that

time, and at age 65 , they earned 81.3% of that amount. This finding implies that the income of non-government workers suffered a drop because the increase in pension was insufficient to cover the loss of labor income. By contrast, for government workers, the increase in pension was so rapid that it even exceeded the rate of decrease in labor income. At age 60, government employees actually earned 4% more than those who were age 50 at that time.

Figure 8 plots the difference in saving rates for the two groups. Similar to the results over time, government employees who receive more generous pension plans also save more. Interestingly, the difference between the two groups again begins to diverge at exactly the same age at which the divergence is seen in Figure 4: age 45, the age at which Chinese workers gradually begin to retire. The two lines are nearly parallel to each other between age 35 and age 45, with a gap of only $2\% - 3\%$. However, starting at age 45, the gap quickly increases. At age 65, the gap reaches 15%. The regression equation (1) can also be used to assess the difference between the groups. Columns (3) and (4) in Table 1 illustrate the difference between government workers and non-government workers. The results indicate that the saving rate increases quickly as retirees age in the case of government employees. Their saving rates increase by 5.1% for every five years of age. No such pattern is observed for non-government workers.

In summary, both time variation and group variation are consistent with the fact that higher pensions lead to higher saving. During the time period when pensions are higher, the saving rates are higher. For the group with higher pension income, the saving rates are correspondingly higher as well. More importantly, the difference only begins to manifest at the point at which workers begin to retire. Both pieces of evidence support the hypothesis that pension income may be a major motivator of the high saving rates of the elderly in China.

4.3 Pension Reform as a Natural Experiment

Previous subsections have presented suggestive evidence that the saving rates of the Chinese elderly are closely related to pension income. However, these two empirical facts may be subject to endogeneity problems. For example, if a positive economic shock occurred in 2002, this would temporarily increase pension income. Meanwhile, as households have a tendency to save a larger percentage of income from a temporary positive economic shock to smooth their lifetime consumption, saving rates would also be higher. In addition, individuals who are more risk-averse will have a greater tendency to work for the government because government jobs are typically more secure. More risk-averse individuals would have saved more even if they did not work for the government. To provide better estimation of the causal effect of pension income on saving, I make use of the 1997 pension reform as an exogenous shock.

In 1997, a national reform was implemented to convert the Chinese pension system from a PAYG system to a defined contribution system. However, before this national reform, beginning in the early 1990s, certain provinces had initiated their own experimental reform in SOEs,[9] each adopting their own target replacement rates ahead of the national reform. Table 2 summarizes the target replacement rates for various provinces ahead of the national reform (World Bank, 1997). The data were obtained from the provincial statistical yearbook. Among the 12 provinces surveyed in the CHIP, nine provided information regarding replacement rates. Either the remaining three did not implement a reform, or the pertinent information regarding their replacement rates is missing; therefore, these three provinces are excluded from the sample in the following analysis.[10] Figure 9 visualizes the intuition of the identification strategy of the reform. The graph only

[9]The analysis in this section uses a sample of SOEs only.

[10]The average household income of the provinces with missing information was 14.34% lower than that of the rest of the country. This implies that the analysis presented in this subsection may not be fully representative of the national population; instead, it is likely to be biased toward richer provinces.

uses a male sample, so the retirement age is 60. I divide provinces with information regarding replacement rates into three groups according to initial replacement rates in 1995. I compare the group with the highest replacement rates and the group with the lowest replacement rates. The provinces with the top three replacement rates are Shanxi (95%), Hubei (85%) and Sichuan (95%).[11] The provinces with the bottom three replacement rates are Jiangsu (65%), Guangdong (70%) and Yunnan (71%). Figure 9 shows that in 1995, before the reform, workers in provinces with low replacement rates suffered from a substantial drop of approximately 28% in disposable income at the time of retirement, while the income of workers in provinces with high replacement rates barely changed. In 2002, with the convergence of replacement rates after the pension reform, the change in disposable income barely differed across those provinces at age 60. In summary, the identification comes from a triple difference: retired and non-retired, before and after the reform, and provinces with high and low replacement rates.

I constructed a triple-difference model as follows:

$$\begin{aligned}\log(Income_{i,p,t}) &= \beta_0 + \beta_1 After_t + \beta_2 Retire_{i,p,t} + \beta_3 \Delta Rate\_Rp_p \times Retire_{i,p,t} \\ &\quad + \beta_4 \Delta Rate\_Rp_p \times After_t + \beta_5 Retire_{i,p,t} \times After_t \\ &\quad + \beta_6 \Delta Rate\_Rp_p \times Retire_{i,p,t} \times After_t + \beta_7 X_{i,t} \\ &\quad + \sum \beta_{8,p} Prov_p + \sum \beta_{9,p} Prov_p \times After_t + \varepsilon_{i,p,t} \end{aligned} \tag{2}$$

where the subscript i represents the household, p represents the province, and t represents time. $Retire_{i,p,t}$ is an indicator variable representing whether an individual is retired. $\Delta Rate\_Rp_p$ represents the change in the target replacement rates in each province after the reform. $Prov_p$ is the

[11] Chongqing was a city in the Sichuan province and became a municipality directly under the central government in 1997. For consistency, I treat Chongqing as a city in the Sichuan province in both waves.

province dummy variable. $\Delta Rate\_Rp_p$ does not enter the equation as a separate variable because it is perfectly colinear with the province dummy variable. The control variables $X_{i,t}$ include age, education and gender. Notably, it is important to control the province dummy variables as well as their interactions with the time dummy. As suggested in Figure 9, workers in provinces with lower replacement rates tend to have higher income on average in 1995. One possible explanation for this difference is that if the replacement rate were the same for all provinces, it would be more difficult for local governments in rich provinces to cover pension payments. Therefore, they tend to set their replacement rates lower to relieve their fiscal burden. Moreover, the gap in income shrinks in the year 2002, suggesting possibilities of different trends among different provinces. Controlling province dummies and their interaction with the time dummy helps to alleviate the problem.

In this model, the parameter β_6 in front of the triple-difference term $\Delta Rate\_Rp_p \times Retire_{i,p,t} \times After_t$ is of key interest. I expect this parameter to be positive. Assuming that two provinces had the same average wage of workers before and after the reform but different replacement rates before the reform, the retirees in the province with the lower initial replacement rate experienced a greater increase in the replacement rate and therefore benefited more as a result of the convergence of the target replacement rates after the reform. A similar model can be used to investigate the responses in consumption and saving by changing the dependent variable.

Notably, this econometric model makes three implicit assumptions. The first assumption is the similarity of life-cycle income profiles across different provinces. The replacement rate is defined as income after retirement as a percentage of income before retirement for the same individual. However, this estimation uses cross-sectional data and compares the income of individuals immediately after retirement with the income of other individuals immediately before retirement. The

assumption of the similarity of life-cycle income profiles is necessary to ensure that the difference between these two groups of individuals is a good proxy for the replacement rate.[12] The second assumption is that people of the same age in different provinces are at the same stage in their life cycles. The reason that this assumption is required is because according to the life-cycle model, even if the level of income is the same, consumption is not necessarily the same for individuals at different stages of their life cycles. This assumption is likely to be true because the retirement age is the same across China. Therefore, individuals in different provinces should be near the same age when they are in the near-retirement stage of their life cycles. The final assumption is that the order in the *de facto* replacement rate is positively correlated with the trend in the *de jure* replacement rate, which means if a province has higher *de jure* rate, it should maintain a higher *de facto* rate as well. This assumption is necessary because the replacement rates used in the econometric model refer to the *de jure* rate, but the pension income is determined by the *de facto* rate. The identification between the two is not valid unless the order in the *de facto* rate follows that in the *de jure* rate. This assumption will be tested later in this subsection.

Table 3, Column (1), presents the results of the analysis. As expected, the estimated coefficient $\widehat{\beta}_6$ is positive and statistically significant. A coefficient value of 0.383 implies that for a retiree in a province where the replacement rate was increased by 10 percentage points with respect to another province, after the reform, his income increased by 3.83 percentage points more with respect to a retiree in the other province. The next question to address is the following: how do households respond to such a change in pension income? Table 3, Column (2) reports the corresponding

[12]In China, not all retirees enjoy the same policies. A retiree's pension income is determined by the policy that was in place during his working life. When a new pension policy is implemented, workers who have already retired (called "old people") remain in their original plan, workers (called "new people") who have not joined the labor force use the new plan, and workers who have already started working but have not yet retired (called "middle men") use a mixture of the new and old plans. However, because the econometric setup controls for age and relies on the discontinuity at retirement age for identification, the newest pension plan in effect is always captured.

change in consumption.[13] This coefficient is also positive, implying that consumption moves in the same direction as income. However, this change is statistically insignificant, implying that the response in consumption is not commensurate with the increase in income. A strong increase in income accompanied by an insufficiently strong response in consumption implies an increase in saving, as indicated in Table 3, Column (3).

However, there are still two potential threats to the identification strategy. First of all, in China, the *de jure* replacement rate may be different from the *de facto* replacement rate, as mentioned above. Moreover, pensions are pooled at the province level and the pools are managed by each province separately; therefore, despite the implementation of the same target *de jure* rate across the country, the *de facto* rates may differ across provinces. Ultimately, it is the *de facto* rate that determines pension incomes and, therefore, consumption patterns. However, policy variations are based on the *de jure* rate. Will the difference between these two rates affect the identification strategy? For example, the identification strategy requires the replacement rate to be the same across provinces after the reform. According to policy, the *de jure* rate will be the same across provinces; will the *de facto* rate be the same as well? To investigate this question, I performed separate difference-in-differences estimations corresponding to before and after the reform using following equation.

$$\begin{aligned} \log(Income_{i,p,t}) &= \beta_1 + \beta_2 Retire_{i,p,t} + \beta_3 Rate\_Before_p \times Retire_{i,p,t} \\ &\quad + \beta_4 X_{i,t} + \sum \beta_{5,p} Prov_p + \varepsilon_{i,p,t} \end{aligned} \tag{3}$$

The results are presented in Table 4. Table 4 indicates that the original target replacement rates

[13] Because the regression model requires exact timing of retirement, the model can only be run at individual level. Therefore here consumption at individual level is defined as household consumption divided by two.

exerted a strong effect before the reform but not after the reform. This result confirms the validity of the reform. It also indicates that the difference between the *de jure* and *de facto* rates may be not a major concern in the new scheme because pensions in the new scheme are better secured by the government's support. Another threat to the validity of the analysis is that the pension reform period coincided with another important event in China: the massive layoffs of workers in 1997. However, this event is unlikely to have affected the estimation because the source of identification comes from workers near retirement, whereas the massive layoffs affected mostly young workers. Moreover, the original replacement rate was set ahead of this event and is therefore exogenous. To confirm this hypothesis, I ran a probit model to test whether the replacement rate could predict whether workers aged 50-60 in 2002 had ever lost their jobs in the preceding seven years. The regression results indicate that the correlation is statistically insignificant.

5 Why Higher Pension Income Leads to Higher Saving Rates

In the previous section, I presented evidence that suggests the high saving rates of the Chinese elderly are closely related to their pension income and that an increase in pension income over the preceding decade can result in an increase in saving. However, the puzzle remains unsolved. Mechanically, higher income results in a higher saving rate because the saving rate is defined as follows:

$$\text{Saving Rate} = \frac{\text{Income - Expenditure}}{\text{Income}}$$

However, in the above definition, expenditure is endogenous to income; therefore, it is not necessarily true that a higher pension income leads to a higher saving rate. Households can freely decide what to do with their additional pension income: they can either save this income or consume

it. According to the results presented in Table 3, households modify their consumption in the same direction as their income, but only very modestly, thus resulting in higher saving. Why do households not increase their consumption by a sufficient amount such that their saving rates will not increase? This section will address this question.

If households maintain positive saving rates, there can be only two possibilities: either they are saving for themselves or they are saving for others. For older couples, the most important potential concerns for future expenditures are related to medical expenditures. If couples are not saving for themselves, they are most likely saving for their children. Therefore, I propose two possible explanations for why older households do not increase their consumption by a sufficient amount to compensate for increased income: medical expenditures and bequest motives. At the end of this section, I will discuss other possibilities, including transfer payments to children, deteriorating health status and longer life expectancy.

5.1 Concern for Future Medical Expenditures

Future medical expenditures are a common concern in the saving decisions of the elderly. In the analysis by DeNardi, French, and Jones (2010), medical expenditures, especially the massive medical expenditures that occur shortly before the end of the life cycle, are the primary reason why the elderly continue saving in the United States. Chamon and Prasad (2010) have also observed that medical expenditures are related to high saving rates among the elderly in China. To discuss this possibility, I present the following empirical evidence.

First, out-of-pocket medical expenditures in China have been increasing rapidly over the past decade, especially for the elderly. Figure 10 plots the age profiles for average medical expenditures for the 1995 and 2002 waves. I also plot the share of medical expenditures as a percentage of dis-

posable income. A sharp difference is observed between the two years. For the year 1995, there is little variation in medical expenditures across all age groups. The average medical expenditures fluctuate between 400 yuan and 500 yuan between age 30 and age 65, which accounts for only approximately 3-4% of disposable income. There is no evidence of increasing medical expenditures with age. For 2002, however, the pattern is different. Before age 50, medical expenditures remain stable at approximately 750 yuan. For more advanced ages, however, the level of medical expenditures begins to rise quickly, more than doubling by the time an individual reaches age 60. A similar pattern is observed in the share of medical expenditures with respect to disposable income. In summary, the Chinese elderly face increasing medical expenditures.[14] Moreover, these medical expenditures are expected to further increase in the future.

Second, the decrease in medical insurance explains the observed increase in out-of-pocket medical expenditures. Figure A1 plots the best type of medical insurance owned by the household. In China, public medical insurance is considered to be the best type of medical insurance, followed by collective and commercial medical insurance. Because medical insurance can be used by all family members, in most cases, it is typically the best type of medical insurance owned by any household member that will be most commonly used. One noticeable difference observed in Figure A1 is that the percentage of households owning public medical insurance fell from over 60% in 1995 to approximately 20% in 2002. Some households acquired collective or commercial medical insurance as a replacement, but others lost their medical insurance entirely. The reason for this change is China's marketing reform. Initially, the government provided full cradle-to-grave insurance and medical service nearly free of charge for workers. However, with the market reform,

[14]However, despite the increasing medical expenditures in China, it is important to note that these expenditures are still far from the level of such expenditures incurred in the United States. In the United States, the out-of-pocket medical expenditures for the elderly may be multiple times their annual income, especially for rich households (DeNardi, French, and Jones 2010). In China, however, although medical expenditures have increased considerably, they still account for only approximately 10% of the annual income of an average elderly household.

free public medical insurance has been gradually replaced with commercial and collective medical insurance.

What is a possible effect of medical expenditures on saving rates? If current medical expenditures increase further, how will household saving behavior respond? An increase in medical expenditures has two potential effects. First, increased medical expenditures at present imply that there may be even higher expenditures in the future, which is especially true for older individuals. In this case, precautionary motives may cause households to increase their present saving rates to prepare for future medical expenditures. On the other hand, in the definition of the saving rate, medical expenditures are subtracted from saving. This implies that mechanically, medical expenditures suppress saving in the current period. The direction in which medical expenditures will alter saving rates depends on the relative strength of these two effects. A model is required to answer this question.

5.2 Bequest Motives

Bequest motives are another important factor suggested in the literature to explain the saving rates of the elderly (Hurd 1987; Hurd 1989; Bernheim 1991; Kopczuk and Lupton 2007). However, identifying bequest motives is notoriously difficult because even if a bequest is observed when parents pass away, the bequest may be either purposeful (left for the children) or accidental (intended to prepare for the parents themselves in case they were to live longer). Do bequest motives exist in China? The rigorous identification and estimation of bequest motives are beyond the scope of this paper. However, I will provide some evidence that suggests that bequest motives do exist in China.

First, most Chinese elderly state that they want to leave bequests to their children and that

they do not need to save for their old-age support. Yin (2010) studies the strength of bequest motives in China. He used a dataset called the "Survey of Living Preferences and Satisfaction," which was conducted as part of the 21st Century Center of Excellence Program of Osaka University. In the survey, there is a question asking the elderly whether they agree with the statement, "I want to leave as large a bequest as possible to my children." Table 5 shows the distributions of their responses: 62.45% of the surveyed people stated either, "I think so" or "I tend to think so." A mere 9.83% stated, "I tend not to think so" or "I do not think so." In addition to direct questions asking about bequest motives, there is also indirect evidence. In CHARLS 2011, a question was included that asked the elderly, "Who can you rely on for old-age support?" Table 6 reports the distribution of the answers to this question. Although it is widely believed that children are the most important source of old-age support in China (Banerjee, Meng, and Qian 2010), the data indicate that this is not the case in urban China. Table 6 shows that only approximately 30% of the elderly rely on their children for support. More than double that amount rely on pension income. This observation further confirms that in urban China, pension income is the most important source of old-age support. In Figure 3, I illustrate that pension income accounts for over 80% of income after retirement, whereas transfer income from children accounts for less than 10%.

Interestingly, very few elderly people state that they rely on savings for their old-age support (8% of households below age 50 and 2.65% of households above age 60). This finding has important theoretical implications. Savings refer to the stock of wealth that a household has accumulated, and pension income is the annual flow of income. The fact that most of the elderly rely on pension income instead of savings implies that for most Chinese elderly, the annual flow of pension income is sufficient to cover their old-age expenditures. In this case, if they maintain a significant level

of saving (which is the case, according to the data),[15] it is likely that they are not saving for themselves. This implies a strong motive to save for bequests.

A second piece of evidence is the relationship between the number of children and the saving rate. If a bequest motive exists, a natural conjecture is that saving rates will be lower for households without children. Although the CHIP cannot be used for this purpose because it captures only children living in the household, CHARLS 2011 is suitable for this purpose because it contains information concerning all children regardless of whether they live in the household. The CHARLS 2011 data indicate that for households above age 60, the saving rates are 16.7% for households without children and 27.8% for households with children. The difference of 11.1% between these values is statistically significant after controlling for factors such as age, education, and household income.

Might there be other possible factors that may prevent household expenditures from increasing by amounts commensurate with increases in pension income? Although it is not possible to discuss all such possibilities, I would like to discuss three possible channels.

The first possibility is that their children may seek help in purchasing a house or paying for their own children's educational expenditures. To consider this possibility, in Figure 11, I plot the transfer expenditures to family members outside the household. The figure demonstrates that transfer expenditures cannot explain the pattern in saving rates because transfer expenditures peak at age 55, which implies that if these expenditures serve as a motive for saving, households should save in advance of age 55, at which time this motive should start to diminish. The saving rate, however, continues to increase after age 55.

Another possibility it is not that households choose not to increase consumption but rather

[15]In 2002, the average wealth of households aged 60 or above is 908.55 thousand yuan, which is about fives times the average disposable income.

that their deteriorating health conditions prevent them from increasing expenditures. To evaluate this possibility, I plot the percentage of healthy households and the saving rates of households of different health statuses. Figure 12 indicates that the deterioration in health status is constant from age 30 onward and is therefore unlikely to match the increasing trend in saving rates beginning at age 45. Moreover, even when the data are separated by health status, a strong increase in saving rates after retirement is still observed when comparing households with similar health status but at different ages. Another important observation is that healthy households maintain higher saving rates. If a deteriorating health status prevented households from increasing their consumption, then unhealthy households would be expected to save more because of their lower consumption. The data, however, indicate the opposite. Therefore, I conclude that changing health status alone cannot explain the high saving rates of the Chinese elderly.

Finally, can increasing longevity as a result of the economic development in China explain higher saving rates because the elderly need to prepare for a longer life? This hypothesis contradicts some empirical observations. First of all, there is no evidence that the life expectancy of the elderly increase tremendously in China during the investigated period. World Bank (2010) shows that from 1990 to 2008. China experienced a surprisingly small increase in life expectancy at birth (5 years), which is smaller compared to other developing countries including Brazil (6 years), Egypt (6 years), India (8 years) and Indonesia (7 years), even though these countries have experienced much slower economic growth than China. Moreover, the increase in life expectancy at birth in developing countries is mostly attributable to the drop in infant mortality. The increase is much smaller for the elderly. Figure A2 shows that the expected years of life increased by less than one year for individuals aged 60 from 1995 to 2002. Liu et al. (2009) obtained even smaller estimates. They estimated that the remaining life expectancy of adults aged 60 and above only

increased by 0.9 years from 1987 to 2006. Moreover, an important share of this increase came from a cohort effect. Younger cohorts are born with better economic conditions, have better nutrition intakes and are generally healthier. As a result, the increase in life expectancy would appear to be even smaller if we followed a specific older cohort. Secondly, even if the life expectancy increases, it does not necessarily imply that the saving rate would increase. In Table 6, the elderly indicate that pension income is the most important resource they rely on for old-age support. Pension income persists until the end of the life cycle, which implies that the elderly do not have to maintain higher saving.

In summary, previous sections have provided evidence that high pension income may be an explanation for why the Chinese elderly save at such high rates. Upon the receipt of additional income, households increase their saving instead of increasing consumption, possibly as a result of concerns related to future medical expenditures as well as bequest motives. However, without a model, it is difficult to understand whether these factors are quantitatively important. I turn to this in the following section.

6 Life Cycle Model

In this section, I develop and estimate a dynamic life cycle model of household saving decisions that captures the key empirical features described in the previous sections. Such a model will prove useful for two reasons. First, the previous sections have highlighted several possible drivers that may explain the high saving rates of the Chinese elderly. Using such a model, it will be possible to analyze the relative importance of all of these drivers. Second, it will be possible to perform various simulation exercises. For example, the potential global impact of a potential slowdown in the Chinese economy is of worldwide concern. Because one direct effect of the economic slowdown

is on pension income, as it is indexed to average wages, which are captured in such a model, this model will enable an analysis of how the Chinese saving rate will evolve during an economic slowdown. Chinese saving has a global impact, as it is one of the major financing resources of many developed countries (the U.S., for example).

I first provide an overview of the model. Then, I provide details regarding each component of the model. Afterward, I introduce the estimation method and discuss how each parameter in the model is identified.

6.1 Overview of the Model

The outline of the model follows DeNardi, French, and Jones (2010), Hubbard, Skinner, and Zeldes (1995), Gourinchas and Parker (2002) and Palumbo (1999). In this model, I assume representative households that make joint decisions. These households earn income[16] together and make consumption decisions together. Many cohorts are included in the model. Different cohorts enter in the year 1995 with different starting ages. Each household begins with a given education level, health status and amount of initial assets. Each household may live up to a maximum age of T.

Households face four types of shock in the model: health shock, medical expense shock, income shock and mortality shock. Households will experience three stages per year. The first stage is the realization of shocks. Health shock is realized first. Conditional on current age and health status, each household may change to a different health status. After this stage, health status remains fixed throughout the year. Conditional on health status, a household may experience

[16]Ideally, I should estimate the income processes of a husband and wife separately and then aggregate them. However, there is a limitation in the dataset that prevents such an approach. To estimate the dynamic features of income (for example, permanent shock or temporary shock), information on past income is necessary. However, information on past income is available only at the household level.

(1) no medical expenditures, (2) modest medical expenditures, or (3) high medical expenditures. The probability of each level of expenditure varies depending on health status. At the same time, household income will be determined by health status, age, education, income shocks and cohort effects.

The second stage consists of consumption decisions. After all shocks are realized, the household will know its income and medical expenditures for the year. The government guarantees a minimum consumption level. The household decides how much to consume and how much to save. Utility will be derived from consumption and will be affected by other variables, such as health status. The final stage is the realization of mortality shock. Each household has some probability of dying and of deriving utility through bequest motives. If a household survives, it will move to the next period.

6.2 Utility

A representative household[17] i born in cohort c at age t derives utility from consumption $C^i_{t,c}$. The utility function is assumed to be the CRRA (Constant Relative Risk Aversion) function with utility shifter $\delta(h^i_t, l^i_t)$, where h^i_t is the current health status and l^i_t is leisure.[18] Previous research (Attanasio and Weber 1995; Palumbo 1999; Banks, Blundell, and Tanner 1998) has demonstrated that both health and leisure are important in understanding consumption patterns near retirement.

[17]China maintains the highest female labor force participation rate within major countries in the world (U.S. Bureau of Labor Statistics 2012), which is 7% higher than the second highest country (Canada). The rate is even higher in urban areas. Therefore, in the model, I assume that the wife in a household always joins the labor force in China. In countries with a low female labor force participation rate, the female labor supply may partially substitute for the role of saving in buffering negative economic shock (Attanasio, Low, and Snchez-Marcos 2005; Attanasio, Low, and Sanchez-Marcos 2008).

[18]If a variable contains no subscript c, it implies that I assume that there is no difference in that variable among different cohorts. For example, there is no subscript c for leisure, which implies that I assume that households will engage in the same amount of leisure at age t regardless of the cohort. For income, a subscript c is present, implying that in this model, different cohorts will have different incomes when they reach the same age.

The utility function takes the following form:

$$u^i\left(C^i_{t,c}\right) = \delta(h^i_t, l^i_t)\frac{\left(C^i_{t,c}\right)^{1-v}}{1-\nu}$$

where $\delta(h^i_t, l^i_t) = 1 + \delta_1 h^i_t + \delta_2 l^i_t + \delta_3 h^i_t l^i_t$.

At the end of each year, there is a mortality shock. Each household may die with a probability of m_t. In the case of death, there is some utility derived through bequests:

$$b^i\left(A^i_{t,c}\right) = \left(\theta_0 + \theta_1 Child^i\right)\frac{\left(A^i_{t,c} + \kappa\right)^{1-\nu}}{1-\nu}$$

where $Child^i$ is a variable that indicates whether the couple has any children, and A^i_t represents the assets remaining after death. θ_1 is introduced to capture the sharp difference in saving rates between households with children and households without children.

6.3 Education and Health Status

In the model, each household begins with a given education level E^i. I assume that no further education can be received, meaning that E^i remains fixed throughout the life cycle. There are two types of education: high and low.

There are also two possible health statuses: good health and poor health. Unlike education, health can evolve over time depending on the household's current age and health status.

6.4 Income Process

Household income in the model[19] depends on education, health, age and birth cohort. Income consists of a deterministic component and a stochastic component. More specifically, income takes the following form:

$$\log(Y_{t,c}^i) = \log(\overline{Y}_{t,c}^i) + e_t^i$$

where $\overline{Y}_{t,c}^i$ is the deterministic component, which is assumed to be $\overline{Y}_{t,c}^i = f_c\left(t, E^i, h_t^i\right)$. The function f_c can differ for different cohorts. In practice, the income process is estimated using the following equation:

$$\begin{aligned}\log(Y_i) &= \alpha + \beta_1 Age_i + \beta_2 Age_i^2 + \beta_3 Edu_i + \beta_4 Edu_i \cdot Age_i \\ &\quad + \beta_5 Edu_i^2 \cdot Age_i + \gamma X_i + e_i\end{aligned}$$

Here, the control variables X_i include health, employer type, province of residence and whether the income information is recalled.

The stochastic component e_t^i includes permanent income shock and temporary income shock:

$$\begin{aligned}e_t^i &= u_t^i + \varepsilon_t^i \\ u_t^i &= \rho u_{t-1}^i + \epsilon_t^i\end{aligned}$$

where ε_t^i and ϵ_t^i are independent and identically distributed, and they are also independent of each other. Both types of shock satisfy the normal distribution: $\varepsilon_t^i \sim N(0, \sigma_\varepsilon^2)$ and $\epsilon_t^i \sim N(0, \sigma_\epsilon^2)$.

One possible caveat for the modeling of the income process is the potential endogeneity in the

[19]Because interest income and transfer income will be separately added to the model in a later stage, in the estimation of the income process presented here, I take away these two components of income.

timing of retirement. Treating retirement as exogenous when it is actually endogenous will lead to an overestimation of shocks (Low, Meghir, and Pistaferri 2010). However, in China, although there is some difference in the timing of retirement depending on gender and work type, retirement is typically mandated instead of being a personal choice. Early retirement usually occurs because of disability or work-related injury, and late retirement is usually requested by employers because of special skills possessed by the worker (experienced doctors, for example). This scenario is also the scenario most commonly considered in the previous literature (Banerjee, Meng, and Qian 2010).

The identification of temporary and transitory shock is similar to the approaches adopted by Meghir and Pistaferri (2004) and Chamon, Liu, and Prasad (2013) for application to China. Table 7 reports the estimation of the parameters and standard errors. Appendix B provides more technical details regarding this estimation.

It should be noted that the deterministic component of the income process is estimated for each cohort separately.[20] It is crucial to distinguish between the life cycle profile for a specific cohort and the cross-sectional profile in a specific wave. In a stationary economy, these two profiles are equivalent to each other. Those who are currently 60 will receive the same amount of income five years in the future as the amount that those who are currently 65 receive in the present year. In a growing economy, especially one that is growing as rapidly as that of China, these two profiles can differ tremendously from each other because of economic development. Younger cohorts usually receive higher incomes when they reach a given age compared with older cohorts. In such a case, the income of individuals who are currently 65 will no longer serve as a valid proxy for the income of individuals who are currently 60 five years in the future. Previous literature on the Chinese

[20]For simplicity, the structure of the stochastic component is assumed to be the same for all cohorts.

saving rate has not made this distinction (Chamon, Liu, and Prasad 2013; Song and Yang 2010).

Figure 13 plots the income of each cohort in the past five years. Unlike the hump-shaped income profile of a standard life cycle model, in China, income continues to increase for all cohorts because of economic growth.[21] Even after retirement, household income continues to increase at a rate no slower than that of a working household. The reason for this pension growth after retirement in China is that the level of pension income is indexed to the average worker's wage in China, which is rising quickly as the Chinese economy grows. Notably, in this paper, all income and expenditures are adjusted according to the price level in year 1995; therefore, the results are robust to inflation.

Individuals have not experienced decreases in income in the past, and they do not expect their income to decrease in the future. In CHIP 2002, a question was asked regarding the expectations of changes in future income. Figure 14 presents the results. Fewer than 20% of Chinese households reported an expectation that their household income would decrease in the future. More interestingly, as workers retire, a smaller percentage of them expect their income to decrease, implying that retirees mostly expect their pension income after retirement to readily increase. No individuals at age 65 in the sample expected their income to drop in the future.

In short, whereas cross-sectional profiles predict that household income will decrease after retirement, life cycle profiles predict that income will continue to rise. When households make consumption-saving decisions, they take into account their life cycle profiles instead of cross-sectional profiles. The two different profiles will generate vastly different predictions. Figure 15 plots the cross-sectional profile for 2002 and various predicted life cycle profiles for different

[21] In the 1995 wave, there is a small dip for all cohorts. This is because during the 1992-1993 period, China experienced high inflation. The data have been adjusted to the consumer-pricing index; therefore, this inflation induces a temporary drop in the true income for that year.

cohorts in the model. It is clearly apparent that in the cross-sectional profile, income begins to decrease slowly after age 55. The life cycle profiles, however, indicate that income continues to grow for all cohorts, even for cohorts who have already retired.

6.5 Medical Expenditure Process

In principle, medical expenditures should be estimated in a similar fashion as the income process. However, there is a limitation of the available datasets that prevents this approach. To date, there are no available panel data for China that contain information regarding medical expenditures.[22] This limitation will result in two difficulties in the estimation of the medical expenditure process. The first difficulty lies in distinguishing between permanent shock and temporary shock. The second difficulty lies in estimating the medical expenditure profiles for each cohort.

To address the first difficulty, I estimate the permanent component and transitory component of medical expenditure shocks separately using different datasets.

I assume that health status captures the permanent features of medical expenditures because health is the most important determinant of medical expenditures. Health status also captures the evolution of medical expenditures because a household's level of medical expenditures typically decreases when its health status improves. More importantly, the China Health and Nutrition Survey, which is a panel survey, contains information regarding health status. Therefore, it is possible to estimate the transition probability for health status, which can be used to represent

[22]The CHNS is a panel survey; however, it does not contain information regarding medical expenditures. The CHIP contains information regarding medical expenditures, but it is not a panel survey. The income process can be estimated using the CHIP because the CHIP records the income history for each household over the preceding five years. No similar history information is available for medical expenditures.

the permanent shock of medical expenditures. For simplification, I assume

$$\Pr(h_t^i = j | h_{t-1}^i = k) = \frac{N(h_t = j, h_{t-1} = k)}{N(h_{t-1} = k)}$$

which means that the health transition probability is a function only of age and previous health status. In the model, I define two possible health statuses: healthy and unhealthy.[23] Figure A3 plots the probability that a household will maintain its health status. As expected, as a household ages, it becomes more difficult for it to remain in a healthy status and less likely for it to leave unhealthy status.

The transitory shock of medical expenditures is captured by medical expenditures that are conditional on health status. Households of the same health status can incur different levels of medical expenditures. In the model, I consider three possibilities: no shock, low shock and catastrophic shock. In each case, the associated medical expenditures are $M_{t,c}^{i,1}$, $M_{t,c}^{i,2}$, and $M_{t,c}^{i,3}$, respectively. Specifically, a household of education level E^i and health status h_t^i will have a probability $\pi(h_t^i, E^i)$ of experiencing some sort of medical shock. Conditional on experiencing such a shock, there is a probability ϕ that the shock will be a catastrophic one. In summary, medical expenditures are modeled as follows:

1. $M_{t,c}^{i,1}$ if no shock occurs (with probability $1 - \pi$)

2. $M_{t,c}^{i,2}$ if a low shock occurs (with probability $\pi\,(1 - \phi)$)

3. $M_{t,c}^{i,3}$ if a catastrophic shock occurs (with probability $\pi\phi$)

To estimate the medical expenditure process, I further assume that $M_{t,c}^{i,3} = \gamma M_{t,c}^{i,2}$ and $\phi =$

[23] In the survey, each household member was asked individually for his or her self-evaluated health status. One's health could be reported to be "very good," "good," "fair" or "poor." A healthy household is defined as one in which both members of the couple rate their health statuses as "very good" or "good."

0.05.[24]

A second difficulty is to determine the profile of medical expenditures for each cohort. Similar to income, the process of medical expenditures in China is unlikely to be stationary. The cost of medical services changes every year. The change in out-of-pocket medical expenditures experienced by a household is determined by two factors: the total medical expenditure and the percentage of the total that the household itself must pay. Assume

$$M_{t,c}^{i,j} = s_{t,c} \cdot \overline{M}_{t,c}^{i,j}$$

where $\overline{M}_{t,c}^{i,j}$ represents the total medical expenditure and $s_{t,c}$ represents the share of out-of-pocket payment. Because the survey included a question regarding the proportion of its medical expenditures for which each household was obliged to pay, $s_{t,c}$ is known, and $\overline{M}_{t,c}^{i,j}$ can be recovered from $M_{t,c}^{i,j}$ using the two available data points. To estimate future medical expenditures, I make two additional assumptions. First, $\overline{M}_{t,c}^{i,j}$ is assumed to increase smoothly each year at the given age, specifically,

$$\overline{M}_{t,c+k}^{i,j} = \overline{M}_{t,c}^{i,j} + k \cdot \Delta_t$$

where Δ_t can be estimated using the data from the 1995 and 2002 waves for each age. This specification assumes that a cohort that is younger by k years will need to pay $k \cdot \Delta_t$ more in total

[24] ϕ and γ cannot be independently identified. Because medical expenditures are continuously distributed, the smaller ϕ is, the larger γ will be. I have also tested other values of ϕ and have found the estimation results yielded by the rest of the model to be similar.

medical expenditures. For $s_{t,c}$, I assume

$$\begin{aligned} s_{t,c} &= s_{t,1995-t} \text{ if } t+c \leq 1995 \\ s_{t,c} &= \frac{2002-t-c}{7} s_{t,1995-t} + \frac{t+c-1995}{7} s_{t,2002-t} \text{ if } 1995 < t+c < 2002 \\ s_{t,c} &= s_{t,2002-t} \text{ if } t+c \geq 2002 \end{aligned}$$

Note that the current year can be recovered from $t+c$. This specification assumes that prior to 1995, the rate is fixed to the level of 1995, and that after 2002, the rate is fixed to the level of 2002. Between these two years, the rate changes at a constant rate. The reason for this specification is that no further data are available to describe the variation in the rate in greater detail. Despite the many limitations of this specification, it is the most reasonable option given the availability of the data.

6.6 Constraints

There are two major constraints in the model. The first is the liquidity constraint. Because the financial system in China is not highly developed, borrowing typically requires collateral, meaning that it is rare for a household to be able to borrow an amount greater than that corresponding to the assets it owns. According to the data, fewer than 1% of households possess negative assets. Specifically, I assume

$$A^i_{t,c} \geq 0, \forall t, c$$

The second restriction is the guarantee of a minimum standard of living. This is a program that is intended to ensure that poor households maintain a minimum standard of living. Although this standard is defined differently for different provinces in China, for simplicity, I assume a

single country-wide standard. Following Hubbard, Skinner, and Zeldes (1995), I assume the rules governing this constraint to be that the government will guarantee a minimum consumption of

$$T_{t,c}^{i} = \max\left\{\underline{C} + M_{t,c}^{i} - Y_{t,c}^{i} - (1+r)\, A_{t,c}^{i}, 0\right\}$$

and that there is a budget constraint of

$$A_{t,c}^{i} = (1+r)A_{t-1,c}^{i} + Y_{t,c}^{i} + T_{t,c}^{i} - C_{t,c}^{i} - M_{t,c}^{i}$$

Here, $\underline{C}$ is the minimum consumption, which is estimated from the average consumption of the bottom 1%. If the family receives government transfers, I impose $C_{t,c}^{i} = \underline{C}$, and $A_{t+1,c}^{i} = 0$.

6.7 Optimization Problem

The timing of the model can be summarized as follows:

1. A household that belongs to a specific cohort c at an age of t begins with assets $A_{t-1,c}^{i}$, health status h_{t-1}^{i}, education level E^{i}, and permanent income shock u_{t-1}^{i}.

2. Health shock is realized, determining whether the household will experience a change in health status h_{t}^{i}.

3. Income shock and medical expenditure shock are realized, determining the household's income $Y_{t,c}^{i}$ and medical expenditures $M_{t,c}^{i}$.

4. The government determines whether to provide a transfer to the household in accordance with the minimum consumption rules.

5. Each household is left with cash in hand equal to $(1+r)A_{t-1,c}^{i} + Y_{t,c}^{i} + T_{t,c}^{i} - M_{t,c}^{i}$ and

determines how much to consume ($C^i_{t,c}$) and how much to leave for the next period $A^i_{t,c}$. The saving rate in this period is determined as follows:

$$rate^i_{t,c} = \frac{rA^i_{t-1,c} + Y^i_{t,c} + T^i_{t,c} - M^i_{t,c} - C^i_{t,c}}{rA^i_{t-1,c} + Y^i_{t,c} + T^i_{t,c}}$$

6. A mortality shock is realized at the end of the year. Each household will move into the next year with a probability of $1 - m_t$.

The maximization problem can be written as follows:

$$\begin{aligned} V_t(A_{t-1}, h_{t-1}, u_{t-1}; E) &= \max_{C_t}\{\delta(h_t, l_t)\frac{(C_t)^{1-v}}{1-\nu} \\ &\quad +\beta E_t V_{t+1}(A_t, h_t, u_t; E)\} \end{aligned}$$

subject to

$$\begin{aligned} A_t &= (1+r)A_{t-1} + Y_t + T_t - C_t - M_t \\ T_t &= \max\{\underline{C} + M_t - Y_t - (1+r)A_{t-1}, 0\} \\ A_t &\geq 0 \\ \log(Y_{t,c}) &= \log(\overline{Y}_{t,c}) + e_t \\ e_t &= u_t + \varepsilon_t \\ u_t &= \rho u_{t-1} + \epsilon_t \\ M^j_{t,c} &= s_{t,c} \cdot \overline{M}^j_{t,c} \quad (j = 1, 2, 3) \end{aligned}$$

The solution will yield a policy function:

$$C_t\left(l_t, M_t, \varepsilon_t, A_{t-1}, h_t, u_t; E\right)$$

and this function will be different for different cohorts.

6.8 Method of Simulated Moments

The parameters in the model are estimated in three different ways: taken from the literature, estimated externally and estimated within the model. The first category includes the discount factor, which is assumed to be 0.98. The second category includes the interest rate, the income process and the medical expenditure process. The methods for estimating the income process and the medical expenditure process have been introduced in previous subsections. The interest rate is estimated as the average one-year interest rate for savings accounts since 1995. Parameters in the final category are estimated using the Method of Simulated Moments (McFadden, 1989). This category includes (1) the CRRA risk-aversion parameter (ν), (2) the utility shifters ($\delta_1,\ \delta_2,\ \delta_3$) and (3) the bequest motives ($\theta_0,\ \theta_1,\ \kappa$).

The major moments used in the estimation are the amounts of saving separated by cohort, health and education at the two available data points. More specifically, I choose six cohorts:[25] two health levels, two education levels and two years of data. Because health information is available only for the 2002 wave of the CHIP, in practice, these data total 36 moments. Additionally, I consider the difference in saving rates between families with and without children for a single cohort.

The simulated moments are obtained using the following procedure. First, I estimate the

[25]Household head born in 1929-1931, 1932-1934, 1935-1937, 1938-1940,1941-1943, 1944-1946.

income process and the medical expenditure process for the six selected cohorts as well as other necessary information, such as health transition probability and leisure for each age. Second, I use the 1995 data to determine the distributions of the number of children,[26] health, education and starting assets for use as the initial conditions. For each cohort, I perform a certain number of simulations with different incidences of shocks. The number of simulations is proportional to the cohort size. Third, I aggregate the simulations into four groups for each cohort (education by health). Then, I determine the saving in the first year of the simulation (matched to the year 1995) and the saving seven years later (matched to the year 2002). Finally, I compute the difference in saving rates for one chosen cohort sixteen years later (matched to the year 2011, the CHARLS survey year) between households with children and households without children.

I will now discuss how the chosen moments can be used to intuitively identify the parameters. The relative degree of risk aversion ν can be identified by considering how individuals value current consumption relative to the future. If individuals are highly risk-averse, they will tend to engage in higher current consumption because the future is uncertain. That is to say, CRRA risk aversion can be identified from changes in consumption between the two waves. Preference shifters ($\delta_1,\ \delta_2,\ \delta_3$) can be identified as the correlations between consumption and corresponding factors (leisure, health) and their interactions. The difference in consumption between households with different health statuses will identify δ_1. Because the leisure variable changes rapidly during the process of retirement (ages 50 to 60), the corresponding change in consumption will identify δ_2. Because δ_3 represents the interaction between health and leisure, the different changes in consumption during the retirement process for healthy and unhealthy households will help to identify δ_3. Finally, θ_1 is identified as the difference in saving rates between households with

[26]The distribution of the number of children is estimated from the CHARLS because the CHIP does not capture children not living in the household.

and without children. $\theta_0 + \theta_1$ (and therefore θ_0) can be identified from the amount of assets a household leaves behind upon death, which is equivalent to the average saving throughout the life cycle. κ is the curvature of bequests; if this quantity is positive, it indicates that bequests are a luxury good. Therefore, the different rates of saving among households of different income levels (for example, households with different education level) will help to identify the parameter κ. In the data, both health and education inform the income process; therefore, differences in consumption between the healthy and unhealthy and between the educated and uneducated will help to identify this parameter.

More technical details about obtaining the standard error from the Method of Simulated Moments are provided in Appendix C.

7 Results

Table 8 presents the estimated coefficients of the model. The model yields several interesting results. First of all, the estimated CRRA degree of risk aversion equals 1.989, which is very similar to estimates for the United States (DeNardi, French, and Jones 2010). This implies that the Chinese saving pattern can be explained by a reasonable parameter value. It is not required that Chinese households be highly risk-averse to explain their high saving rates. My finding also reinforces the finding of Carroll, Rhee, and Rhee (1994) that culture does not play an important role in saving behavior. Second, children are the most important source of bequest motives. In my estimate, I find that $\widehat{\theta_1} > \widehat{\theta_0}$, implying that more than half of the bequest motives are explained by children. Note that in the identification, $\widehat{\theta_0}$ serves as a residual claimer in the model[27] meaning that if there is any other factor that affects saving decisions but that is not captured by the model, it

[27]In the previous section, I argued that θ_0 is identified as the average saving rate across the life cycle.

will be incorporated into the estimate of θ_0. The fact that $\widehat{\theta_0}$ is not especially high implies that the model captures most important factors that may affect the saving rate.[28] Moreover, the estimated bequest curvature $\widehat{\kappa}$ is positive and statistically significant, implying that bequests are a luxury good in China. This finding is also consistent with the fact that richer households maintain higher saving rates on average (Dynan, Skinner, and Zeldes 2004). Finally, the coefficients of the utility shifters are statistically insignificant. δ_1 is identified as the difference in consumption between healthy and unhealthy households, conditional on income and expenditures. The fact that $\widehat{\delta_1}$ is insignificant implies that the differences in income and expenditures between healthy and unhealthy households capture most of the difference in saving. The estimation of $\widehat{\delta_1}$ also verifies that deteriorating health status, which requires δ_1 to be negative, cannot explain the high saving rates of the elderly, as discussed in previous sections. δ_2 is identified as the change in consumption during the retirement period. The insignificance of $\widehat{\delta_2}$ implies that work-related expenditures and substitutions between leisure and consumption cannot explain the rise in saving rates on their own. [29]

Figure 16 - 18 presents the matching qualities for income, medical expenditures and consumption.[30] The model best matches the income profile. This result is expected because the income process is estimated separately and all information is drawn from the same dataset. Although

[28]The ratio $\frac{\widehat{\theta_1}}{\widehat{\theta_0}+\widehat{\theta_1}}$ gives the estimate of the lower bound of the share that bequests account for. The lower bound assumes that the household has no bequest motives other than bequests for children. In reality, bequest motives can also exist for spouses, other relatives or charitable donations.

[29]In the United States, previous research has documented a puzzle known as the "retirement-savings puzzle" (Hamermesh 1984; Hausman and Paquette 1987; Bernheim 1991). The life-cycle model predicts that there should be little change in consumption in the case of expected retirement. However, the data indicate that in the United States, consumption falls considerably during retirement. If this is also the case in China, then this drop in consumption can be mapped as an increase in saving. The explanation for the puzzle includes substitutions between leisure and consumption and work-related expenditures (Banks, Blundell, and Tanner 1998; Aguiar and Hurst 2005). In the model, this requires $\delta_2 < 0$.

[30]In practice, the moments match consumption patterns distinguished by education and health status separately. For presentation purposes, I collapse all information for a single cohort together. Because the cohort size is drawn directly from the data, there is no aggregation bias.

medical expenditures are also estimated outside the model, the matching quality is not as good as that for income because some component of the medical expenditures is estimated based on another dataset: the CHNS instead of the CHIP. The simulated consumption also tracks the data well, although the model slightly overestimates the consumption of younger cohorts and underestimates the consumption of older cohorts.

Figure 19 presents the matching of saving rates in the 1995 and 2002 waves.[31] Because the data are cross-sectional, I also create a simulated cross-section, although the simulation model is based on the life cycle approach. Each point in the graph corresponds to the saving rate of a specific cohort at a specific age in the life cycle. The cross-sectional profile from the simulation is composed of the life-cycle profiles of six selected cohorts. The model successfully matches several important empirical facts. First of all, the simulation reproduces the trends in saving rates observed in 1995 and 2002. In 1995, the increase in saving rates after retirement was not prominent, whereas in 2002, saving rates increased quickly among older retirees. Second, the simulation captures the fact that in 2002, the saving rate was generally higher compared to that in 1995. However, although the model fits the saving rates for the older cohorts very well, the model also predicts that households should save at a lower rate compared with the data for households in their early 50s. This implies that some mechanisms that are not captured in the model may be important motives for saving by the middle-aged but not by the elderly.

Figures 20 and 21 plot the matching of moments for different types of households in the year 2002.[32] Overall, the matching results are similar to those for time-series variations. The model successfully reproduces the fact that better-educated households and healthy households

[31] According to the definition of the saving rate, the estimation bias predominantly originates from income, medical expenditures and consumption. Although interest income and asset income also affect saving rates, the effects of these types of income are limited because of their relatively small magnitude.

[32] The results of the simulation for 1995 are similar.

maintain higher saving rates. However, the simulated difference between different education levels is smaller than that observed in the data and the simulated difference between different health status is larger. The remainder of the time-series variations and cross-sectional variations can be attributed to heterogeneous preferences, different expectations about the future and unobserved heterogenous shocks.

A final question is that of why older people save at a higher rate. The difference in saving rates between older households and younger households can be decomposed into the following effects: (1) older households are at a later stage of the life cycle (life cycle effect) and (2) older households belong to older cohorts (cohort effect). Therefore, is the cross-sectional pattern explained predominantly by the life cycle effect or the cohort effect? Figure 22 plots the life cycle saving rate of a selected cohort and compares it to the cross-sectional pattern. The graph indicates that older households save more predominantly because of the life cycle effect. The cohort effect, if anything, lowers the saving rates of the elderly. Because the estimated value of the bequest curvature κ is positive, the saving rate will be higher for richer households. In China, younger cohorts are richer in life cycle resources, meaning that they will maintain higher saving rates at a given stage of the life cycle if all else remains constant.

Previous graphs presented the quality of the matching of the moments used in the estimation procedures of the model. To test the power of the model, in Figure 23, I compare two groups that were not matched during estimation: government and non-government employees. I generated the income profile, medical expenditure profile and initial conditions for government employees and non-government employees separately and performed the model simulation using the parameters estimated in Table 8. The model successfully predicts that government employees maintain higher saving rates compared with their non-government counterparts, although the discrepancy between

the two groups indicated by the simulation underestimates that observed in the data. There are two reasons why government employees maintain higher saving rates. First, as suggested in Figure 8, government employees enjoy more generous pension plans, and higher pension income leads to higher saving. Second, government employees are better educated and healthier, which are characteristics associated with higher saving.

7.1 Simulation 1 - Factors that Determine Saving Rates

The previous subsection demonstrated that the model can reproduce important empirical features of the data. The next task is to identify the driving force of the high observed saving rates. In the empirical sections, I presented evidence that high saving rates are related to pension income. However, even if there is an increase in pension income, saving will not increase if the household consumption also increases by a sufficient amount. I demonstrated that bequest motives and concerns for future medical expenditures may be potential explanations for why consumption does not increase commensurately with income. In this subsection, I use the model to run simulations that can help to understand the relative importance of these three factors.

Figure 13 and Figure 15 illustrate that in China, there is a sharp difference between life cycle profiles and cross-sectional profiles. Because of China's economic development and the fact that pensions are indexed to the average wage of current workers, pension income will continue to increase even after retirement. The cross-sectional profiles, however, predict lower incomes for the elderly because of the cohort effect. In the framework of the life cycle model, a household relies on the life cycle profile instead of cross-sectional profile to make current consumption decisions.

The predictions of the life cycle model differ greatly for increasing and decreasing income profiles. For a hump-shaped income profile, household income will decrease after retirement. Because

households attempt to smooth consumption throughout the life cycle and wish consumption to remain relatively constant, consumption will tend to remain constant or decrease at a slower rate than income. Therefore, the saving rate will decrease or even become negative after retirement. By contrast, if income is increasing after retirement and the household still wishes to maintain a constant level of consumption, this will result in a positive and increasing saving rate after retirement.

Figure 24 compares the original simulated cross-sectional profile with a case in which the cross-sectional profile is used instead of the life cycle profile to drive saving decisions. More specifically, instead of using $\left\{\overline{Y}^i_{t,c}\right\}_{t,c}$ for each cohort separately, I use $\left\{\overline{Y}^i_{t,1995-t}\right\}_t$, which means that the cross-sectional profile corresponding to 1995 is used for all cohorts. As discussed above, when the cohort effect is neglected and income is wrongly believed to decrease after retirement, the saving rate also tends to decrease and becomes close to zero after age 60.

Given the fact that pensions continue to grow after retirement contributes to the high saving rates of the Chinese elderly, a related policy question follows: what if pensions are indexed differently? Pension income in China grows quickly even after retirement because it is indexed to current workers' wages. What would happen if pensions are indexed to CPI instead, similar to many other countries around the world? Figure 24 also simulates an alternative policy that pension income is indexed to CPI instead of average worker's wages. Because all of the numbers used in this paper are in real terms, it is equivalent to simulate the case that household income ceases to increase after retirement. The simulation results show that in this case, the saving rates peak at the 55-60 age range and will begin to decrease afterward. The saving rates of the retirees would be lowered by $5\% - 10\%$ if pensions are indexed to CPI instead. Moreover, when pensions are indexed to CPI, the Chinese elderly would maintain a low saving rate compared to

the middle-aged. The simulation results indicate that increasing pension income after retirement is crucial to explain the observations of positive and increasing saving rates after retirement.

However, pension income alone is not sufficient to guarantee a positive and increasing income profile after retirement, as confirmed by Figure 25. Figure 25 compares the original case with the case in which there are no children ($\theta_1 = 0$) and the case in which there is no bequest motive ($\theta_0 = \theta_1 = 0$). Figure 25 shows that if there is no bequest motive, the saving rate will be negative, and there will be no strong increase in saving rates after retirement. The intuitive explanation for this result is that if there is no bequest motive, then the only reason to save is precautionary saving to prevent consumption from dropping. In China, however, because of the strong annual growth in income, even when income uncertainty and growth in medical expenditures are taken into account, the probability of net income (income minus medical expenditures) is unlikely to decrease. As a result, if there is no bequest motive, then households will simply consume their annual income. However, if a bequest motive exists, a household will tend to increase its consumption less rapidly than its income increases, thereby leaving a "triangle"[33] as a bequest. As expected, if there are no children in the household, saving will be significantly lower; in this case, the simulated difference is very similar to what is observed in the empirical data.

A related policy question with respect to bequest motives is the effect of the inheritance tax. At the moment, there is no inheritance tax in China. What would happen if China imposes a 50% inheritance tax, similar to the United States? Figure 25 presents the simulation results. As expected, the saving rates are lower with the existence of inheritance taxes. Old households aged above 60 lower their saving rates by approximately 4%. This magnitude, however, is not as large as expected. One explanation is that inheritance taxes have two effects on saving. The first is the

[33]Figure A4 plots the life cycle income and expenditure of a specific cohort. It is observed that the growth in consumption falls short of the growth in income.

substitution effect because with inheritance taxes, saving is also implicitly taxed, which discourage households from saving. The second is the income effect because children would receive smaller bequests in the case of the same amount saving because part of the inheritance is taxed away when parents die.

Finally, Figure 26 compares the original saving rate to a case with zero medical expenditures. Surprisingly, I find little effect of medical expenditures. If anything, medical expenditures suppress the saving of the elderly. This finding is contradictory to the results of studies conducted in the United States (DeNardi, French, and Jones 2010) and other studies conducted in China (Chamon and Prasad 2010). In their paper, Chamon and Prasad (2010) observed correlation instead of causality. They have noted that in recent years, the Chinese elderly have both incurred high medical expenditures and engaged in high saving. After performing a regression, they found a strong correlation between the two phenomena. However, as discussed in previous sections, there are two causal effects of medical expenditures on saving behavior. The first effect is the mechanical effect. Saving is defined as income minus expenditures; therefore, higher medical expenditures will mechanically reduce saving rates. Second is the precautionary effect. The current saving rate typically accounts for possibly high medical expenditures in the future, and such future medical expenditures have no mechanical effect on current saving and will therefore unambiguously increase current saving. The net causal effect depends on which effect is stronger. My results suggest that the mechanical effect dominates the precautionary effect.

Compared with the United States, there are several major empirical differences. First, although medical expenditures in China have grown considerably, they remain far below the corresponding level in the United States. In China, out-of-pocket medical expenditures account for only approximately 10% of disposable income for the elderly. In the United States, this value is greater than

100% (DeNardi, French, and Jones 2010). A second difference is that in China, the growth of medical expenditures is not very rapid for the extremely elderly. The CHNS is not a survey that is designed for the extremely elderly; therefore, the medical expenditure information it provides for those older than 65 is very noisy. However, the CHARLS data offer a broader coverage of older individuals. Based on CHARLS data, Figure A5 plots the medical expenditures of very elderly people in China. Notably, medical expenditures exhibit the largest growth from approximately age 50 to age 65 and then remain fairly stable beyond that point. The share of medical expenditures with respect to disposable income increases only modestly after age 65. This observation is in sharp contrast with the empirical observations in the United States, where the growth in medical expenditures continues to increase with age. Differences in income levels and culture may help to explain this difference in medical expenditures.[34]

7.2 Simulation 2 - Economic Growth and Saving Rates

Numerous research studies have documented a positive correlation between economic growth and saving rates (Carroll and Weil 1994; Paxson 1996). Habit formation is one of the primary explanations for this correlation - income continues increasing, but consumption does not catch up with the growth in income. This paper reaches a similar conclusion. In the case of the Chinese elderly, their income continues to increase, but their consumption rises only modestly, resulting in higher saving rates as they age. This paper contributes to the previous literature in two respects. First, this paper demonstrates that bequest motives can contribute to habit formation and can help illustrate why the change in consumption is smaller than the change in income. Second, using a model, I can simulate saving rates for different growth rates. However, this model has limited

[34] According to CHARLS 2011, among individuals older than 60 who were sick in the previous month, only 13.49% visited the hospital. Among those who were sick and did not visit the hospital, 55.65% believed that the "illness was not serious" and that they did "not need treatment," and 6.09% claimed to be "poor."

power to predict the aggregate saving rate because the behavior of the youth is not sufficiently well-modeled.[35]

In this paper, I simulate two scenarios of economic slowdown: expected and unexpected. In the first case, I investigate what the saving rate would have been if the Chinese economy had grown more slowly. Instead of the original income profile $\left\{\overline{Y}^i_{t,c}\right\}_{t,c}$ for all cohorts, I use a new income profile $\left\{\widetilde{Y}^i_{t,c}\right\}_{t,c}$, which satisfies

$$\begin{aligned}\widetilde{Y}^i_{1995-c,c} &= \overline{Y}^i_{1995-c,c} \\ \widetilde{Y}^i_{y-c,c} &= \frac{\Pi^y_{k=1995}\left(1+g^k_{new}\right)}{\Pi^y_{k=1995}\left(1+g^k_{old}\right)}\overline{Y}^i_{y-c,c} \text{ if } y > 1995\end{aligned}$$

In the second case, I test the household response in the case of an unexpected economic shock. Each household behaves as if it will maintain its life cycle income profile $\left\{\overline{Y}^i_{t,c}\right\}$. However, in year y, a permanent economic shock hits China, and future economic growth is reduced. Then, each household must solve a new optimization problem, given the initial conditions in year y and the new income profile.

Figure 27 plots the simulated profile for 2002 if the economic growth rate had been slower. An interesting observation is that as the economy slows down, the saving rate will begin to decrease instead of increase as retirees age. When the Chinese economic growth is halved (to approximately 5%), the saving rate remains constant from age 50 to age 65, and if the growth rate is further reduced to 1/4 of the original rate (to approximately 2.5%), the saving rates for the elderly begin to decrease. The simulation results suggest that Chinese economy growth is an important determinant of the level of elderly saving as well as the observation that the elderly save more

[35]There are many factors that do not affect the saving decisions of the elderly but will strongly affect the saving behavior of the youth, such as housing, fertility and children's education. Further investigation is necessary to extend the model to younger households.

than the middle-aged.

Figures 28 and 29 test the response of household saving rates in the case of an unexpected economic slowdown for households aged 50 and 60, respectively. There are several interesting observations. First of all, the decrease in saving rates is stronger in the long run. For a household aged 50, the saving rate actually increases by 10% compared with the original saving rate when the economic growth rate is decreased to 4%. Ten years later, the saving rate drops to 10% less than the original rate. Second, the change in saving rates is very sensitive to the change in economic growth. Between the 6% scenario and the 4% scenario, although there is a difference in economic growth of only 2 percentage points, the difference in saving rates can be as high as 20 percentage points 15 years later. Finally, older households respond more strongly to changes in economic growth. When economic growth slows to 6%, households of age 50 exhibit only a modest response. The saving rate is only 5% lower 10 years later. However, that value is almost doubled for households of age 60. The intuition behind the simulation results is older households have less time to respond to a shock. They need to rapidly adjust their level of wealth within a short window of time.

The results presented above suggest that strong growth in pension income after retirement is necessary to maintain the high saving rates of the elderly. Therefore, policies that slow economic growth or directly reduce pension income (for example, causing pension income to no longer be indexed to the current wage) will immediately reduce the saving rates of the elderly.

8 Conclusion

The Chinese elderly maintain a high saving rate. Their saving rates not only remain positive but also continue to grow after retirement. In this paper, I demonstrated that this pattern can be

explained by the pension system in China. I provided evidence using both reduced-form regressions and structural model estimations. The reduced form evidence includes: (1) saving rates are higher in years with higher pensions, (2) saving rates are higher for those with more generous pension plans, and (3) policy reforms that exogenously increase pensions also increase saving rates. These empirical observations raise another question of why households do not increase their consumption sufficiently. I provided evidence medical expenditures and bequest motives can be the potential explanations. To quantitatively evaluation the effect of pensions on saving in China, I build and estimate a dynamic life cycle that takes into account all relevant factors.

The counterfactual simulations of model have important policy implications. First of all, the pension mechanism that indexes the level of pensions to the average wage of current workers greatly contributes to the high saving rates of the elderly. Because the Chinese economy is growing quickly, indexing pensions to average wages results in a quick increase in pension income even after retirement for the elderly. The rise in pensions finally leads to an increase in saving rates. I simulated that if pensions are indexed to CPI instead of wages, the saving rates of the retirees would decrease by $5\% - 10\%$, and saving rates would be lower after retirement. Secondly, bequest motives play an important role in China. Medical expenditures, in contrast, play a limited role because the level of medical expenditures in China is still quite low compared to that in the United States. These results suggest that policies related to inheritance (e.g., imposing an inheritance tax in China) will affect saving rates. Finally, the economic growth rate in China directly affects the saving rates of the elderly, as it alters the profile of pensions of the elderly. In the case of a slowdown of economic growth, the elderly will respond by decreasing their saving. Older households respond more strongly.

The paper has important theoretical implications as well. The paper shows the counter-

intuitive observation that the elderly keep extremely high saving rates can be well explained with the life cycle framework with reasonable estimates of parameters. It is not necessary to assume Chinese have high degree of risk aversion in order to explain their high saving rates. Moreover, when applying the life cycle model in a fast-developing economy, it is important to distinguish between the life cycle profile and the cross-sectional profile, as these two profiles lead to vastly different predictions.

The paper sheds light on areas of future research. The paper presents the importance of bequest motives in understanding the saving behavior of the Chinese elderly. However, in this paper, bequest motives are exogenous; therefore, it would be interesting to investigate how bequest motives are formed and what the determinants of bequest motives are. Moreover, the paper only investigates part of the household saving in China: the saving of the elderly. The saving behavior of the middle-aged and the young remain unexplored. Modeling their saving behaviors can be more challenging because many factors can be subtracted away from the saving decisions of the elderly (education, marriage, fertility, job seeking, household purchases, etc.).

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Appendix A - Definitions of Variables and Summary Statistics

Appendix A defines certain key variables that are used throughout the paper.

Age of household - defined as the age of the head of household.

Educated household - defined as a household in which at least one member of the couple has received a high school diploma or better.

Household employed by the government - defined as a household in which at least one member of the couple is employed by the government sector.[36]

Healthy household - defined as a household in which both members of the couple rated their health status as "very good" or "good."[37]

Disposable household income - defined as the total net household income, including taxes and social security payments. Total household income includes labor income (wages if employed, net profits if self-employed), pension income, asset income (rent, interest) and transfer income from the government.

Lagged household income - in each wave, households were asked to recall their disposable income over the previous four years. However, unlike the current wave, no detailed information is available regarding household income for this recalled income, only an aggregate value.

Total household expenditures - total household expenditures include food, clothing, utility, rent, communication, medication, education, transfers, purchases of non-durable goods and financial expenses (interest payments).

Total household assets - total household assets include the value of the house, financial assets

[36]The reason for this definition is that as long as one family member works for the government, the entire family will receive some benefits with regard to education and medical treatment.

[37]The reason for this definition is that as long as one member of a household is in poor health, medical expenditures are expected to increase considerably.

(cash in hand, savings accounts, value of stocks owned, etc.) and durable goods (motorcycles, cars, computers, etc.).

Table A1 reports the summary statistics of the data.

Appendix B - Estimation of the Income Process

The income process is assumed to be described as follows:

$$\log(Y^i_{t,c}) = \log(\overline{Y}^i_{t,c}) + e^i_t \tag{4}$$

The stochastic component e^i_t includes both permanent shock and temporary shock:

$$\begin{aligned} e^i_t &= u^i_t + \varepsilon^i_t \\ u^i_t &= \rho u^i_{t-1} + \epsilon^i_t \end{aligned}$$

where $\varepsilon^i_t \sim N(0, \sigma^2_\varepsilon)$ and $\epsilon^i_t \sim N(0, \sigma^2_\epsilon)$, and the two components are independent of each other.

To estimate σ^2_ε, σ^2_ϵ and ρ, I made two further assumptions: that the time-series process is stationary and that the stochastic process is the same for all processes. Under these assumptions, I can write the following equations:

$$var(e^i_t) = \sigma^2_\varepsilon + \frac{\sigma^2_\epsilon}{1-\rho^2} \tag{5}$$

$$cov(e^i_t, e^i_{t-1}) = \rho\frac{\sigma^2_\epsilon}{1-\rho^2} \tag{6}$$

$$cov(e^i_t, e^i_{t-2}) = \rho^2\frac{\sigma^2_\epsilon}{1-\rho^2} \tag{7}$$

First of all, I estimate equation (4) for each cohort; I then combine all residuals $\widehat{e}^i_t$ together. Using equation (6) and equation (7), I can estimate parameter ρ as follows:

$$\widehat{\rho} = \frac{\widehat{cov}(e^i_t, e^i_{t-2})}{\widehat{cov}(e^i_t, e^i_{t-1})}$$

Inserting $\widehat{\rho}$ into equation (6) yields

$$\widehat{\sigma}_{\epsilon}^{2} = \frac{1-\widehat{\rho}^{2}}{\widehat{\rho}} \widehat{cov}(e_{t}^{i}, e_{t-1}^{i})$$

Finally, insertion into equation (5) yields

$$\widehat{\sigma}_{\varepsilon}^{2} = \widehat{var}(e_{t}^{i}) - \frac{\widehat{\sigma}_{\epsilon}^{2}}{1-\widehat{\rho}^{2}}$$

The standard errors of the estimated parameters can be obtained through bootstrapping.

Appendix C - Standard Errors of the Method of Simulated Moments

Assume that in the model, there are M parameters to be estimated. $\mathbf{\Theta}$ is an $M \times 1$ vector containing all parameters. There are J moments to be matched, and $\widetilde{\mathbf{\Phi}}(\mathbf{\Theta}_0) and \mathbf{\Phi}$ represent the moments simulated using parameters $\mathbf{\Theta}_0$ and the true moments, respectively. The moment condition is

$$E(\widetilde{\mathbf{\Phi}}(\mathbf{\Theta}_0) - \mathbf{\Phi}) = 0$$

Because $J > M$, this condition cannot be exactly identified; the MSM estimator can be defined as

$$\widehat{\mathbf{\Theta}}_{MSM} = \arg\min_{\mathbf{\Theta}} (\widetilde{\mathbf{\Phi}}(\mathbf{\Theta}) - \widehat{\mathbf{\Phi}})' \widehat{\mathbf{W}} (\widetilde{\mathbf{\Phi}}(\mathbf{\Theta}) - \widehat{\mathbf{\Phi}})$$

where $\widehat{\mathbf{\Phi}}$ is the sample analogue of the true moments and $\widehat{\mathbf{W}}$ is the estimated weighting matrix.

Obtaining the variance of $\widehat{\mathbf{\Phi}}$ is more complicated. Because not all parameters are estimated within the model, the above process will treat parameters that are estimated outside the model as known instead of unknown, resulting in the underestimation of the variance. Pakes and Pollard (1989) have stated that under certain regularity conditions, the asymptotic distribution of MSM estimators can be written as follows:

$$\sqrt{N}\left(\widehat{\mathbf{\Theta}}_{MSM} - \mathbf{\Theta}_0\right) \rightarrow N(0, \mathbf{\Omega})$$

where

$$\mathbf{\Omega} = \left(1 + \frac{N}{I}\right) \left(\mathbf{D'WD}\right)^{-1} \mathbf{D'WSWD} \left(\mathbf{D'WD}\right)^{-1}$$

N is the number of observations included in the data, and I is the number of simulations. $\mathbf{S}$ is the $J \times J$ variance-covariance matrix of sample moment $\widehat{\Phi}$. $\mathbf{D}$ is the first-order derivative of the

simulated moments with respect to the parameters,

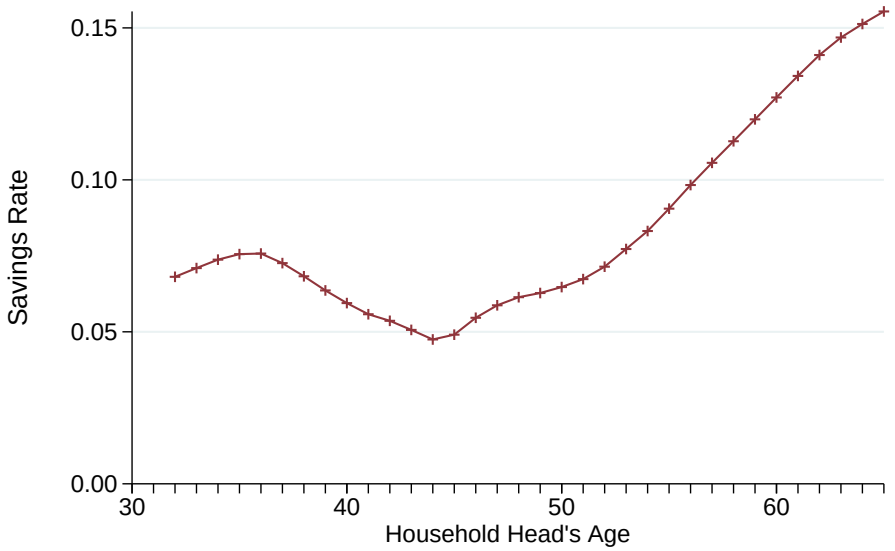
$$\mathbf{D} = \frac{\partial \widetilde{\mathbf{\Phi}}\left(\mathbf{\Theta}_0\right)}{\partial \mathbf{\Theta}'}$$

An efficient estimator can be obtained by setting $\mathbf{W} = \mathbf{S}^{-1}$; $\mathbf{\Omega}$ will be simplified to $\left(1 + \frac{N}{I}\right)\left(\mathbf{D}'\mathbf{S}^{-1}\mathbf{D}\right)^{-1}$.

In practice, I set $\widehat{\mathbf{W}} = \mathbf{\Sigma}$, where the elements of $\mathbf{\Sigma}$ are equal to those of $\mathbf{S}^{-1}$ on the diagonal and equal to zero on the off-diagonal to overcome the potential small-sample bias, as suggested by Pischke (1995).

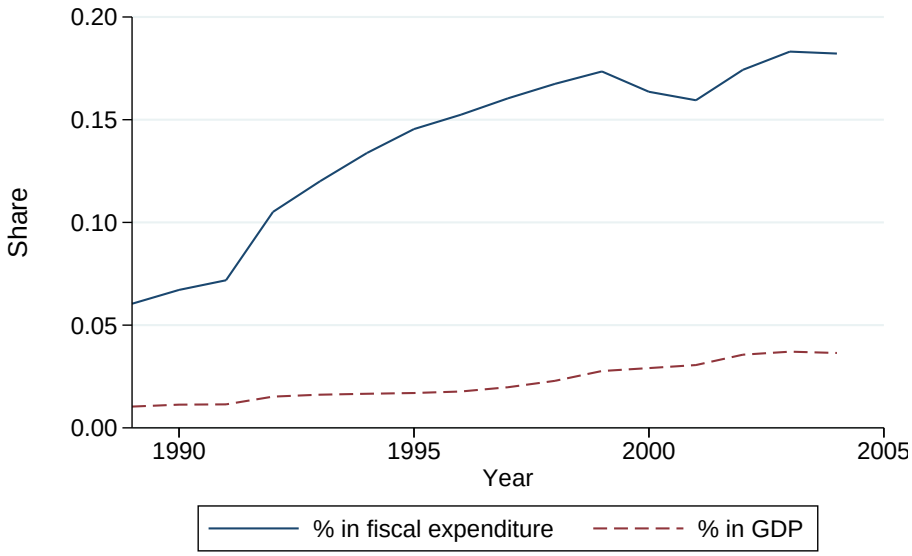
Tables and Figures

Figure 1: Age Pattern of Chinese Saving Rate in 2002



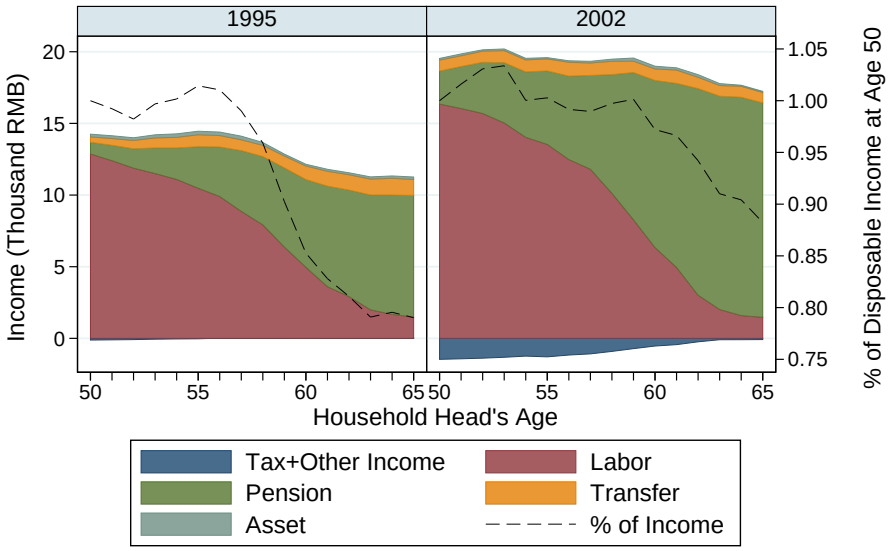
Source: Chinese Household Income Project, 2002.

Figure 2: Total Pension Payment as Share of Fiscal Expenditure and GDP



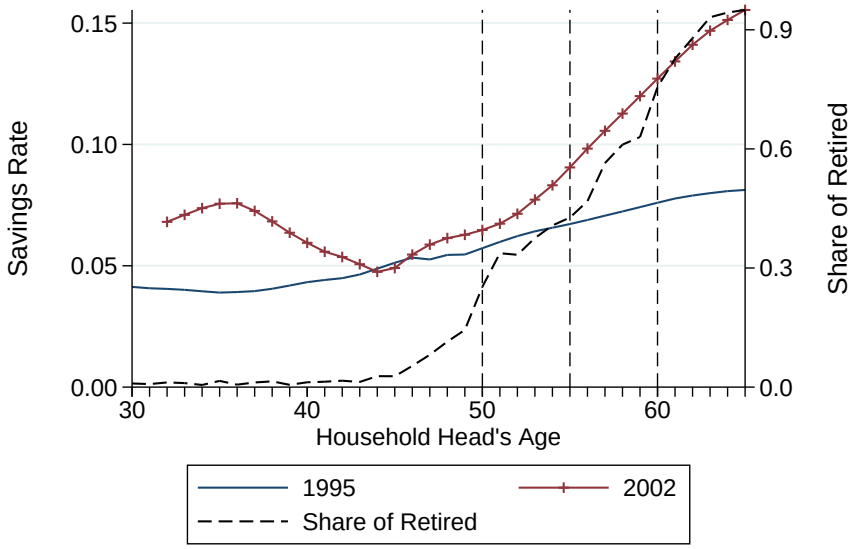
Source: National Bureau of Statistics of China.

Figure 3: Composition of Disposable Income by Survey Years



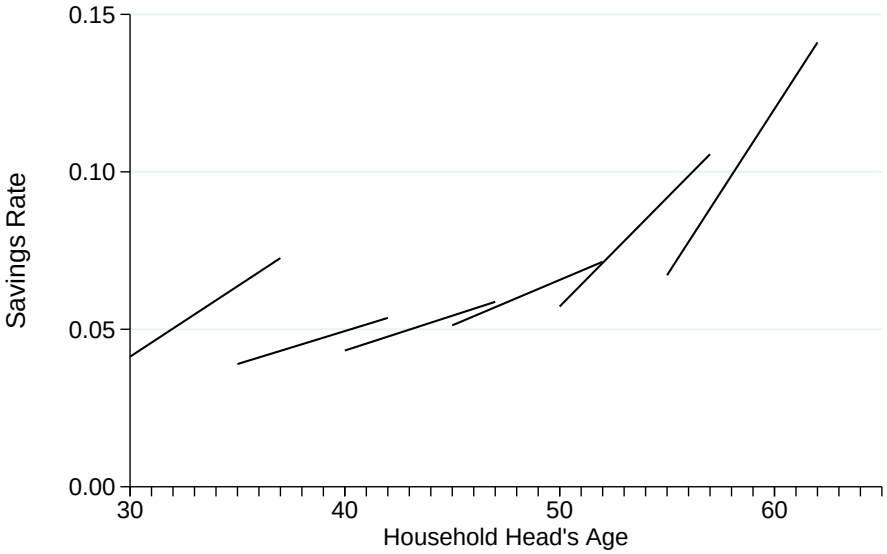
Source: Chinese Household Income Project, 1995, 2002.

Figure 4: Age Pattern of Chinese Saving Rate by Survey Years



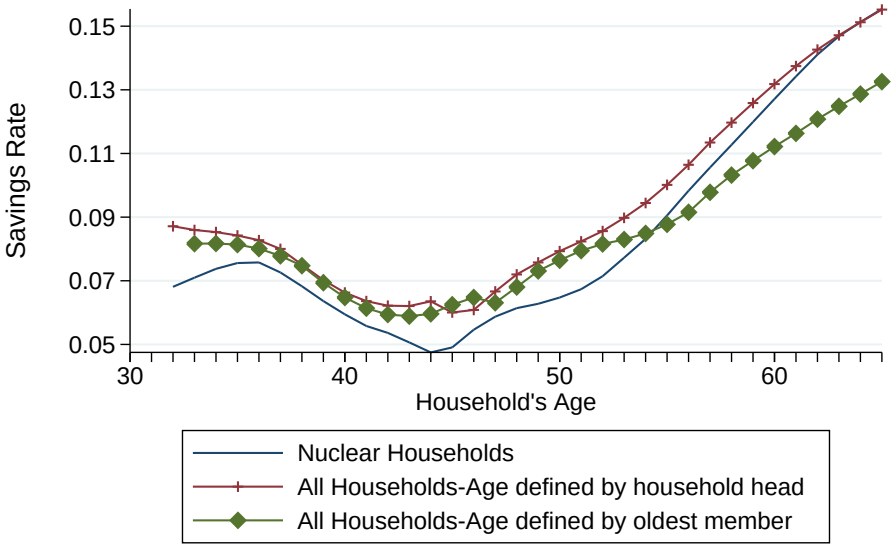
Source: Chinese Household Income Project, 1995, 2002.

Figure 5: Age Pattern of Chinese Saving Rate by Cohorts



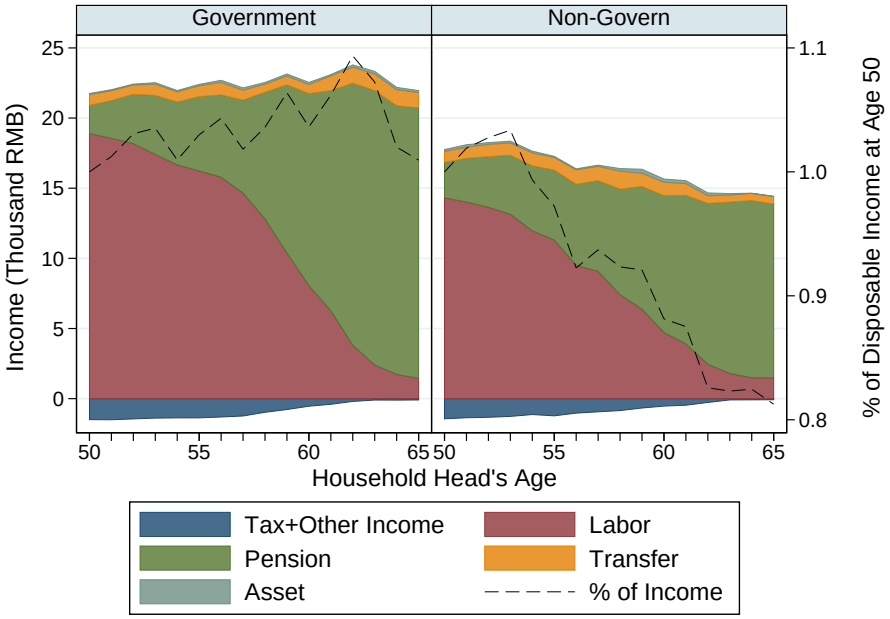
Source: Chinese Household Income Project, 1995, 2002.

Figure 6: Robustness of Age Profile of Saving Rate against Selection



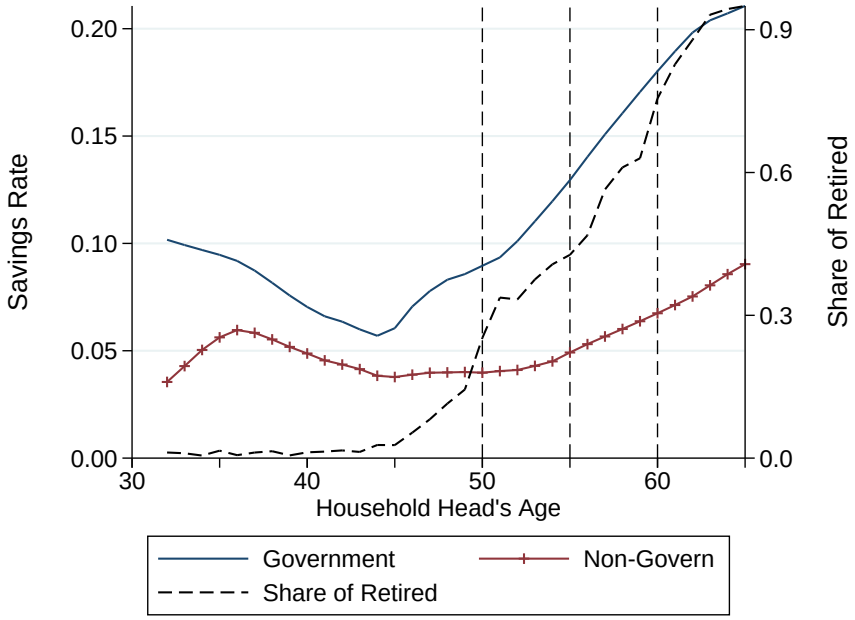
Source: Chinese Household Income Project, 2002.

Figure 7: Composition of Disposable Income by Employment Types



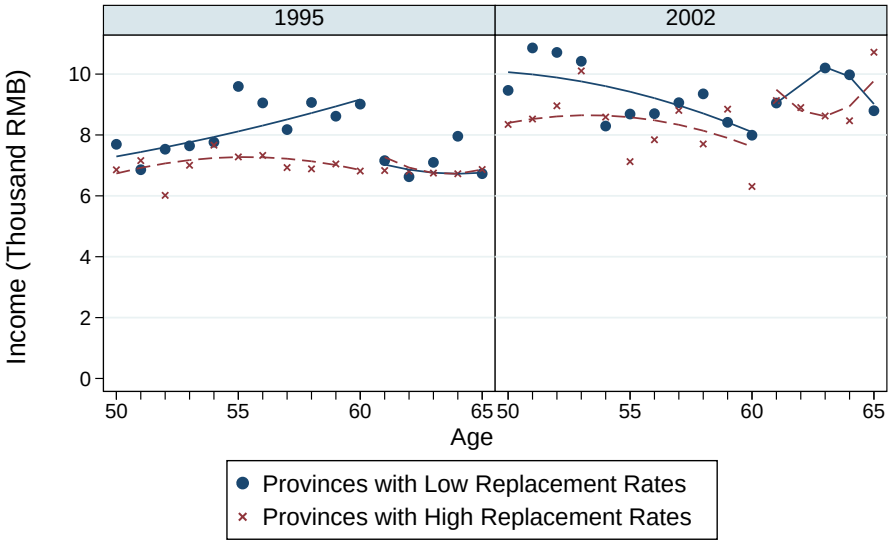
Source: Chinese Household Income Project, 2002.

Figure 8: Age Pattern of Chinese Saving Rate by Employer Types



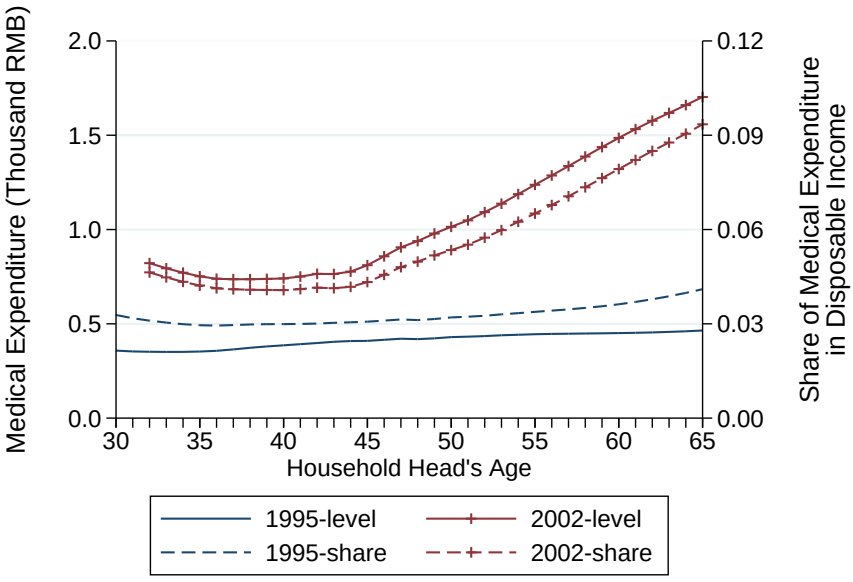
Source: Chinese Household Income Project, 2002.

Figure 9: Profile of Disposable Income by Provinces with Different Initial Replacement Rates



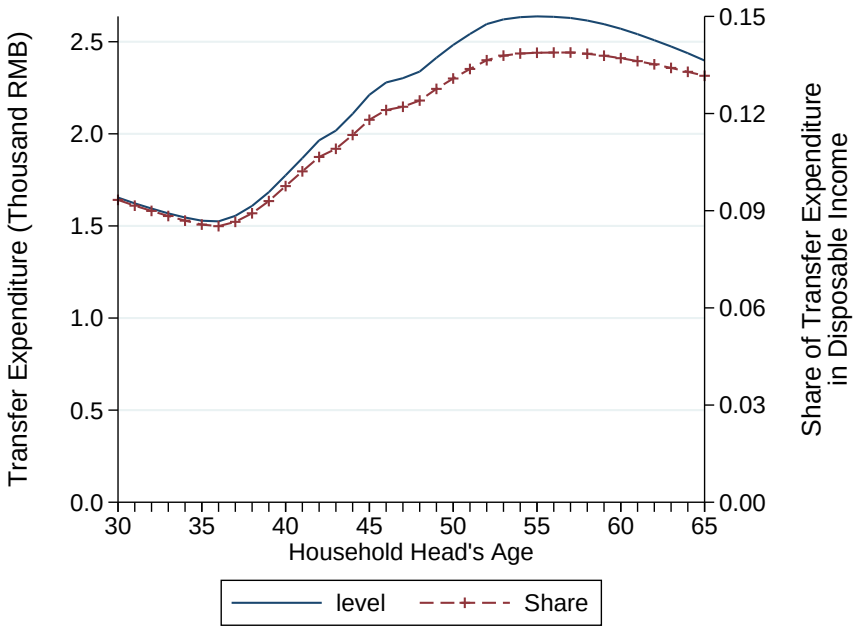
Source: Chinese Household Income Project, 1995, 2002.

Figure 10: Out of Pocket Medical Expenditure by Years



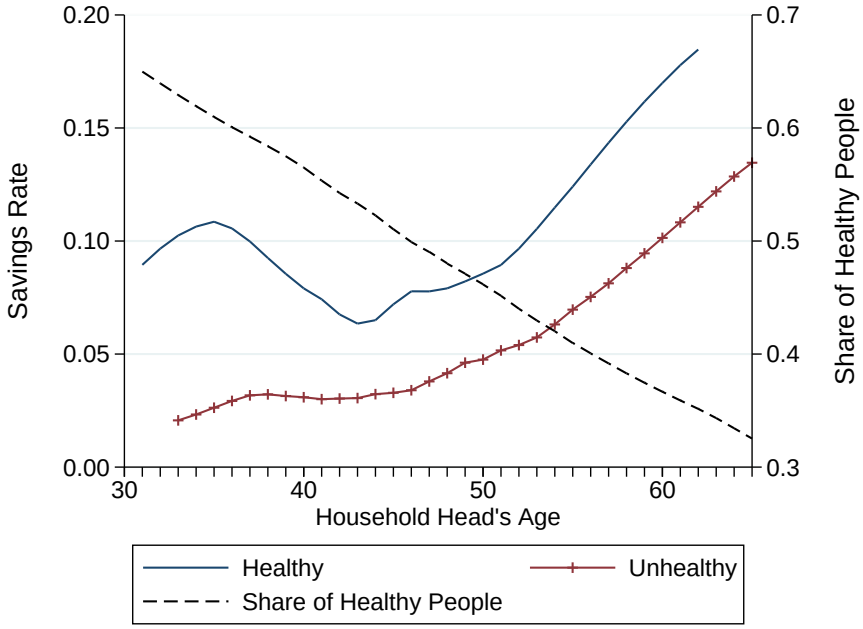
Source: Chinese Household Income Project, 1995, 2002.

Figure 11: Age Pattern of Transfer Expenditure in 2002



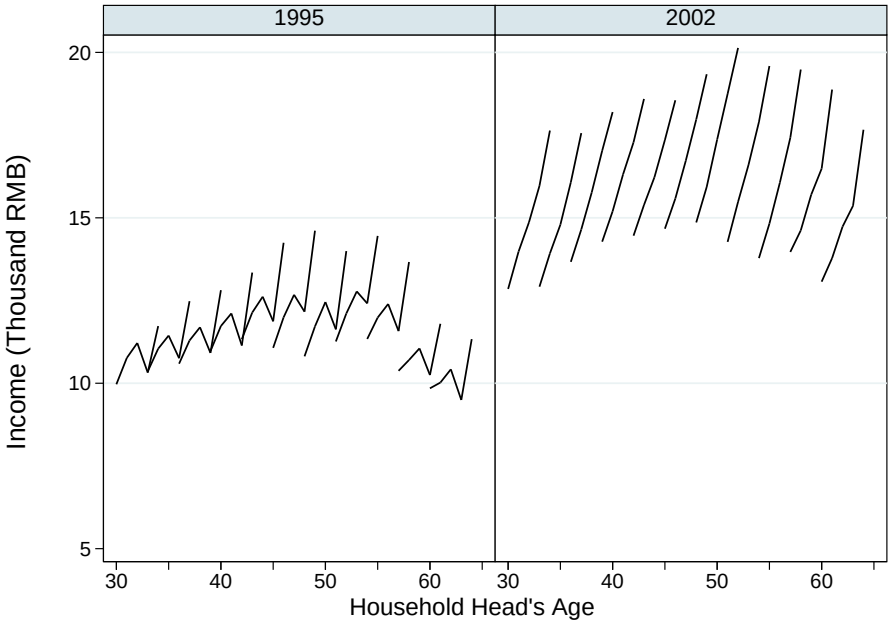
Source: Chinese Household Income Project, 2002.

Figure 12: Age Pattern of Chinese Saving Rate by Health Status



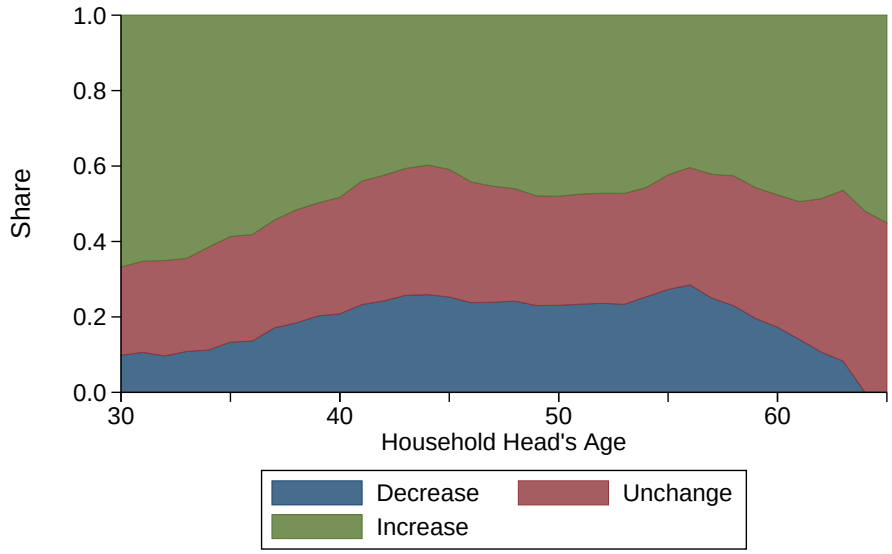
Source: Chinese Household Income Project, 2002.

Figure 13: Life Cycle Profile of Income



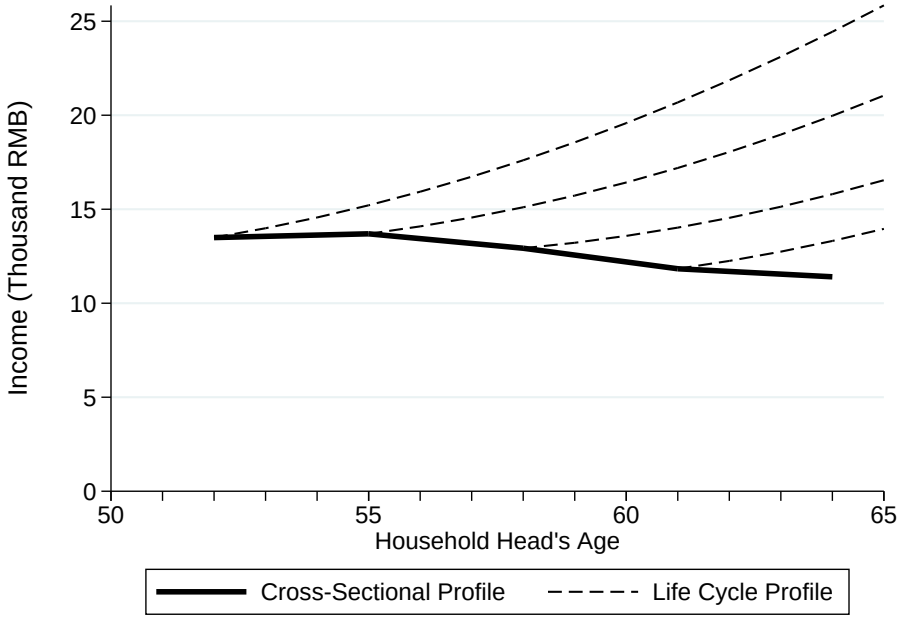
Source: Chinese Household Income Project, 1995, 2002.

Figure 14: Expectation of Future Income Change (2002)



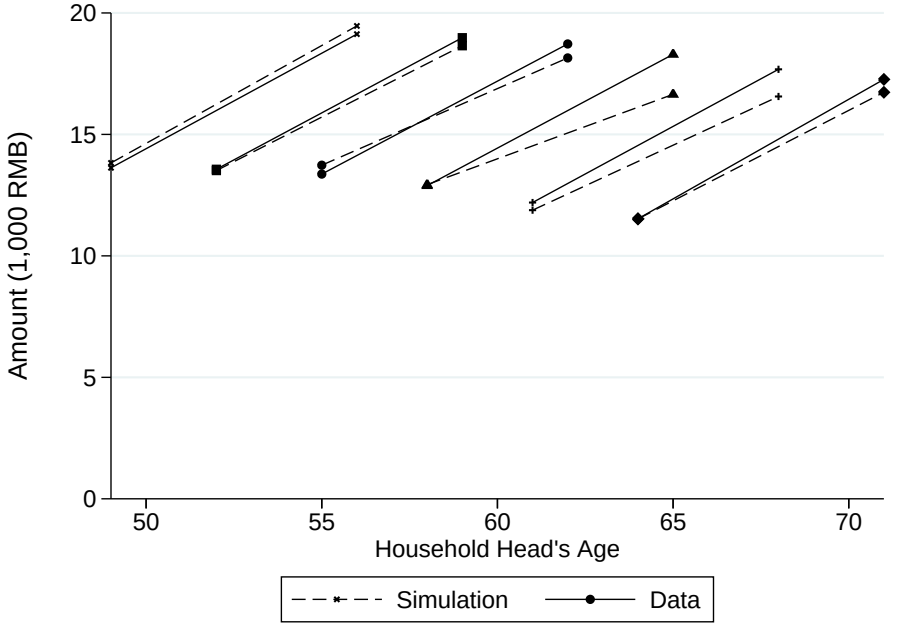
Source: Chinese Household Income Project, 2002.

Figure 15: Cross-Sectional Profile versus Predicted Life Cycle Profile of Income in Year 2002



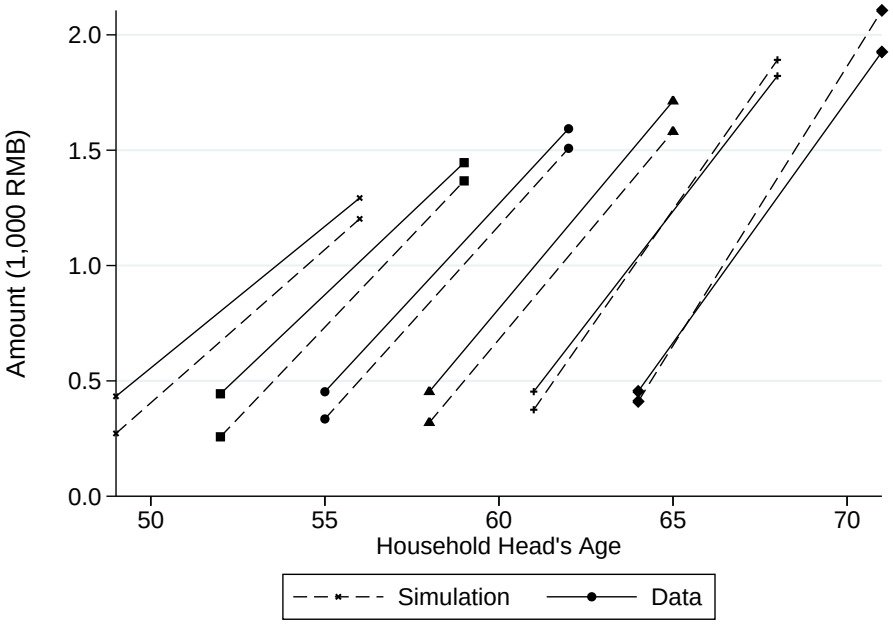
Source: Chinese Household Income Project, 1995, 2002.

Figure 16: Match of Income



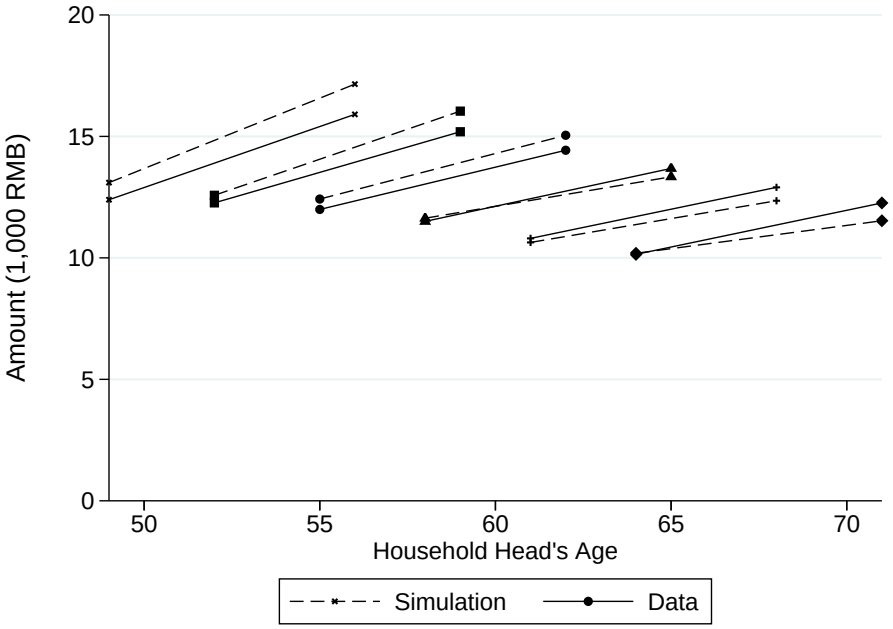
Source: Chinese Household Income Project, 1995, 2002.

Figure 17: Match of Medical Expenditure



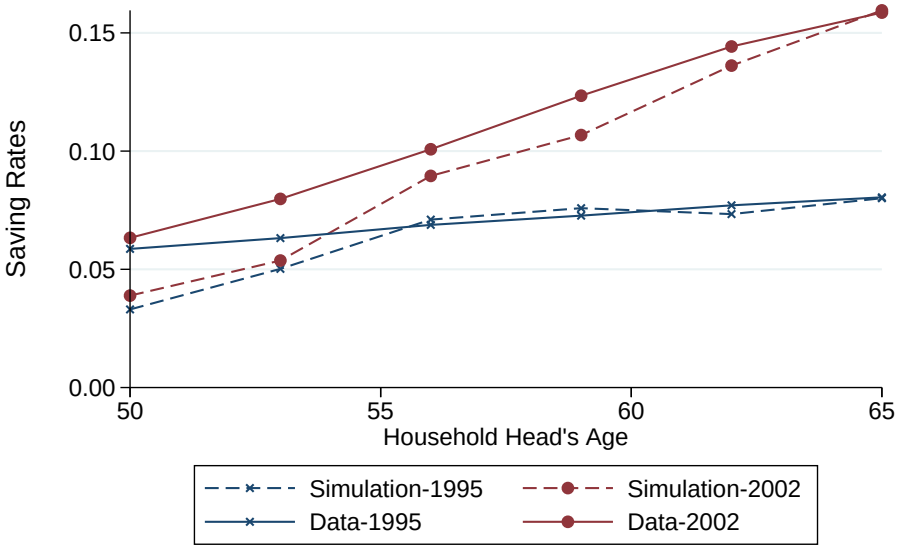
Source: Chinese Household Income Project, 1995, 2002.

Figure 18: Match of Consumption



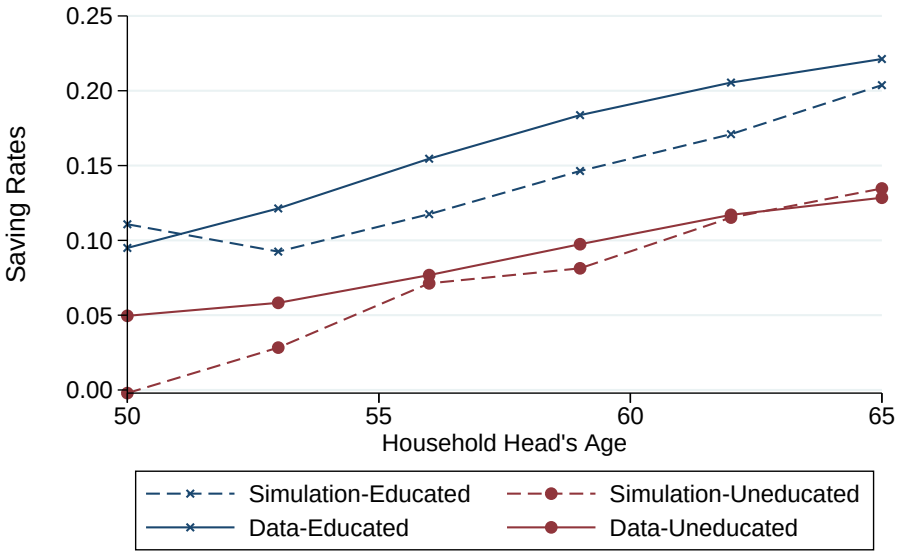
Source: Chinese Household Income Project, 1995, 2002.

Figure 19: Match of Saving Rates for Different Waves



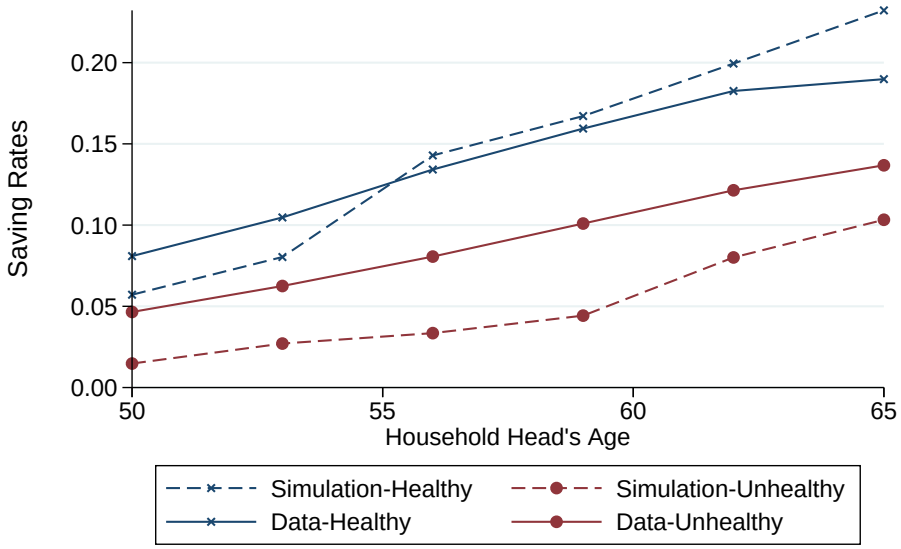
Source: Chinese Household Income Project, 1995, 2002.

Figure 20: Match of Saving Rates for Different Education Level



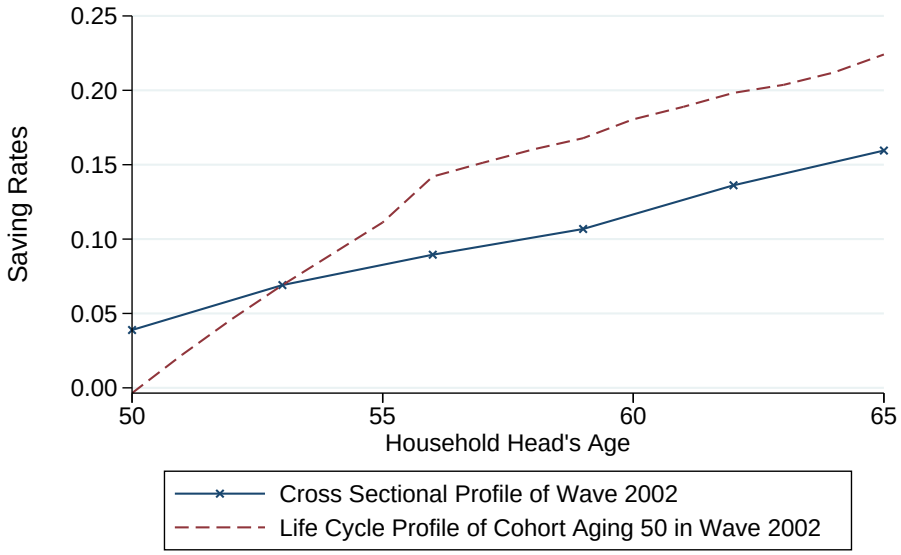
Source: Chinese Household Income Project, 1995, 2002.

Figure 21: Match of Saving Rates for Different Health Status



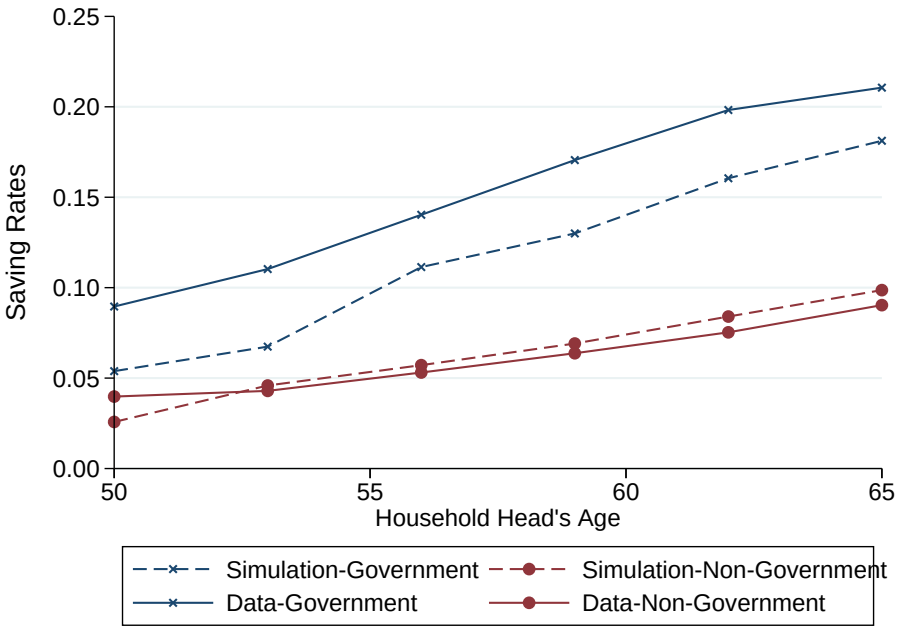
Source: Chinese Household Income Project, 1995, 2002.

Figure 22: Comparing Life Cycle Profile and Cross Sectional Profile



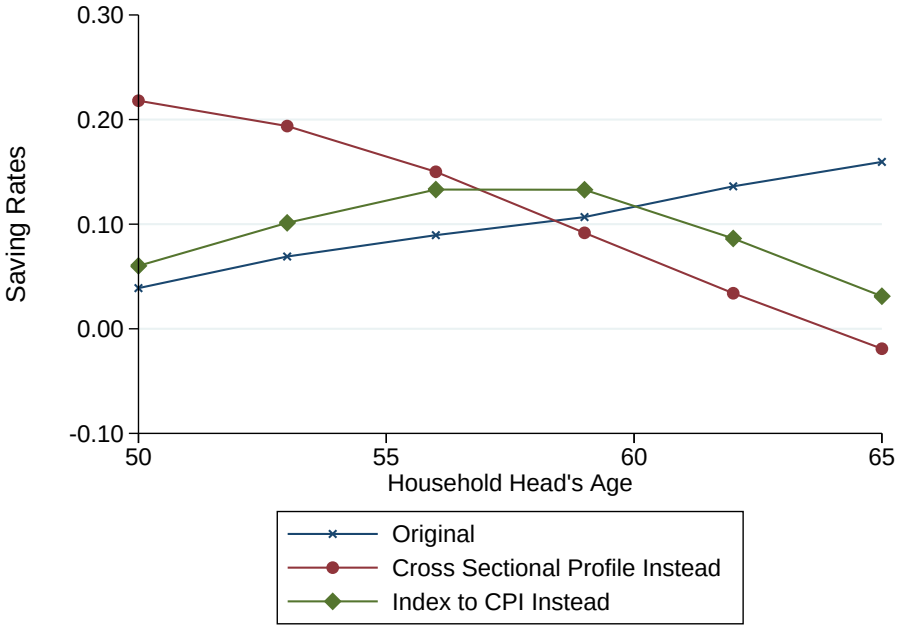
Source: Chinese Household Income Project, 1995, 2002.

Figure 23: Match of Saving Rates for Different Employment Types



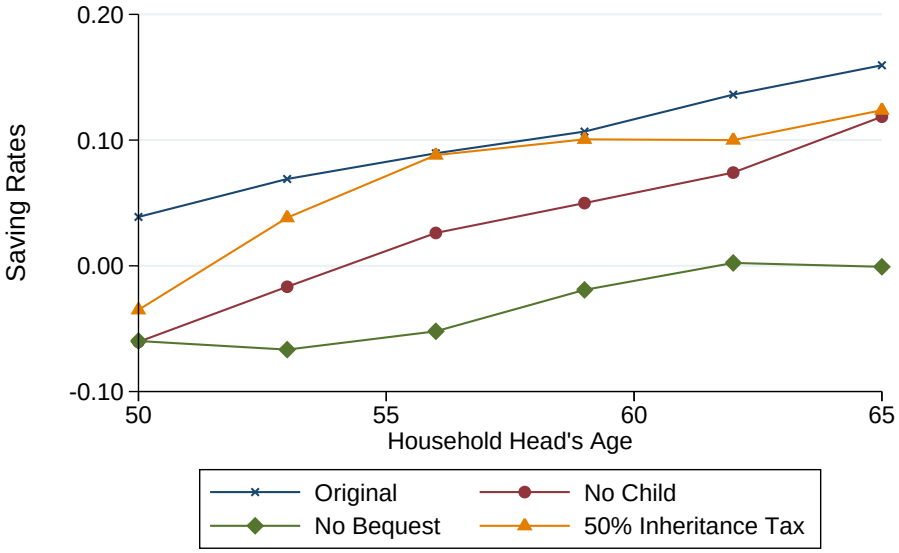
Source: Chinese Household Income Project, 1995, 2002.

Figure 24: Experiment 1 - Effect of Pension



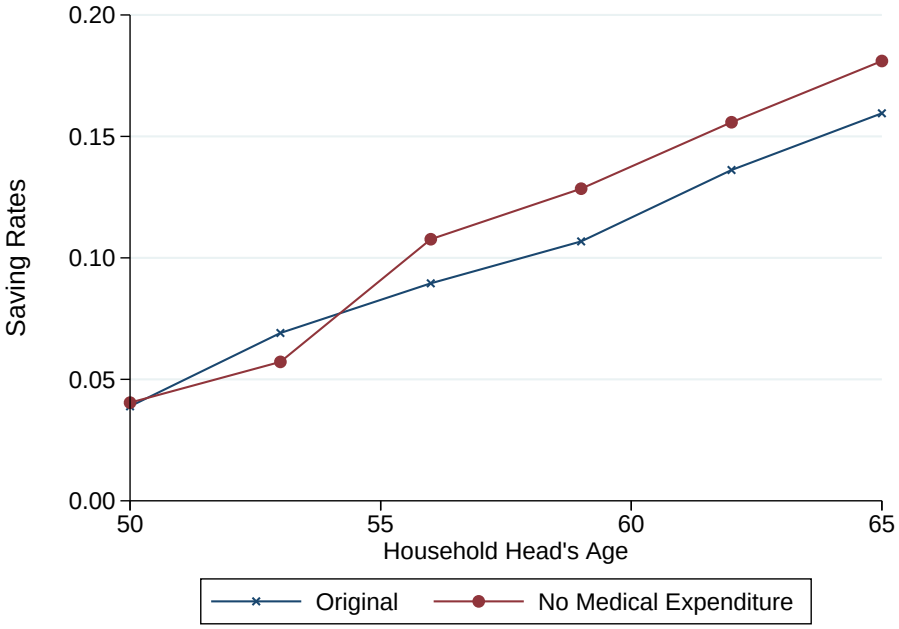
Source: Chinese Household Income Project, 1995, 2002.

Figure 25: Experiment 2 - Effect of Bequest Motives



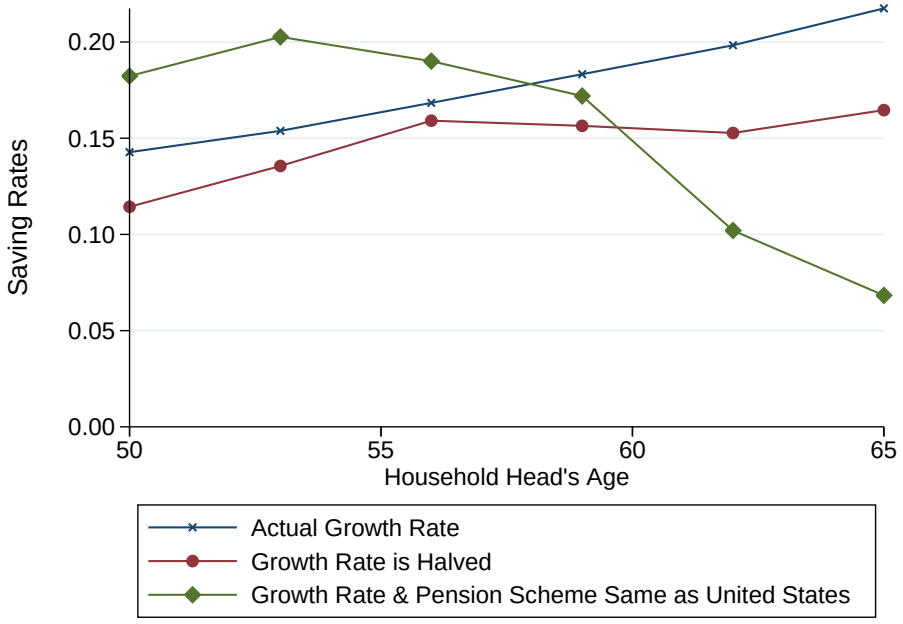
Source: Chinese Household Income Project, 1995, 2002.

Figure 26: Experiment 3 - Effect of Medical Expenditures



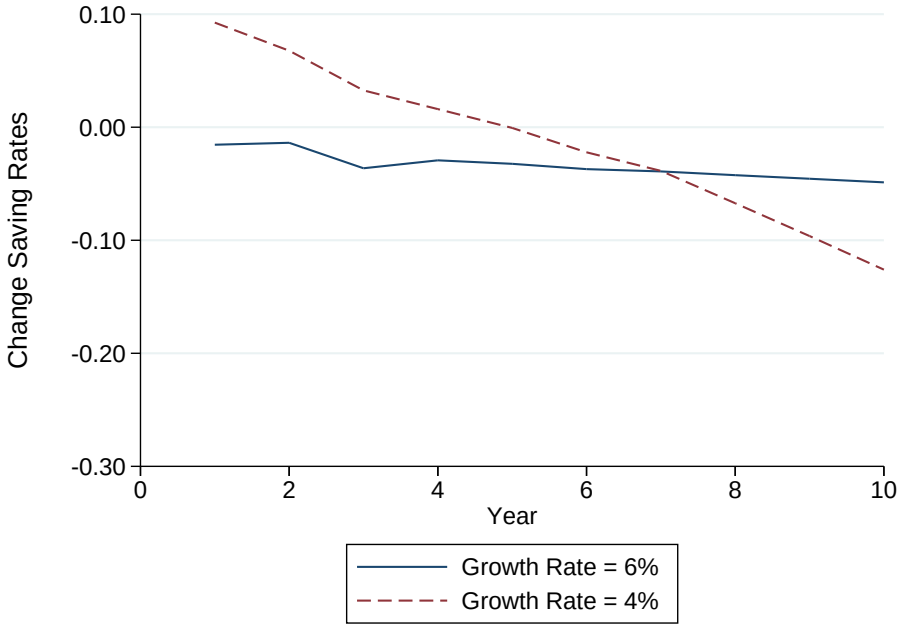
Source: Chinese Household Income Project, 1995, 2002.

Figure 27: Simulation of Cross Sectional Saving Rate with Different Growth Rate



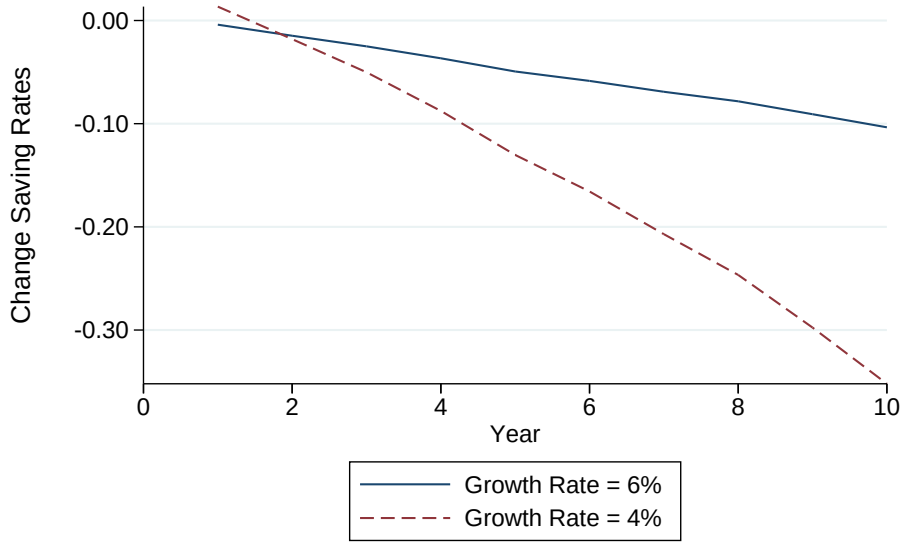
Source: Chinese Household Income Project, 1995, 2002.

Figure 28: Response of a Slowdown in Economic Growth (Age = 50)



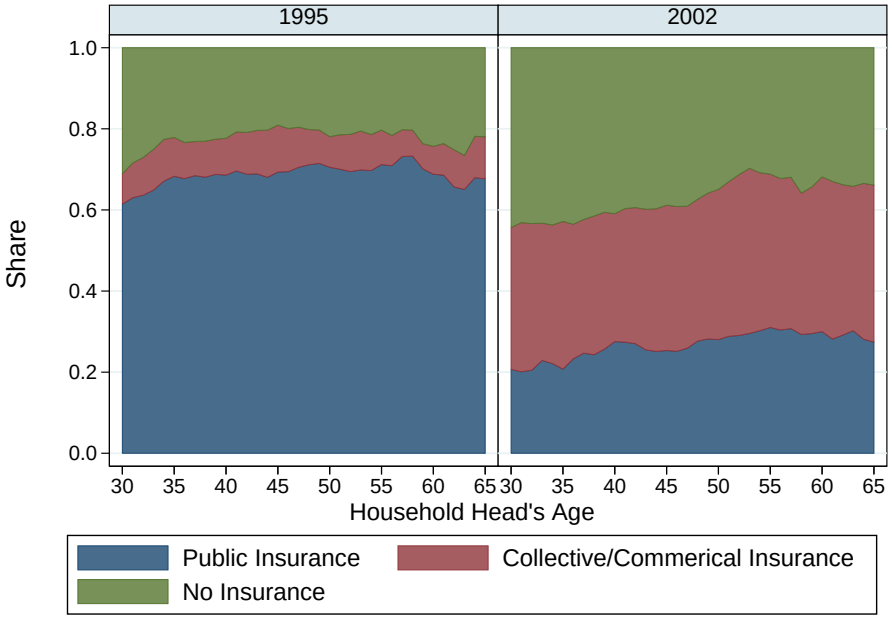
Source: Chinese Household Income Project, 1995, 2002.

Figure 29: Response of a Slowdown in Economic Growth (Age = 60)



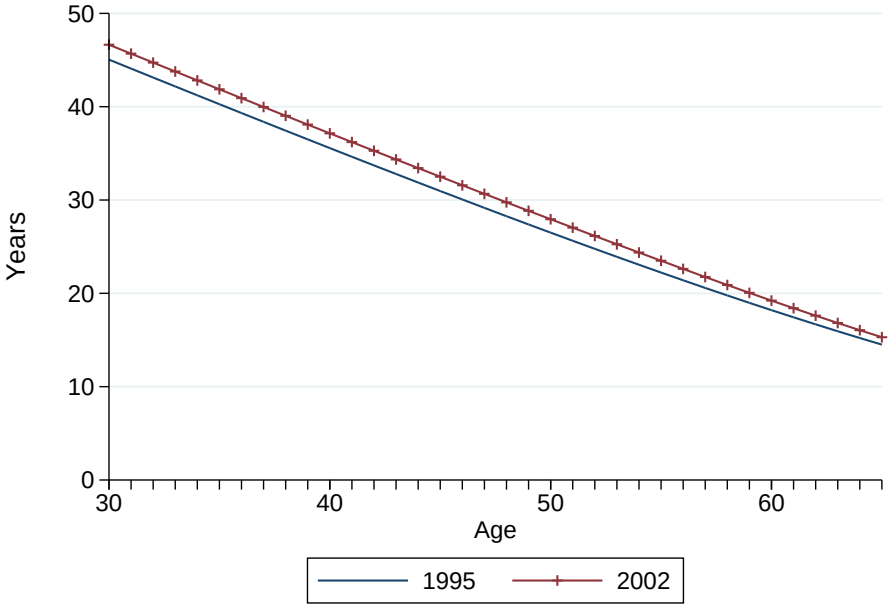
Source: Chinese Household Income Project, 1995, 2002.

Figure A1: Type of Medical Insurance by Survey Years



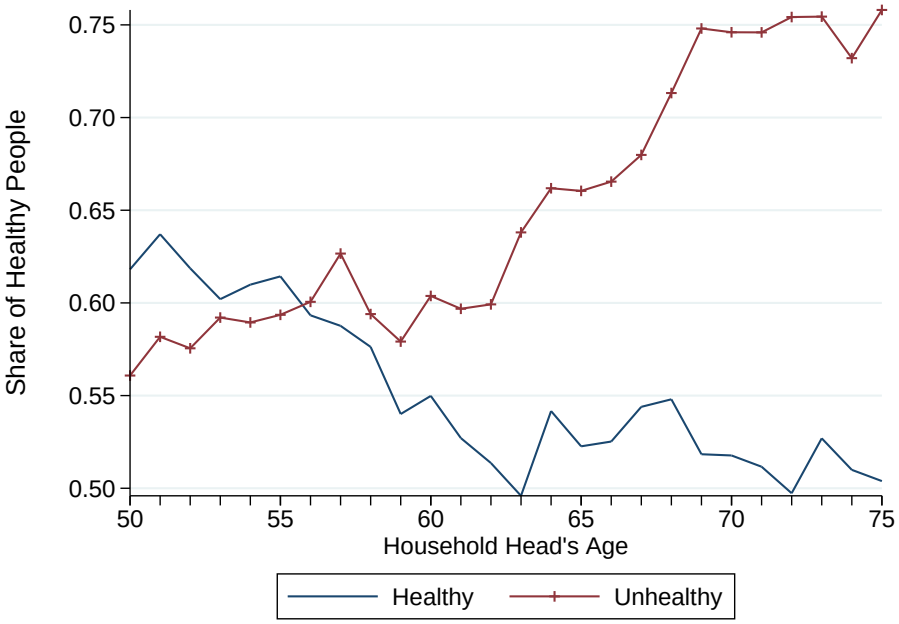
Source: Chinese Household Income Project, 1995, 2002.

Figure A2: Expected Life Remaining



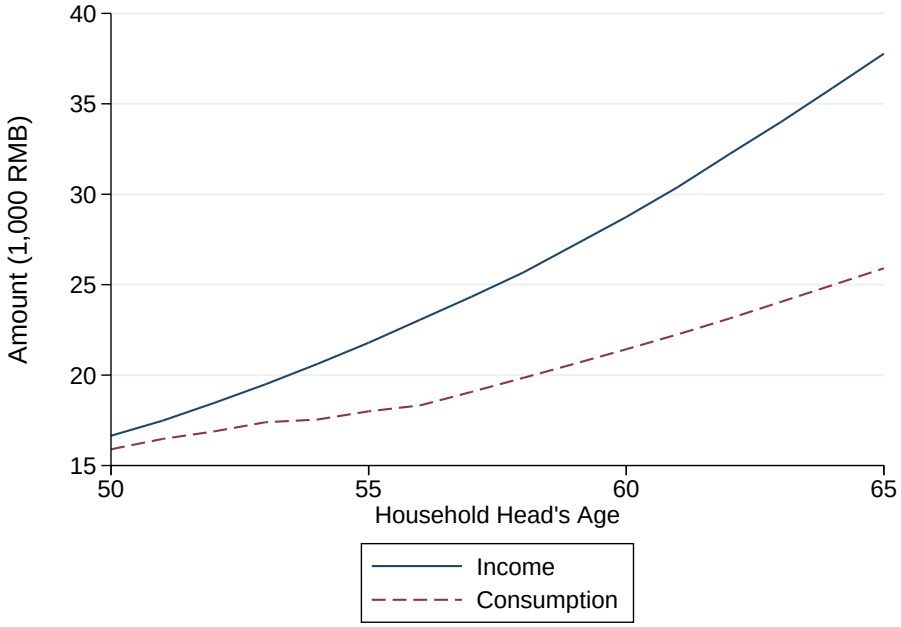
Source: Author's calculation based on mortality rate provided by China Insurance Regulatory Commission.

Figure A3: The Probability Staying in the Same Health Condition



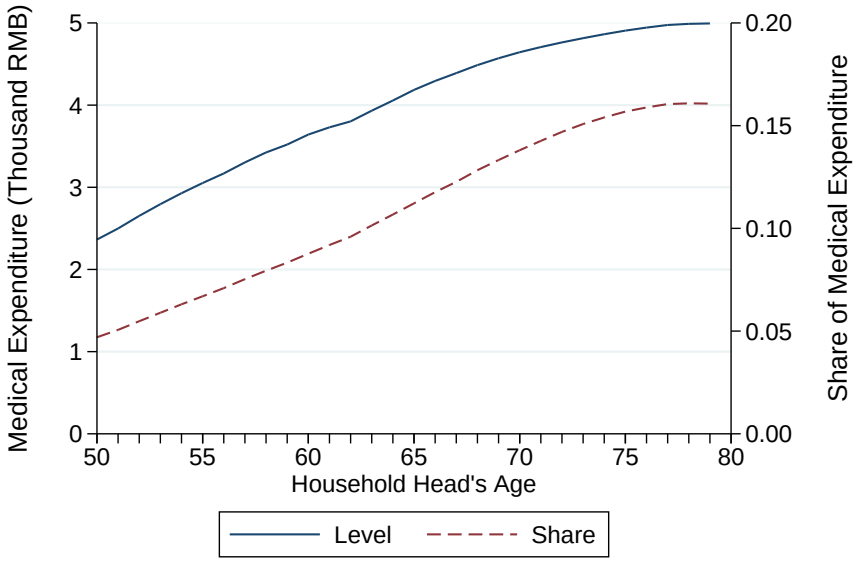
Source: Chinese Health and Nutrition Survey, 1997, 2000, 2004, 2006.

Figure A4: Comparing Life Cycle Profile of Income and Expenditure



Source: Chinese Household Income Project, 1995, 2002.

Figure A5: Medical Expenditure of the Very Elderly



Source: CHARLS, 2011.

Table 1: Test of the Increase in Saving Rates as Households Age

Wave	1995	2002		
Group	All	All	Non-Government	Government
	(1)	(2)	(3)	(4)
Age 50-54	-0.0010	0.0457**	0.0614**	0.0281
	(0.0182)	(0.0218)	(0.0276)	(0.0318)
Age 55-59	0.0245	0.0735***	0.0380	0.119***
	(0.0194)	(0.0276)	(0.0382)	(0.0402)
Age 60-64	0.0258	0.0892**	0.0129	0.186***
	(0.0207)	(0.0357)	(0.0541)	(0.0352)
Age 65-69	0.0143	0.155***	0.108***	0.205***
	(0.0259)	(0.0304)	(0.0407)	(0.0454)
Educated	0.0446***	0.0305	-0.0005	0.0674***
	(0.0148)	(0.0209)	(0.0350)	(0.0241)
Government	0.0154	0.0431**		
	(0.0141)	(0.0197)		
Observations	2,069	2,338	1,297	1,041

Source: Based on data from the Chinese Household Income Project, 1995 and 2002.
Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors are provided in parentheses. Province dummies are controlled but not reported.

Table 2: Difference in Replacement Rates Across Provinces Before National Reform

Province	Replacement Rate (%)
Beijing	75
Shanxi	95
Jiangsu	65
Henan	75
Hubei	85
Guangdong	70
Chongqing	95
Sichuan	95
Yunnan	71

Source: World Bank (1997)

Table 3: Estimation of the Effect of Increased Pension Income on Saving Rates Treating the Pension Reform as an Exogenous Shock

Dependent Variables	log(Income)	log(Expenditure)	Saving Rate
	(1)	(2)	(3)
Junior High	0.136***	0.135***	0.0420
	(0.0144)	(0.0157)	(0.0265)
Senior High	0.250***	0.227***	0.0888***
	(0.0148)	(0.0158)	(0.0268)
College or Above	0.440***	0.416***	0.106***
	(0.0169)	(0.0177)	(0.0305)
Female	-0.136***	0.0254***	-0.302***
	(0.00822)	(0.00825)	(0.0146)
Age	0.0281***	0.0258***	0.00692
	(0.00256)	(0.00280)	(0.00484)
Age Squared/100	-0.0219***	-0.0231***	-0.000749
	(0.00274)	(0.00307)	(0.00522)
Retired	-0.520***	-0.183	-0.701***
	(0.118)	(0.117)	(0.219)
After Reform	0.420***	0.384***	0.0270
	(0.116)	(0.116)	(0.198)
ΔReplacement Rate*Retired	-0.417***	-0.167	-0.605**
	(0.147)	(0.153)	(0.276)
ΔReplacement Rate*After	0.247*	0.234*	0.00774
	(0.139)	(0.139)	(0.232)
Retired*After	0.416***	0.113	0.615**
	(0.150)	(0.148)	(0.274)
ΔReplacement Rate	0.383**	0.0760	0.685**
*Retired*After	(0.186)	(0.194)	(0.347)
Observations	11,380	11,499	11,380

Source: Based on data from the Chinese Household Income Project, 1995 and 2002.
Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors are provided in parentheses. Province dummies and industry dummies are controlled but not reported.

Table 4: Placebo Test of Pension Reform

Wave	1995	2002
	(1)	(2)
Junior High	0.157***	0.114***
	(0.0194)	(0.0213)
Senior High	0.238***	0.265***
	(0.0198)	(0.0221)
College or Above	0.380***	0.481***
	(0.0227)	(0.0252)
Female	-0.134***	-0.139***
	(0.0108)	(0.0123)
Age	0.0417***	0.0172***
	(0.00379)	(0.00365)
Age Squared/100	-0.0357***	-0.0115***
	(0.00426)	(0.00372)
Retired	-0.535***	-0.0793
	(0.117)	(0.0903)
Retired*Original Replacement Rate	0.432***	0.0309
	(0.149)	(0.111)
Observation	5,714	5,666

Source: Based on data from the Chinese Household Income Project, 1995 and 2002.
Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors are provided in parentheses. Province dummies and industry dummies are controlled but not reported.

Table 5: Distribution of the Objective Question "*I want to leave as large a bequest as possible to my children*"

	Urban Households	
	Observations	Percentage
I think so	81	17.69%
I tend to think so	205	44.76%
I can't say one way or the other	127	27.73%
I tend not to think so	38	8.3%
I do not think so	7	1.53%
Total	458	100%

Source: Yin (2010)

Table 6: Distribution of the Objective Question "*Who Can Be Relied On for Old-Age Support*"

Sample	Below 50	50-60	Above 60
Children	36.07%	31.71%	28.68%
Savings	8.00%	3.36%	2.65%
Pension or retirement salary	50.15%	59.34%	63.51%
Commercial pension insurance	1.82%	0.93%	0.31%
Other	3.95%	4.65%	4.86%
Observations	987	1,397	1,625

Source: CHARLS 2011.

Table 7: Estimation of Parameters in the Income Process

Parameters	Variable	Estimate (S.E.)
ρ	auto correlation, persistent component	0.8667 (0.0074)
σ_ϵ^2	innovation variance, persistent component	0.0451 (0.0028)
σ_ε^2	innovation variance, transitory component	0.0039 (0.0022)

Table 8: Estimation of Parameters in the Model Using the Method of Simulated Moments

Parameters	Variable	Estimate (S.E.)
θ_0	base bequest motive	97.24 (14.7648)
θ_1	additional bequest motive with children	126.8 (19.4594)
κ	bequest curvature	18.91 (3.1710)
ν	CRRA degree of risk aversion	1.989 (0.1934)
δ_1	preference shifter of health	-1.332 (1.5503)
δ_2	preference shifter of leisure	0.0996 (0.0864)
δ_3	preference shifter of interaction between health and leisure	0.1948 (0.1450)

Table A1: Summary Statistics of Data

Year	1995		2002	
Education	High	Low	High	Low
Age	40.51	47.03	42.83	48.69
	(9.72)	(10.48)	(8.78)	(10.34)
Government	0.57	0.28	0.56	0.34
	(0.49)	(0.45)	(0.50)	(0.47)
Healthy			0.57	0.44
			(0.49)	(0.50)
Disposable Income	13.94	11.94	21.39	15.84
	(5.62)	(5.21)	(9.78)	(8.07)
Income Lagged 1 Year	11.78	10.26	19.72	14.49
	(5.92)	(5.36)	(9.23)	(7.79)
Income Lagged 2 Year	12.58	10.97	18.23	13.62
	(5.86)	(5.44)	(8.55)	(7.30)
Income Lagged 3 Year	11.97	10.65	16.87	12.85
	(5.81)	(5.36)	(8.06)	(6.98)
Income Lagged 4 Year	11.13	10.00	15.64	12.11
	(5.61)	(5.15)	(7.62)	(6.70)
Total Expenditures	12.94	11.51	19.64	14.95
	(5.33)	(5.05)	(9.79)	(8.12)
Total Assets	23.88	22.10	110.10	83.83
	(26.95)	(26.73)	(83.30)	(74.85)
Observations	2,072	3,039	2,280	2,447

Source: Based on data from the Chinese Household Income Project, 1995 and 2002.

Note: Standard errors are provided in parentheses.