Population Aging and Economic Growth:

Will the population aging reduce household saving in China?

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Abstract

Over the next three decades, from 2010 to 2040, China is projected to have a population increase of 15.7 percent in its population aged 60 years or over. This dramatic increase would be the fastest in the world. One of the likely major consequences of this demographic transition is a downward pressure on household saving rates as the life cycle hypothesis (LCH) suggests. This paper uses a household saving model to analyze the effects of demographic factors on household saving rates in China. The regression results suggest that the increasing proportion of elders in China would have a positive impact on household saving rate. This finding implies that the population aging transition in China would not put a downward pressure on household savings and hence on economic growth.

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Contents

I. Introduction

Population aging refers to an increasing proportion of the elder population. Aging has already become the dominant demographic trend globally. From the perspective of economic growth, demographic transition is always considered an essential factor towards the economic growth. On one side, aging has its most direct influences on the labour market. With an increasing number of elders and decreasing number of youths, the aging population would directly reduce the labor supply and, thus, might negatively impact productivity and economic growth. On the other side, the effect of aging has is felt on the households and national savings, and, thus, capital accumulation, investment, and real output. In China, the ratio of the working-age (15 years - 64 years) to the non-working-age population reached its peak in 2010 and is expected to decrease nearly to its 1980 level at the end of 2050. This phenomenon is mainly due to the rapidly increasing number of elderly people and decreasing number of younger people (Banister, Bloom, and Rosenberg, 2010).

According to the simple life-cycle model of consumer behavior, after retirement, elderly people do not save their money anymore but run down the savings they accumulated during the working years. Increasing the number of the elders, thus, leads to a decrease in the total saving rate. The purpose of this paper is to use empirical evidence to assess the aging-saving and saving-growth relationships, respectively in China. Leff (1969) and Modigliani (1970) provided strong empirical evidence for a significant positive relationship between economic growth and saving rates. Leff and Modigliani conclude that the higher the aggregate saving rate, the higher the level of capital accumulation and, thus, the faster the economic growth, and vice versa (Lee and Mason, 2007; Solow, 1956). What was already known is that "the

higher the saving rates, the higher the economic growth" (Deaton & Paxson, 2000). Therefore, this paper will mainly focus on measuring the relationship between aging and saving.

Among existing theories on saving and aging relationship, the most notorious is the one that uses the life-cycle hypothesis (LCH), introduced by Franco Modigliani in early 1950s. This hypothesis argues that individuals smooth consumption over their lifetimes given their expected lifetime resources. In early ages (under 16 years), young individuals do not have income and depend on their parents; thus, they do not accumulate savings. In mid-ages, individuals earn income and save for the retirement; therefore, their saving rate would be positive. After retirement, individuals do not have income, the retired individuals run down their accumulated savings; their saving rate is accordingly negative. According to this hypothesis, population aging has a direct and significant effect on saving rates: aging is traditionally believed to reduce aggregate saving rates because people who are initial savers will reduce and the dis-saving fraction will rise. The consequence is to decelerate the country's economic growth (Solow, 1956; Lee and Mason, 2007).

However, as the assumptions in the LCH model are simplistic, there are some potential problems and possible flaws. For example, from the "Survey of Consumer Finances" held by the Federal Reserve Board in 1993, Carroll (1997) notices the survey result reports only 15% respondents reveal their primary saving motivation is to finance consumption when they become old. Whereas, 43% respondents show that the primary saving motivation is to prepare for future income emergencies. This outcome indicates that income uncertainty is another essential ingredient when household making saving decisions, which was left out in classical LCH.

Moreover, from the perspective of micro studies, cross-country evidence also show that microdata in some countries would show the elder household dissaving, which is likely to confirm the LCH. However, several studies indicate that this behaviour is not always the fact for different countries at different development stage. Bosworth et al. (1991) find positive saving for people over 65 in both Canada and Japan. Besides, Lyndall (1955) finds slight dissaving of the elderly in data from the United Kingdom, while Statistics Canada (1973) and Borsch-Supan (1992) find positive savings for people aged 65 or over in Canada and West Germany, respectively (as cited in Hassan, Salim & Bloch, 2011).

In addition, some researchers have tried to study the saving-aging relationship based on the dependency ratio. They have obtained similar findings with classical LCH. For example, Leff's (1969) dependency hypothesis is constructed on a life-cycle model by Lewis (1983). Lewis' findings also help to support Leff's (1969) hypothesis that a decline in dependency ratio raises the saving rates. Their econometric estimations show that a 24% to 21% fall in the dependency rate can explain the 6% point rise in the aggregate saving rate from 1830 to 1900. Meredith (1995) estimated that a 10% point rise in old dependency ratio explains a reduction of the savings rate by around 9% while a 0.1% fall in the children dependency ratio would result in an increase in the savings ratio of about 6.1 percentage points. For most developed countries, the evidence supports the significant negative relationship between aging and household saving rates, which is consistent with the LCH hypothesis. (Hassan, Salim & Bloch, 2011)

However, the expected correlation between the dependency ratio and saving rates is insignificantly positive for some developing countries, particularly for those transition

economies such as Brazil, China, Latin American and Caribbean (LAC) countries, although the display of a negative relationship would be expected for developed countries. Such outcome is simply because household saving rates remain high in old age in developing countries (Jorgensen, Rocha & Fruttero, 2011). Jorgensen (2011) also found significant empirical evidence for Brazil that the old-age dependency ratio has a positive relationship with private saving rate, both in the short run and long run.

Based on this large number of studies, there is still no consensus on the question of whether the saving rate can be understood purely using the life-cycle hypothesis. Furthermore, will the demographic shift in China also have an impact on the saving rate in that country? This paper will focus on China since this country is experiencing its great transition period. Huge variations in both demographic structure and household saving rates are taking place in recent decades and may continue in future. Over the past few years, the demographic structure shifted to a new regime in that country. The younger generations have fewer or even no siblings, middle-aged generations have fewer dependent children, and elder generations have fewer adult children. In traditional Chinese families, the younger generations need to support their retired parents. Consequently, with fewer siblings, the young generations will save more to support the heavier burden of providing upstream transfer to their parents. With fewer dependent children, a household can consume less and save more due to the lighter burden of childcare and education expenses. The older household has more incentive to save for old age security due to the reduced number of children. However, it seems that, since China has entered into the population-aging phase, the household saving rate has been kept high and has even increased. Therefore, one may therefore ask whether the high saving rates

in China can be understood only regarding the life-cycle hypothesis---the idea that people save during their working age for retirement, and elder households dis-save. The current situation in China is very similar to Jorgensen (2011)'s finding for Brazil, the household saving rates remain high in old age, in which the saving trend does not follow the pattern predicted by the LCH hypothesis. To be more specific, this paper will concentrate on whether the household saving rate is significantly influenced by the demographic factors in China. The precise research question is to examine the relationship between population aging and household saving rate in China by using annual time-series data.

The rest of the paper is organized as follows: section 2 provides a brief description of current aging and saving circumstances in China. Section 3 reviews some literature on the studies of the relationship between aging and savings. Section 4 presents the model in detail and discusses the empirical results. Section 5 concludes.

II. Population aging and saving in China:

2.1. Aging trends in China

China experienced a rapid demographic change in past three decades. Like most other developed countries, population aging concerns resonate in China. In 2014, 9 percent of the population was aged 65 and over. More than 30 percent of the population will be aged 60 years and over in 2050[1]. Remarkably, the proportion of the population over 80 years old (the oldest-old) is considerable compared with other countries. Twenty-three million people aged 80 years old or over lived in China in 2013, which is the largest population all around the world for people in that oldest group. Equally important, China will reach 90 million for people aged 80 years and over in 2050, this number is still the highest in the world. Additionally, China has its very unique pattern for population aging due to the extraordinary high speed of its aging process. For instance, to change the portion of people aged 60 years old and over from 7% to 14%, France spent 115 years; Sweden spent 85 years and the United States took approximately 69 years. In contrast, according to World Population Aging Report (2013), it will only take 26 years in China. Among the four BRIC[2] countries, which are at a similar development stage, China also has the fastest aging speed (Figure 2.1). From 2012 to 2050, the population aged 60 years and over will increase about 20%; this speed is 1.5 times that of Brazil and twice as fast as India and Russia.

The fundamental causes of China's aging demographics are similar to the ones in the other aging countries. The increased life expectancy, the decreased fertility rate as well as the

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[1] The data is collected and summarized from "population aging and development 2010". Published by United Nations Department of Economic and Social Affairs, Population Division, http://www.un.org/en/development/desa/population/publications/

[2] From perspective of economics, **BRIC** refers to a grouping acronym that including the countries of **B**razil, **R**ussia, **I**ndia and **C**hina, which are all deemed to be at a similar stage of newly advanced economic development.

age structure dynamics are three key factors that result in the population aging in China (Judith, B., David E. Bloom., & Larry, R., 2010).

Firstly, the fast growing number of elder households and the lower mortality, together, promote the elderly proportion's rapid climb. As predicted in the Population Aging Report (2013) of United Nations, this trend will continue in the future. In the next 30-year period, from 2010 to 2040, China will see an increase of 15.7 in the proportion aged 60 years or over, from 12.4 percent to 28.1 percent. This increase will be the fastest in the world. Such rapid speed of aging is mainly due to the better living conditions and longer life expectancy in China. Greater longevity has obviously been a key factor in population aging. In the 1960s, Chinese people would expect to live for only 43 years old on average. In 2010, the average life expectancy reached 74.83 years with 77.37 years for females and 72.38 years for males. By 2050, this number is expected to reach nearly 80. The increased life expectancy is very sensitive to the declines in mortality rate and, thus, induces a very high speed of population aging in China. Moreover, the baby boom generation in the 1960s moves through the population age structure. Shortly, they gradually become a relatively large group of older generations in the near future. Due to this factor, population aging is expected to accelerate rapidly as more of the baby-boom generation enters to their 60s.

Secondly, the rapid decline in fertility rate is another essential factor. After the introduction of the "one-child policy" in 1979, a substantial decline in fertility took place from 1979 to 1980. The population growth rate has decreased significantly as a result. Total fertility rate dropped from 6 in 1950-1955 to 2 in 1990-1995 (Figure 2.2). In 1995, the fertility rate was roughly below 2. The one-child policy was even stricter in the urban areas.

In a very short period, the fertility rate in the urban areas fell considerably, dropping from 3 children per family to just 1 child per family during the 1970s to 1980s. The fast declining number of births in China has produced a larger proportion of aging population. Since in the 1990s, the declining number of births simulates its population aging process faster than in many other developing countries.

Moreover, as a result of the falling fertility rate, the ratio of the working-age (15-64) to non-working-age population grew rapidly starting in the late 1970s, as previously mentioned. This ratio reached its peak right in recent years and is projected to decline (in significant part because of the increasing elderly population) to nearly its 1980 level by 2050 (Banister, Bloom, and Rosenberg, 2010). The dependency ratio is an important ratio for measuring the number of dependents needing to be supported by each person, on average, especially in a society where children are a source of old-age support and the social pension system is still under development. In China, the youth dependency ratio[3] had a sharp decline from 68% to 37% from 1988 to 2007, while the elder dependency ratio[4] increased sharply during this period (Figure 2.3A, B). The elder dependency ratio will increase to roughly 38.9 percent in 2050, which is even higher than predicted for Japan (37.8%) and US (21.6%) in that year. Thus, the change in dependency ratio may exert a significant impact on the household saving decision in China (Judith, B., David E. Bloom., & Larry, R., 2010).

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[3] Definition from World Bank: Youth Age (children) dependency ratio is the ratio of younger dependents (people younger than 15) to the working-age population--those ages 15-64. Data are shown as the proportion of dependents per 100 working-age population.

[4] Definition from World Bank: Old Age (Elder) dependency ratio, is the ratio of older dependents (people older than 64) to the working-age population--those ages 15-64. Data are shown as the proportion of dependents per 100 working-age population.

Figure 2.1

Historical and projected sizes of population aged 60 or over for BRIC countries:

2012- 2050

Population aged 60 years or over						
	Number (thousands)		Proportion of total population (percentage)		Share of persons aged 80 years or over (percentage)[1]	
	2012	2050	2012	2050	2012	2050
Country or area						
China	180690	439206	13	34	11	22
India	100213	323092	8	19	9	14
Russia	26498	39338	19	31	16	19
Brazil	21650	64686	11	29	15	23

Note:

1. Persons aged 80 years or over (the "oldest old") as a percentage of the population aged 60 years or over.

Source: United Nations Report: Population aging and development 2012

Figure 2.2
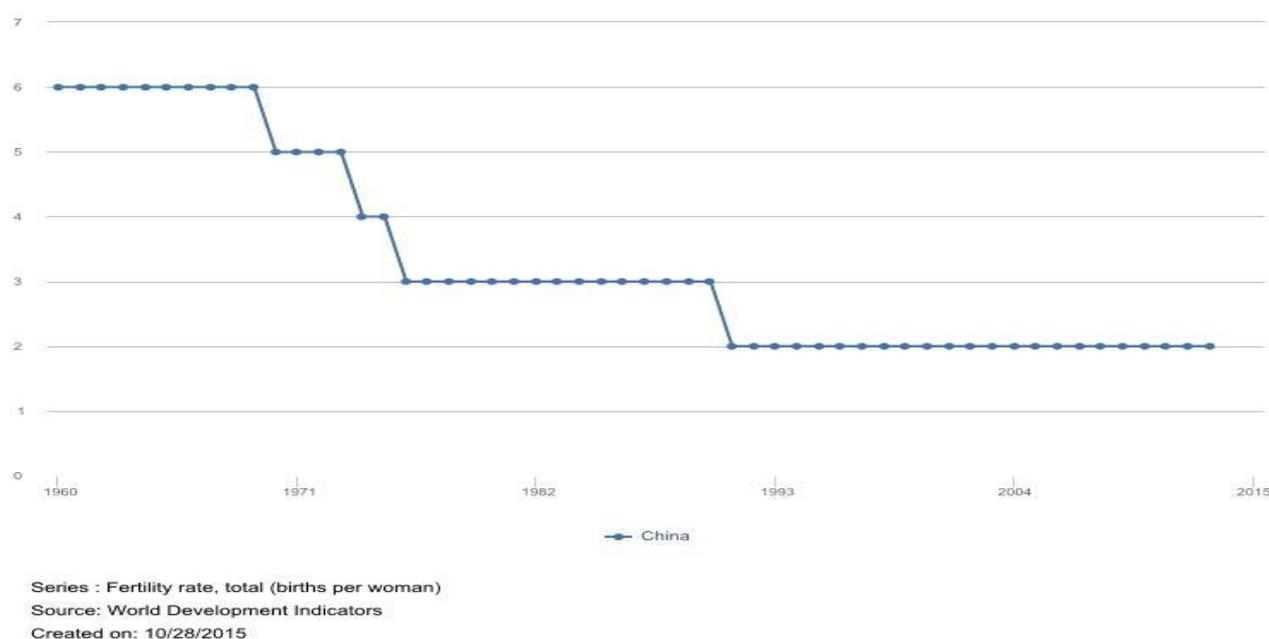
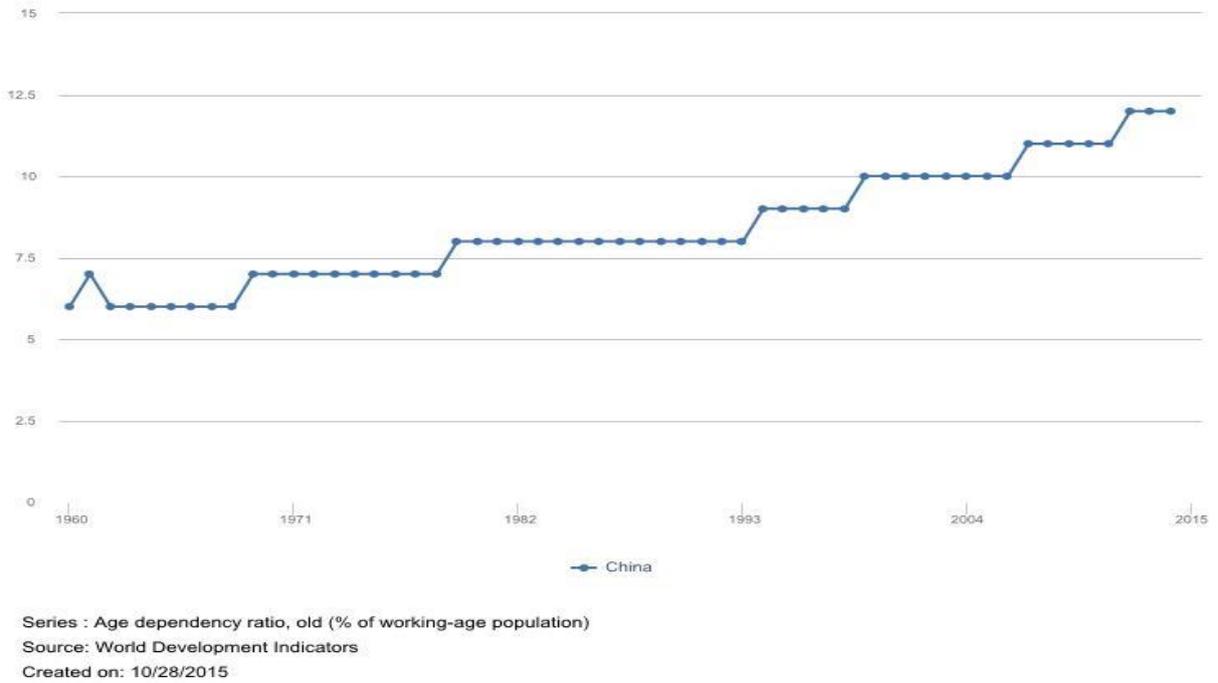Fertility rate, total (births per woman)

Series : Fertility rate, total (births per woman)
Source: World Development Indicators
Created on: 10/28/2015

Figure 2.3A

Age dependency ratio, old (%)

Series : Age dependency ratio, old (% of working-age population)
Source: World Development Indicators
Created on: 10/28/2015

Figure 2.3B
Age dependency ratio, young (%)

Series : Age dependency ratio, young (% of working-age population)
Source: World Development Indicators
Created on: 10/28/2015
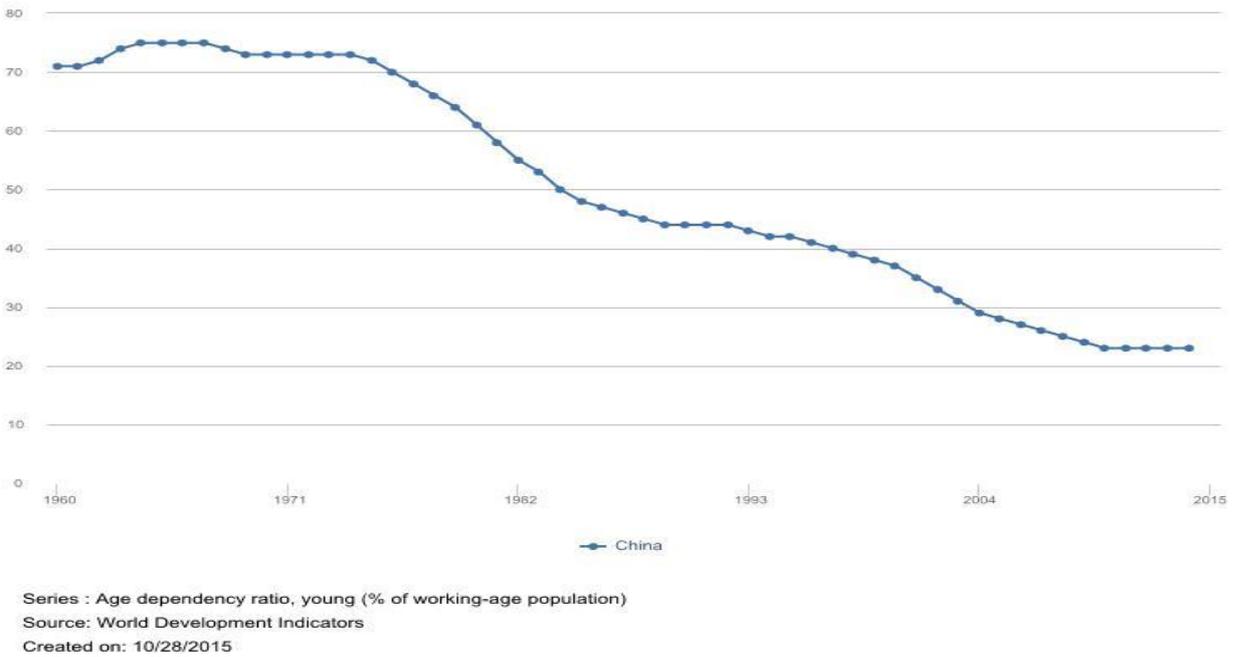
2.2. Saving in China

Over the same period, when a dramatic demographic transition took place in China, a dramatic evolution of China's household saving rate began to take place as well. However, historically, the household saving rate in China has not always been high. Before 1978, the household saving rate was, on average, lower than 5%. Until 1978, the saving rate started to rise. In a short six-year period, from 1978 to 1984, the household saving rate increased by 15% (CC. Curtis., S. Lugauer., & NC Mark, 2011). Then, after a decline to 10% in 1987, the saving rate has since recovered to a general upward trend until today, which reached at around 27% at the end of 2010（Figure 2.3A and Figure 2.3B）.

The high saving rate has greatly contributed to China's economic growth in the past three decades. In the 1980s, the ratio of gross national saving to GDP was only about 35 percent. However, in the 1990s, this rate grew to 41 percent. After China joined the World Trade Organization (WTO) in 2003, the growing speed of aggregate saving was even faster, climbing from 38 percent to 53 percent from 2000 to 2007. Since 2000, China has been the country that has the highest national saving rate worldwide, far surpassing the saving rates in Korea, Japan, and other East Asian countries. Because the growth of corporate profits outpaced that of household income, although the household saving rate declined as the fraction of China's total savings, household saving nonetheless climbed robustly (Mees and Ahmed, 2012). In comparison, the household saving rate in OECD countries[5] rose from 6 percent to 16 percent of GDP from 1978 to 2009, while the household saving rate in China

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[5] OECD countries: abbreviations for "Organization for Economic Co-operation and Development."

climbed from 12 percent to 27 percent of GDP during the same period. This exerts far-reaching implications for both the Chinese economy and the rest of the world.

Several factors can be considered to explain China's high saving rate. One of the fundamental factors is the undeveloped social security system. The level and scope of existing social security system in China is far from sufficient coverage. The current system mostly covers urban citizens, but cannot cover all the rural residents even though they occupy a larger portion of the total population. Although the Chinese government is on the way to improve the social security system, the massive size of a more than 1.3 billion population brings several challenges. Developing an effective pension program for 1.3 billion people is an extraordinarily difficult project. In the short term, it is unlikely that Chinese people will enjoy the full benefits and totally rely on the social benefits. As a result, they will have to rely on their own savings to support themselves after retirement and continue saving behaviour even after retirement. Moreover, the one-child policy has exacerbated this problem. The tradition in China requires adult children to support their parents. In the future, one single child needs to support two parents and maybe four grandparents, which would be a greater pressure for younger households. In this case, parents have to save more during their working years instead of relying on their children to ensure their preparation for future emergencies.

Similarly, another important reason for high saving rates is for the precautionary saving motivation resulting from the huge structural changes that Chinese households have experienced. China experienced a great transformation, going from a closed economy under tight government control to an open economy with greater reliance on free markets. Such structural changes associated with other political reforms lead to increased income

uncertainty for future planning. For example, numerous people lose their jobs during this transformation period. "The so-called "iron rice bowl"[6] of cradle-to-grave socialism, with guaranteed lifetime employment and benefits, was gradually abolished. Workers in state-owned enterprises (SOEs) have experienced massive layoffs since the 1990s, (Liu, 2014). From this point of view, households have to save more for their unpredictable future income.

Other reasons such as undeveloped financial market, liquidity constraints, high housing prices, and higher cost of education have accelerated the saving rate in China, and even the cultural factor plays a significant role.

As a result, based on some recent studies, the aging-saving profile shows an unusual pattern in China. The household saving rate has had a dramatic increase in the past three decades. The younger and elder generations have higher saving rates in comparison with the early 1990s' levels. The saving rate increased from 16.1 percent to 21.5 percent during the period of 1990 to 2005. According to the LCH, the saving rates tend to be negative in the early working years. Then, in mid-ages, when individuals earn income and accumulate savings for the retirement, the saving rate would be positive. After retirement, individuals do not have income, the retired individuals run down their accumulated savings, and the saving rate is negative. Such a "hump-shaped" life cycle figure is often found in typical cross-sectional studies in other economies (as cited in Ge, Yang & Zhang, 2012). However, the household age-saving figure has a U-shaped pattern in recent years, in China (Figure 2.4). In the early 1990s, younger families had a relatively low saving rate, which increased with

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[6] "Rice Bowl": Definition from Double-Tongued Dictionary, Retrieved 2007-01-02：is a Chinese term used to refer to an occupation with guaranteed job security, as well as steady income and benefits for the entire life span.

the age of households until they reach the age of retirement. Nevertheless, in recent years, younger and elder households show a relatively higher saving rate. This is because the younger and older households expanded their saving rates by over 10% points, much more than middle-aged households (S. Ge, Yang & Zhang, 2012).

Recent studies that have attempted to explain the confusing U-shaped age-saving profiles in China have examined several factors such as the rapid increasing private burden of expenditures on housing, education, and healthcare and the transformation of life cycle earnings profiles and incomplete pension reforms in China (as cited in Ge, Yang & Zhang, 2012)

Figure 2.3A

The domestic saving in China: 1978 - 2012
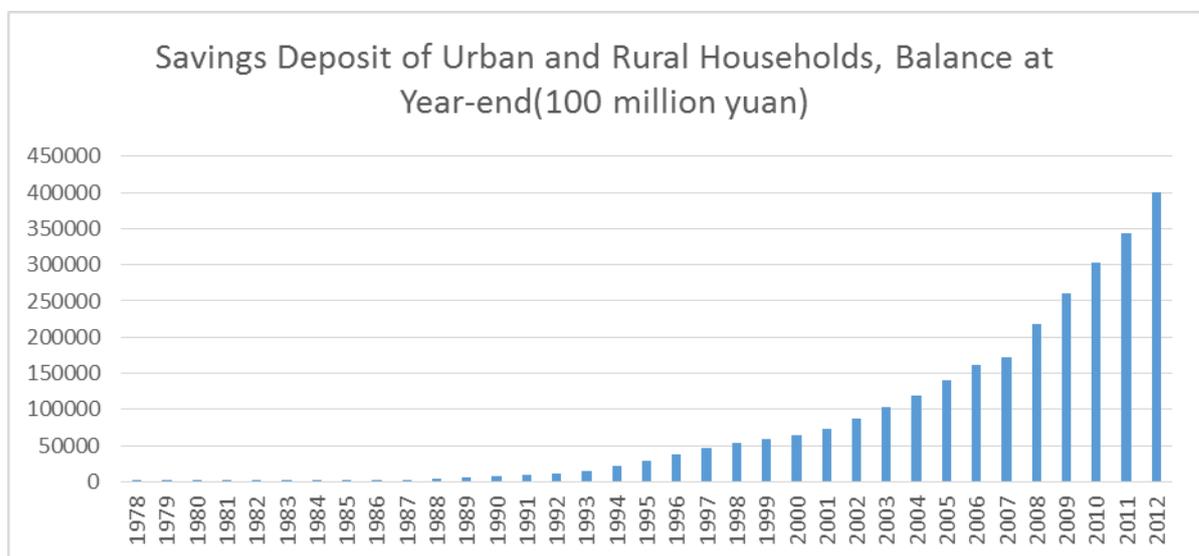
Source: National Bureau of Statistics of China (2015).

Figure 2.3B

The household saving rate in China: 1978-2010

Household Saving Rate in China
1978-2012

Source: National Bureau of Statistics of China. (2015)

Figure 2.4

Age-saving profiles and their changes over time: 1989-1991 to 2004-2006.

A. Average Household Saving Rates in 1989-1991 and 2004-2006

Source: Institution for the study of labor, discussion paper No.7026, 2012

III. Detailed literature review:

Life-cycle hypothesis (LCH) is the analysis of saving behaviour with the demographic transition, rather than steady-state growth. The hypothesis was developed by Modigliani and Brumberg (1954). Studies based on LCH always found a significant negative effect of a large aging population on household saving. Although there is much support for elements of the LCH, there are also exceptions to the saving behavior of the elders. Instead of dis-saving as suggested by the general LCH hypothesis, a large number of elder populations still have strong motivation to increase savings after the retirement age. This is mainly because LCH ignores the factors such as future income uncertainty. Additionally, the uncertainty of future heath expenditure is another critical concern that LCH does not consider. Chou et al. (2013) indicate that the implementation of a comprehensive "National Health Insurance" in Taiwan in 1995 helped to reduce the uncertainty about future medical expenditures, which resulted in an increased consumption and, thus, reduced household saving rates (as cited in AFM Hassan, R Salim & H Bloch, 2011). However, such uncertainties cannot be ignored in analyzing the case of Chinese saving decisions today, as previously mentioned in this paper.

Studies based on youth and elderly dependency ratios that pay a particular attention to the interaction between demographic transition and saving in the course of development include Leff, (1969), Bilsborrow (1980), and Ram (1982). These papers generally find a negative association between dependency ratio and savings, as a decrease in dependency ratio always increases savings, and this conclusion is always true for developed countries. However, for some developing countries like Brazil and Latin American and Caribbean countries (LAC), the expected correlation between the dependency ratio and saving rate is

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insignificantly positive. Jorgensen (2011) finds econometric evidence for Brazil: the elder dependency ratio positively causes household saving rate, in both short and long run. The reason is simply due to the fact that household saving rates remain quite high in old age. This finding is contrary to most literature on developed countries, but not necessarily contrary to what is found in middle-income transition countries.

In addition, there are also studies that are not directly concerned with the age structure, but controls for age in examining the effects of social security on saving, which are highly correlated to age to test its impact on the saving (M. Feldstein, 1995).

Most of the econometric models used would rely on these two variables—household saving and demographic changes, and other explanatory factors. The general form of the assessment of the relation between demographic changes on saving is

$$S=C+\alpha D+\beta Z+\mu \qquad\qquad [1]$$

where S is the household saving rate, C is the constant term, D is a vector of demographic variables and Z is a vector of the other variables such as disposable income and μ is an error term.

In this model, researchers typically use panel data of several countries or regions for this study. Dependency ratios are used to represent the demographic variables. In some studies, the dependency ratio is distinguished between elder and young dependency ratio. For those studies where the dependency ratio is separated into elder and young, the impacts of the elder dependency ratio are generally more significant than those of the youth dependency ratio. According to these studies, the applicability of these methodologies to China is not clear. In recent years, the studies on the aging-saving relation in China are still under way. Different

research methods led to different conclusions, no consensus has emerged. For example, Tang (2007) uses a VAR model to analyze the demographic transition and saving rate in China. He found that both elder and youth dependency ratios have positive effects on savings either in the short term or the long term (as cited in Song & Yuan 2013). Thus, population aging will increase the household saving rate in China. Song and Yuan (2013) also use a VAR model and found that in the long term, the youth dependency ratio has a negative effect on the saving rate but will gradually weaken, while the elder dependency ratio has a positive impact on savings and this effect will gradually strengthen. Various conclusions were reached by using different methods.

Instead of using the VAR model, other studies used the linear regression model. Qian (1988) estimated two basic household saving models. The first is based on the absolute income model (AIM) and the second is based on the permanent income model (PIM). The AIM is based on the Keynesian theory, where a linear relationship exists between current saving and income. While for the PIM, the saving rate is related to permanent income. To be more specific, individuals' consumption and, thus, savings are smoothed along the lifespan of the individuals. The impact of income on saving will depend on the income transfer during the whole life period. However, since the period chosen in Qian's study has experienced too much uncertainty, numerous political reforms took place and China's economic structure has experienced a significant transformation since 1978, Qian's result is not very useful for the current situation in China. Besides, this model does not include demographic variables; it only has disposable income.

Later, Mackellar and Wakabayashi (1999) modified Qian's model to examine how demographic changes affect the household saving rate. They added demographic variables (dependency ratios) into Qian's model (1988). The model was both used for the urban and rural area in China. The conclusion from Mackellar and Wakabayashi's (1999) paper is that household savings in China are predicted to reach their peak level in 2025 and then start to decline. Both elderly and youth dependency ratios have significant effects on household saving in China. While a reduced youth dependency ratio will favour household savings, and its effect is weaker than that of the elder dependency ratio. Another implication is that total savings will come to be dominated by urban savings in China. However, the study of Mackellar and Wakabayashi (1999) only takes the dependency ratio into the model, which remains a simplistic model and ignores other explanatory variables, which may also result in omitted-variable bias in the estimation. Moreover, like most of the previous quantitative analysis, the analysis in Mackellar and Wakabayashi (1999) did not consider the stationarity for the time series data. Spurious regression problems might be presented in their analysis. For these reasons, we revisit the same problem while correcting for the deficiencies in this paper.

Table 3.1 presents the results of some studies in different countries using different methods of research, which vary the findings to the relationship between saving rate and the demographic dependency ratio.

Table 3.1

Summary of previous studies on the relationship between saving rate and dependency ratios.

Studies	Countries	Significance of dependency ratio	
		Elderly	**Youth**
Weil (1994)	Panel of 14 countries (1960-1985)	Significantly negative	Significantly negative
Horioka (1991)[7]	Japan (1956-1987)	Insignificant negative	Significantly negative
Jorgensen (2011)	Transition countries, incl.Brazil	Insignificantly positive	N/A
Jorgensen (2011)	Latin American and Caribbean countries	Insignificantly positive	Insignificantly negative
Song and Yuan (2013)	People's Republic of China (1990-2009)	Significantly positive	Significantly negative (SR[1]) Insignificantly negative (LR[2])
Tang (2007)	People's Republic of China	Significantly positive	Significantly positive

Note: 1.SR：Short-run; 2.LR: Long-run

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[7] As cited in Jorgensen (2011)

IV. Analytical and theoretical framework:

4.1 Model specification:

In this paper, I will estimate the aging-saving relationship using the model in Maxime Fougère and Marcel Mérette (1999), which was once used to examine the relationship between household saving and demographic change in Canada. This model includes variables like household wealth, demographic factors, public sector deficit, real interest rates, and pension benefits. Therefore, the estimation result is expected to be more accurate. The model is as follows:

$$\text{Log}(S/Y_d)= \beta_0 + \beta_1 \log (W_{(-1)}/Y)+ \beta_2 \log(Gbal/Y) + \beta_3 \pi_{(-1)} + \beta_4 R$$

$$+ \beta_5 \log（AgeDep） + \beta_6 \log ((OAS+CQPP)/Y)+\beta_7 \text{Gallup} \qquad [2]$$

where S is the real personal savings; Y_d is the personal disposable income; (S/Y_d) is the household saving rate. Y is the GDP, W_{-1} is the beginning-of- period real net worth, Gbal/Y is the total public sector deficit as a share of GDP, π_{-1} is the lagged one period year-over-year change in CPI, R is the real after-tax interest rate, AgeDep is the total age dependency ratio, (OAS\CQPP)/Y is the ratio of Old Age Security, and Canada and Quebec Pension Plans benefits to GDP and Gallup is an index of job uncertainty based on the Gallup poll.

A similar model will be used to estimate the household saving rate in China. Due to some data collection issues, for example, since the social benefits system in China is entirely different from the one in Canada and the it is still underdeveloped in China nowadays, the data set for pension benefits is incomplete. It follows that the variables (OAS\CQPP)/Y and Gallup are excluded in the new equation. From this point of view, if such variables are statistically significant to the household saving rate in China, then omitted-variable bias

(OVB) may occur, since omitted variables may include necessary information and, thus, we may underestimate the influence of these factors. Besides, annual per capita disposable income is used instead of the variable "beginning-of-period real net worth" and would be separated into two parts: urban disposable income and rural net income. In addition, the total age dependency ratio is separated into the elder dependency ratio and the youth dependency ratio in order to capture the two effects separately. Therefore, I modify the model as follows (equation [3]):

$$\text{Log (SR)} = \beta_0 + \beta_1 \log (Y_{du}) + \beta_2 \log(Y_{dr}) + \beta_3 \log(DRO) + \beta_4 \log(DRC) + \beta_5 R + \varepsilon_t \quad [3]$$

where SR is the household saving rate. Y_{du} refers to the per capita disposable income for urban households. Y_{dr} is the per capita net income for rural households. DRO is the elder dependency ratio, and DRC is the children dependency ratio. Lastly, R is the annual nominal interest rate.

The data used in this paper comes from the website "National Data" [8] as well as the "Databank of World Bank"[9], which encompasses the period from 1980 to 2012. This is the period that China experienced a dramatic economic transition as well as a demographic transition. Moreover, the data on per capita disposable income in national scope is unavailable until 2013, as before 2013, the data for per capita disposable income[10] (per capita net income in rural area) was collected separately for the urban and rural area in China. In addition, the elder dependency ratio refers to the elder population to the working-age

population, present in percentage form. The ratio describes the number of elderly people that every 100 individuals have to support. Elder dependency ratio is one of the indicators reflecting the social implication of population aging from the economic perspective and the variable we care most in this paper. While the children dependency ratio is the ratio of the children population to the working-age population, also present in percentage form. Children dependency ratio refers to the number of children that every 100 working-age individuals will support.   Table 4.1 concludes summarized statistics:

Table 4.1: Summary Statistics

Variables	Obs	Mean	Std. Dev.	Min	Max
SR	33	20.212	5.303	10.95	28.92
Y_{du}	33	6606.4	6755	477.6	24564.7
Y_{dr}	33	2194.9	2055.38	191.3	7916.6
DRO	33	9.599	1.49	7.58	12.7
DRC	33	38.35	10.6	22.1	61.02
R	33	5.53	2.99	1.98	11.11

4.2 Stationary test and Co-integration analysis:

Since the econometric model presented above uses some time-series variables, it is important to check for their stationarity. The classical regression model always has an important assumption that the variables are stationary. The use of nonstationary data may induce what is known as the spurious regressions problem. In a much-cited article, Granger and Newbold (1974) showed that, when nonstationary variables were used in linear regressions, the values of R-square and t-statistics were frequently very high, even if there did not actually exist any economic relationship between the dependent and independent variables. The econometric results stemming from the use of such data are not meaningful.

Usually, most time series variables are not stationary but appear to be integrated. A nonstationary series that can be transformed into a stationary series by differencing d times is said to be integrated of order d (H.Greene, 2012). As well, since the natural logarithms of the data will not change the co-integration of the original series, and natural logarithms can linearize the trend as well as eliminate the heteroscedasticity of the time series, the logarithms of some real variables are considered in this analysis for both dependent and independent variables.

In order to avoid spurious regressions, we ran both the Dickey-Fuller (ADF) and Phillips–Perron unit-root (PP) tests to check stationarity. All the time series are tested for the period from 1980 to 2012. The results of these two tests are presented in Tables 4.2A and Table 4.2B:

Table 4.1A: The ADF statistic:

Variable	Level Form	First Difference
Log(SR)	-0.953	-5.739 ***
Log (Y_{du})	-0.390	-2.782**
Log(Y_{dr})	-1.076	-2.555*
R	-1.020	-3.792**
Log(DRO)	0.643	-5.271 ***
Log(DRC)	-0.273	-5.676 ***

Table 4.2B: The Philips-Perron test statistic:

Variable	Level Form	First difference
Log(SR)	-0.696	-5.642 ***
Log (Y_{du})	-1.650	-2.846*
Log(Y_{dr})	-2.066	-2.666*
R	-1.242	-4.381 ***
Log(DRO)	0.780	-5.354 ***
Log(DRC)	-0.203	-5.683 ***
ε_t	-4.425***	

Note: *is the null hypothesis of the unit root, which is rejected at 10% critical level, **is the critical level of 5%， and***is the critical level of 1%.

According to the results of the ADF and the Phillips–Perron test, we cannot reject the presence of unit root for all variables at their level form. All the variables are not stationary at their level form. Then we check whether their first differences are stationary. The null hypothesis of non-stationarity is rejected at the first difference level for all variables, which means their first differences are stationary. After integration, all the variables are integrated at the same order: I (1). Lastly, in order to run a regression, the error term ε_t should also be stationary.

Our regression results demonstrate that the error term of equation [3] is stationary at 1% critical level (Table 4.2B), and all the variables are significantly different from zero. The residual from the cointegration regression captures the deviations from the equilibrium of all independent variables and dependent variable. Therefore, later, we can estimate both the short and long run effects of independent variables on household saving rates by including the lagged residuals from the cointegrating regression as our measure of the error correction mechanism.

Additionally, the Johansen test is also applied to check whether a cointegration relationship exists between dependent variable and independent variables (Table 4.3), the results indicate that we can reject the non-cointegration at 1% critical value, and that a cointegration relationship exists (regression result in Table 4.4).:

Table 4.3

Johansen tests for cointegration:

Maximum rank	parms	LL	eigenvalue	Trace statistic	Critical value
0	6	229.16394	.	117.2740	103.18
1	17	255.09412	0.80223	65.4136*	76.07

Sample: 1981—2012

Num. of Obs: 32

Note: because the trace statistic at r=0 of 117.274 is greater than its critical value 103.18 then we reject the null hypothesis of no cointegrating equations. The trace statistic at r=1 of 65.4136 is less than its critical value 76.07, we cannot reject the null hypothesis that there are one cointegration equation.

Table 4.4:   Regression results

	(1) LNSR
log(DRO)	1.858* （0.025）
Log(DRC)	0.831** （0.008）
log(Y_{du})	-0.601* (0.011）
log(Y_{dr})	0.793** （0.002）
R	-0.0427*** （0.000）
_cons	-4.780* （0.030）
Observations (Length of data series)	33
F	40.14
adj. R-sq	0.859
df_m	5
df_r	27

Note: p-values in parentheses. *** is 1% significance level. ** is 5% significance level. *is 10% significance level. The coefficient without a star label is not significant.

The regression result in Table 4.4 can be also presented in equation form:

$$\text{Log (SR)} = -4.78 - 0.6 \log(Ydu) + 0.793 \log(Ydr) + 1.858 \log(DRO)$$
$$\underset{(t)}{} \quad \underset{(-2.3)}{} \quad \underset{(-2.74)}{} \quad \underset{(3.39)}{} \quad \underset{(2.37)}{}$$
$$+ 0.831 \log(DRC) - 0.0427 \underset{(-5.15)}{R} \qquad [4]$$
$$\underset{(2.88)}{}$$

Note: t-values in parentheses

4.3 Analysis of the results:

According the regression results, the urban per capita disposable income has a significant negative effect on the saving rate. This is consistent with the permanent income hypothesis (PIH) developed by Milton Friedman (1957). Friedman's hypothesis suggests that an increase in current or future disposable income increases consumption and, thus, decreases household savings. Our result indicates that one percent increases in urban per capita disposable income results in a 0.6 percent drop in household saving rates.

The rural per capita net income has a positive effect on the household saving rate. A one percent increase in rural per capita net income results in a 0.8 percent increase in savings. This is consistent with most other studies of income-saving relation in rural China. For example: Qian (1998) found positive relationships by using both the absolute income model and the permanent income model in rural areas. This result is also consistent with Masayo Wakabayashi and Landis MacKellar's (1999) results for rural areas, in which they also found a positive relationship between disposable income and saving rate for rural households. Furthermore, the different sign for urban and rural disposable income is reasonable in China nowadays. This is because future uncertainty and emergency are important factors for the high saving rate in China, especially for rural households. The basic life cycle hypothesis assumes that individuals entirely protect themselves against risk, but this is not always the

fact in reality. With higher income uncertainty, households are willing to save more to smooth their consumption not only for predictable variations in income but also for unpredictable changes in income. As a result, precautionary savings is an essential reason to explain why savings do not fall with higher income and why we have different signs for urban and rural disposable income. In China, the pension system and social insurance remain underdeveloped particularly in rural areas. Actually, the pension system in China is specially designed for rural areas and differs significantly from the system for urban households. Participants voluntarily join the pension program and the operation matters are left to local governments. The rural pension benefits are far less than urban pension benefits and the level of participation is very limited in rural places (He & Zhang, 2013). The unbalanced pension benefit is an important reason why the saving rate in urban areas has a negative relation with income while the effect is positive for rural households, since households in the rural areas face larger uncertainty in the future and far less security compared with the urban households in China. Rural households have to save more in order to protect themselves against future income uncertainty.

The cointegration result also provides evidence that both the youth dependency ratio and the elder dependency ratio contribute positively to the saving rate. This result is consistent with the findings by Modigliani (2004), Tang (2007) and Horioka (2008). According to the regression estimation, an increase in elder dependency by 1 percent leads to a 1.9 percent increase to household saving. This result confirms our guess that household saving rates remain high in old age in China. A higher proportion of elder population increases the saving rates in China. Two important reasons explain why aging contributes positively to the

household saving rates. Firstly, households aged 60 years or over now were born before the 1950s in China, the period People's Republic of China was just established at 1949. Social securities and private insurance were totally undeveloped at that time. Therefore, the motivation for precautionary saving is adamant. The older generations have been accustomed to save throughout their life, even after retirement. Secondly, Asian cultures emphasize the importance of "family relationship". In addition to care for one's own future, elders even pay more attention to their children's future. From this tradition, elder generations have a strong bequest motivation for savings.

Furthermore, a decrease in youth dependency by 1 percent will reduce the saving rate by around 0.83 percent. The children dependency ratio unexpectedly has a positive sign with the prediction of the life-cycle hypothesis. The LCH hypothesis believes that, with fewer children to provide financial support and care, parents can consume less and save more. However, this is not the case for China. One explanation for this phenomenon is related to the higher education expenses and living costs for children. Xu (2012) found that, as in most cases, for households in Shanghai, although there is only one child in a family, the education expenses demands 46 percent of the family's total expenses for secondary school, 52 percent for university and even higher if the child is studying abroad (as cited in China Daily, 2005). Choukhmane, Coeurdacier and Jin (2014) summarize the data for average education expenditure on the only child for Chinese household. They found the ratio of education expenditures to total household expenditure rises from approximately 10% for a child under age 15 to 15-25% for a child aged between 15 to 22. Research by Zhu (2005) of the Chinese Academy of Social Science shows that based on the 2003 prices, parents will spend

approximately CNY￥250000 (US$30120) to support a child from birth to age of sixteen. If the child continues their education in university, the education expenditure will rise by US $17000. The increased expense is not only for education, since, in most urban families, each family only has one kid, but parents want to give their child the best.   After their graduation from post-secondary school，parents still need to spend another US $12000 on supporting the child to afford housing and other expenditures (as cited in China Daily, 2005). Such a fast-growing expense of children could never be imagined and predicted in the 1970s and 1980s. Consequently, parents have to spend more to support their children's education and lives in contemporary China, with the declining youth dependency ratio, the household saving rate declines.

Finally, the regression results suggest that the nominal interest rate has a negative effect on saving rates. This is the outcome of the two opposing substitution and income effects of the interest rate on saving.

4.4 Error Correction Model

In order to confirm the significance of the cointegration equation derived above, this paper also uses an error correction model for the household saving rates in single equation form. The ECM is an alternative way to check the strength of the empirical relationship we obtained above and to test the stability of the long-run coefficients.

The single equation form of the error correction model (ECM) can be used to estimate both short-term and long-term influence of independent variables on the dependent variable, as well as the error correction term. In addition, it can help to determine the speed at which

the dependent variable returns to equilibrium after a deviation has occurred. The stochastic

trends of the time series would be corrected if the time series indicating that they have an

equilibrium relationship with an error correlation mechanism.

The basic single equation error correction model is:

$$\Delta Y_t = \alpha + \beta_0 * \Delta X_t - \beta_1 (Y_{t-1} - \beta_2 X_{t-1}) + \varepsilon_t. \qquad [5]$$

The part in parentheses in the equation [5] is the error correction mechanism, especially the

lagged error term for the cointegration analysis. The parameter β_0 estimates the short-term

effect of a change in X (independent variables) on Y (dependent variable). The parameter

β_1 estimates the speed of return to equilibrium after a deviation. The parameter β_2

estimates the long-run effect that one unit change in independent variables has on the

dependent variable. In addition to the long-run effects, short-term nominal interest (Rs) is

included in the ECM since it is considered to affect the saving rate in the short run.

Consequently, our regression model can be extended to the single equation error correction

model as follows:

$$\Delta \log (SR) = \alpha_0 + \alpha_1 \Delta (\log (Y_{du}) + \alpha_2 \Delta \log(Y_{dr}) + \alpha_3 \Delta \log (DRO)$$

$$+ \alpha_4 \Delta \log(DRC) + \alpha_5 \Delta (Rs) - \lambda (\mu_{t-1}) + \varepsilon_t \qquad [6]$$

where

$$\mu_{t-1} = [SR_{(-1)} - \beta_1 \log (Y_{du(-1)}) - \beta_2 \log(Y_{dr(-1)}) - \beta_3 \log(DRO_{(-1)}) - \beta_4 \log (DRC_{(-1)}) - \beta_5 R_{(-1)}],$$

which is the error correction mechanism.

In the above model (equation [6]), all β coefficients correspond to the coefficients in the

previous model (Equation [1]). Besides, β coefficients estimate the long-run effect that a unit

increases in any independent variables on the household saving rate. While all α coefficients are the short-run elasticities, which measure the effect of one unit increase of any independent variable to household saving rate in short-term. Besides, λ is the coefficient on the error-correction term, and λ also corresponds to the adjustment speed toward the long run equilibrium. If λ is significantly different from zero, then there is a cointegration relationship. Table 4.5 includes the information for the Error Correction Model.

The ECM result indicates the following equation， which is written in error correction form:

$$\Delta \log(SR)_{(t)} = -8.316 - \underset{(-3.28)}{0.609} \Delta \log(Ydu) + \underset{(-1.12)}{1.19} \Delta \log(Ydr) + \underset{(2.39)}{2.495} \Delta \log(DRO)$$
$$-\underset{(-0.15)}{0.0966} \Delta \log(DRC) - \underset{(2.09)}{0.0037} \Delta R_s - \underset{(-2.16)}{0.735} (\mu_{t-1}) + \varepsilon_t$$

\[7\]

where:

$$\mu_{t-1} = \log(SR_{(-1)}) + \underset{(-3.73)}{0.08} \log(Ydu_{(-1)}) - \underset{(-2.61)}{1.013} \log(Ydr_{(-1)}) - \underset{(2.65)}{2.4} \log(DRO_{(-1)})$$
$$-\underset{(2.53)}{1.198} \log(DRC_{(-1)}) + \underset{(2.93)}{0.03} R_{(-1)}$$

Note: t-values in parentheses

Table 4.5
Results for the ECM:

	(1) $\triangle$log(SR)
$\triangle$log(Y_{du})	-0.609
	（0.276）
$\triangle$log(Y_{dr})	1.190*
	（0.027）
$\triangle$log(DRO)	2.495*
	(0.049）
$\triangle$log(DRC)	-0.0966
	（0.883）
$\triangle$Rs	-0.0037*
	(0.018)
Log(SR$_{(-1)}$)	-0.735**
	(0.001)
Log ($Y_{du(-1)}$)	-0.800*
	(0.017)
Log ($Y_{dr(-1)}$)	1.013*
	(0.015)
Log(DRO$_{(-1)}$)	2.442*
	(0.020)
Log(DRC$_{(-1)}$)	1.198**
	(0.008)
R$_{(-1)}$	-0.029*
	(0.034)
_cons	-8.316**
	(0.004）
N	32
adj. R-sq	0.342
F	2.465
df_m	11
df_r	20

Note: p-values in parentheses. *** is 1% significance level. ** is 5% significance level. *is 10% significance level. The coefficient without star label is not significant.

According to the equation [7], the coefficient λ on the error correction term is significantly different from zero, it confirm the existence of a cointegration relationship between household saving rate and other variables. In the long run, all variables are statistically significant. The urban per capita disposable income contributes negatively to saving rates while the rural per capita net income has a positive effect, which is consistent with the result in equation [4]. Both elder and youth dependency indicate positive effects on the household saving rate as in equation [4]. Moreover, under both approaches (Equation [4] and Equation [7]), all the estimated β coefficients have the expected signs and are significantly different from zero. In addition, the magnitudes of the β coefficients in equation [7] have changed somewhat, but their value remains reasonably close to the result in equation [4]. So our ECM helps to reinforce the regression results in equation [4].

In the short run, the urban per capita disposable income is statistically insignificant. This is mainly because urban households enjoy more social security benefits. Urban households do not respond to an income change in the short-run. Moreover, the youth dependency ratio is also statistically insignificant, which indicates that in the short run, the declining youth dependency ratio is not a primary factor on the household saving rates. What is worth considering here is the fact that the elder dependency ratio always has a significant positive effect on household saving rate, both in the short-run and in the long-run. This is the same outcome as in Brazil. The result gives us an inspiration that, if the aging trend continues to rise as projected, ceteris paribus, the household saving rate will increase accordingly in China.

V. Conclusion

At the end of the twentieth century, China experienced a dramatic transition in its demographic structure. Since the 1990s, China had a sharp decline in the fertility rate due to the implementation of the one-child policy. Together with lower mortality rate and greater longevity, China's population aged at a faster pace than many other developing countries.

An older population is a crucial concern for a country's economic growth. In this paper, we examined whether the population aging in China would have a negative impact on its economic growth, by evaluating the aging-saving relationship. We first used the regression model. Variables included disposable income of rural and urban households; the elder and youth dependency ratio, and the nominal interest rate. The parameters of this model are estimated using annual time series data from 1980-2012 in China. In order to avoid the spurious regression problem produced by non-stationary series, we first apply the ADF and Phillips-Perron tests, the results indicate that all series are integrated at first order. Then the Johnsen root test is applied to ensure the existence of the cointegration equation. The cointegration relationship suggests elder and youth dependency ratios contribute positively to the household saving rate. In addition, urban per capita disposal income has a negative effect on savings, while rural per capita net income has a positive effect on the saving rate. One possible explanation is for precautionary saving. Households in rural areas are more motivated to secure themselves to prepare for future emergencies due to the lack of sufficient social benefits in rural China.

Then I used the error-correction model (ECM) to reinforce the significance of the cointegration model. The ECM can help capture both short-term and long-term effects of

independent variables on dependent variables. In the long-run, the model has similar findings with the cointegration equation, all the coefficients have the same signs and the values are very close to each other, which reinforces our regression analysis. In the short-run, the youth dependency ratio is statistically insignificant, while the signs of all other variables remain the same under both approaches.

In conclusion, the elder dependency ratio has a positive influence on saving rates in the short and the long run. Moreover, the effect in the long run is stronger in comparison to the short run. This is mainly because the aging phase would become more serious in the future. Over time, the lower mortality rate and longer life expectancy simulates the aging in China. In 2010, 12.4 percent of the total population aged 60 years and over. In 2030, people aged 60 years and over increase to a quarter of its total population. Under the imperfectly developed social pension system and higher living cost, aging in China will strengthen the household saving motivation and, thus, increase household saving rates. This finding implies that the population aging transition in China would not put a downward pressure on household savings and hence on economic growth.

Population aging is not the only factor to influence the household saving rate in China. There are numerous other factors that determine the saving rate in China, which are not considered in this model, for example: the imbalanced sex ratio, cultural factors, the financial market, inflation and income distribution, etc. Further researches on the paper are thus called for.

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