Determinants of Household Saving in China

A thesis

submitted in partial fulfilment

of the requirements for the Degree of Master of

Commerce and Management at

Lincoln University

By

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Lincoln University

2006

Abstract of a thesis submitted in partial fulfilment of the
requirements for the Degree of M.C.M.

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It is a conventional wisdom that since the start of the Chinese economic reform in 1978, the domestic saving structure in China has changed significantly. Previous studies of household saving in China (for example: Qian, 1988, Feltenstein et al, 1990, and Wakabayashi and Mackellar, 1999) have usually relied upon the Keynesian absolute-income hypothesis, Duesenberry's relative-income hypothesis, and Friedman's permanent-income hypothesis. This thesis uses the Modigliani-Brumberg life-cycle hypothesis to examine the determinants of household saving behavior in the Peoples' Republic of China during the period 1978 to 2003. The research uses modern cointegration techniques to examine the impact on saving rates of economic growth, age dependency, wealth, the real interest rate, social security payments and unemployment (as a proxy for income uncertainty). Autoregressive distributed lag models are constructed and tested. The results find that economic growth, the real interest rate and social security payments have the expected effect with significant parameters; age dependency has the expected sign but in one model is not statistically significant; and that unemployment is not significant. The most surprising result is that increases in household wealth are associated with increased saving rates, which may help explain very high economic growth rates in China post 1978.

Keywords: China, Household Savings, Life Cycle Model, Modigliani.

Acknowledgements

Writing a thesis is a hard journey. Thanks to guidance and support from my supervisor, Professor Paul Dalziel, it became enjoyable. His patience in reading my earlier drafts, his timely return of them with thorough and insightful comments, and his sacrifice of his own time in going through the drafts are what made this thesis possible. I would also like to extend my gratitude to my associate supervisor, Dr. Ian MacDonald, for giving me valuable advice on this thesis.

I wish to thank my beloved father and mother for all the support they give me to realize my dream. Finally, thanks to Maggie, for her help on my English and also, thanks to my friends, Rick, George, Bryan and Wendy, for their help on my econometric work and sharing a laugh with me.

Table of Contents

List of Tables and Graphs

Chapter 1: Introduction

1.1 Introduction

This research is motivated by the observation of an interesting phenomenon in China: the consistently high saving rate in China during the last three decades. Since the late 1970s, the Chinese have been among the top five savers in the world. In 1998, China was the third biggest saver only after Singapore and Malaysia (World Bank, 1998).

Recent economic reforms and developments in China have been drawing great attention from economists. One of the most important factors in both the theory of, and policy prescription for, economic development is domestic saving. As China's economic growth is closely associated with high levels of capital investment (Wu, 2000), the issue of household saving is pertinent to widespread concern regarding the sustainability of the present momentum of high economic growth.

Commencing from the Chinese economic reform of 1978, the domestic saving structure in China has changed significantly. Household saving has replaced government saving and corporate saving as the main domestic saving source. Moreover, in recent years, household saving in China has increased not only as a share of total domestic saving, but also relative to household disposable income. It is thus natural to consider the factors contributing to this high Chinese household saving rate, and whether China can maintain its saving rate at the high level of the past few years or not.

With the annual publication of the *The Statistical Yearbook of China* since economic liberalization, most relevant data after 1978 have become available, and thus a systematic study of domestic saving in China has also become possible. Such a study serves to improve understanding of the effects of the recent economic reform in China, and to provide preliminary results for future study on household saving in China as well. Before starting theoretical and empirical investigations, however, it is useful to inspect what the important aspects of Chinese household saving are in general.

First, the Chinese household saving rate of approximately 40 percent, is much higher than the rate of both the average developed country and the average developing country. The structure of Chinese domestic saving varies over time, and unlike many other market-oriented economies, the share of Chinese household saving in total domestic saving is not substantial, but it has changed dramatically since the start of liberalization in 1978 (Qian, 1988).

Second, diversification of household saving, which is associated with rising income and saving, is a phenomenon of the post reform era. In the post reform era, household saving is no longer kept to limited channels, but has diversified into a variety of new financial instruments (Liu & Xu, 1997).

The main purpose of this research is to investigate the determinants of household saving behaviour in China through the estimation of a saving function derived from the standard Modigliani-Brumberg's life cycle framework. Some appropriate adaptation will also be made, in order to allow for modern research that has emphasised income uncertainty as a factor. This research aims to investigate what the determinants of household saving in China are, and to what degree these determinants could affect Chinese household saving behaviour.

Methodologically, our modelling experiment follows the Error Correction Modelling (ECM) procedure. This procedure has several advantages over the traditional econometric procedures used by Modigliani and Brumberg, and minimises the possibility of estimating spurious relations while retaining long run information. This procedure also has the added advantage of providing for the estimation of lag effects without arbitrarily constraining the lag structure at the outset (Hendry, 1995).

1.2 Background

During the last two decades, several important economic events impacting the Chinese household saving took place:

1. In 1978, the Chinese government decided to abandon an inefficient regime, and to reform the economy with the aim of becoming a market oriented one;
2. In 1990, the first Stock Exchange was founded in Shenzhen, and the Shanghai Stock Exchange was founded in the following year; and
3. During the period 1996 to 1999, there were severe and consecutive cuts in the interest rate. The nominal interest rate decreased from 9.19% in 1996 to only 2.25% in 1999 (Qin, 2003).

1.2.1 Domestic saving structural changes

From the founding of the People's Republic of China in 1949, until the eve of operating an economic liberalization policy, China's economy was planned as a highly centralised one, and the government determined resource allocation (Thoburn &

Howell, 1995).

China's household saving rate, however, has always been consistently maintained at a high level. As Liu and Xu (1997) state, except for a brief period of post Great-Leap years in the early 1960s, the Chinese household saving rate remained between 20 to 30 percent prior to the economic reforms of 1978. This high saving rate has not only continued during the post reform era, but it seems to have intensified.

Before economic liberation in 1978, savings were predominantly those which originated from government budget surplus: revenues taken in taxes and enterprise profits in excess of government expenditures. Since 1978, as a result of the economic reform, sources of domestic saving in China have drastically shifted from central government to local enterprises and Chinese households.

Table 1-1 clearly shows that the share of total domestic saving generated by the central government fell from 51.4% in 1978 to only 19% in 1985, while enterprise saving increased from 34.6% to 47.1% between 1978 and 1982, reflecting the profit retention and decentralization of the tax base in favor of enterprises. After 1982, the ratio of enterprise saving declined to only 31% in 1985, resulting from higher taxes, lower enterprise profits, and rising costs due to higher material prices, wages, and welfare expenditures. The share of household saving rose from 14% to 50% during the period 1978 to 1985. By 2003, government saving rates dropped to only 1.86%. In contrast, the rate of household saving increased to over 75% of total domestic saving (see Table 1-1).

Table 1-1. Sources of Domestic Saving in China, 1978-2003

Year	Sources of Domestic Saving			
	Government Budgets	Enterprises	Households	Total
1978	51.40%	34.60%	14.00%	100.00%
1979	42.80%	33.70%	23.50%	100.00%
1980	32.10%	36.60%	31.30%	100.00%
1981	22.30%	45.80%	31.90%	100.00%
1982	18.40%	47.10%	34.50%	100.00%
1983	20.30%	35.00%	44.70%	100.00%
1984	20.60%	33.50%	45.90%	100.00%
1985	19.00%	31.00%	50.00%	100.00%
1986	18.80%	21.70%	59.50%	100.00%
1987	13.10%	25.80%	61.10%	100.00%
1988	7.30%	30.10%	62.60%	100.00%
1989	5.80%	28.30%	65.90%	100.00%
1990	5.20%	26.40%	68.40%	100.00%
1991	4.10%	25.40%	70.50%	100.00%
1992	3.47%	26.08%	70.45%	100.00%
1993	2.83%	25.62%	71.55%	100.00%
1994	2.35%	25.89%	71.76%	100.00%
1995	2.46%	24.84%	72.70%	100.00%
1996	2.04%	25.12%	72.84%	100.00%
1997	1.91%	24.78%	73.31%	100.00%
1998	2.29%	23.95%	73.77%	100.00%
1999	1.96%	24.18%	73.86%	100.00%
2000	2.84%	23.02%	74.14%	100.00%
2001	2.59%	22.10%	75.31%	100.00%
2002	2.10%	22.44%	75.46%	100.00%
2003	1.86%	22.73%	75.41%	100.00%

Source: 1978-1991 Xie Ping (1993); 1992-2003 Statistical Year Book of China (various issues).

1.2.2 Diversification of household saving

The diversification of household saving is a phenomenon of the early 1990s, resulting from rising income and saving. In the post reform era, household saving is no longer kept to limited channels, but has diversified into a variety of new financial instruments (Liu & Xu, 1997).

Previously household saving channels were limited to cash, bank deposits, and treasury bonds, but households may now diversify their portfolios into enterprise bonds, financial bonds, short term financial instruments and, in particular, stocks. In the early 1990s, stock exchanges were founded in Shenzhen and Shanghai. Most households in the years from 1991 through 1993 seemed to prefer newly issued stocks listed on the Shenzhen and/or Shanghai stock exchanges. Untransferable stocks were a second choice. According to a survey conducted by a research team of the Shanghai Social Sciences, approximately 40% of urban household total saving was kept in stock markets; about 30% of total saving went to treasury and/or enterprise bonds; only 20% to bank deposits, with approximately 10% retained in cash (Liu & Xu, 1997).

With the exception of the above financial channels, a recent development is emerging funds to support a new system of medical care, pensions, and housing. In most major Chinese cities, the newly emerging housing accumulation funds and pension funds have become important alternative channels for households to diversify their savings. This diversification of savings into housing accumulation funds and pension funds, however, is not merely for high returns but is also a result of risk consideration.

Table 1-2. Summarizes the Key Events Impacting on Chinese Household Saving

Year	Events
1978	Decision to open economy
1990	Shenzhen stock exchange founded
1991	Shanghai stock exchange founded
1996 to 1999	Severe and consecutive cuts in the nominal interest rate

1.3 Study Rationale

The basic motivation of this research is to investigate the important determinants of household saving in China. Previously, there have been a few well-known models often employed to analyze saving functions in different economies. These models are the Keynesian absolute income model; Duesenberry’s relative income model;

Friedman's permanent income model and Modigliani-Brumberg's life cycle model. Previous researchers such as Qian (1988), Feltenstein et al. (1990) and Wakabayashi and Mackellar (1999) adopted the absolute income model and the permanent income model in estimating Chinese household saving function. However, previous researchers have rarely adopted the life cycle model, which should not be ignored.

1.3.1 Definition of household saving rate

In China, there are no direct estimates of household saving rate. Chinese household per capita disposable income data and Chinese household per capita consumption data were available following 1978. In this research, household saving rate is defined as the following equation (1.1):

$$SHR = \frac{YD - YC}{YD} \qquad (1.1)$$

Where,

1. *SHR* is the household saving rate,

2. *YD* is household per capita disposable income,

3. *YC* is household per capita consumption.

There are generally two ways of defining SHR in the literature, namely, in percentage of GDP and in percentage of per capita income. Qian (1983) and Feltenstein et al. (1990) used the first way to estimate their household saving rate series while Qin (2003) employed the second route.

The second method of estimating saving rate series has several advantages over the first one. The most important advantage is that the first method reflects the trends of total domestic saving rate only, while the second method represents the exact trends of the household saving rate. Mainly because of this, and also because of the convenience of being able to acquire relevant data, this study has used the second method to create the Chinese household saving rate series.

1.4 Models

This thesis researches three models, namely, the basic life cycle model, the extended life cycle model, and the adjusted life cycle model. All data used in this thesis are in an annual time series. The sample period covers 26 years, beginning in 1978 and ending in 2003.

1.4.1 The basic life cycle equation

The basic life cycle equation was first introduced by Modigliani and Brumberg in 1954. According to LCH (Life Cycle Hypothesis), a household is predicted to accumulate assets during the prime working years, and then draw them down after retirement. The model then predicts that consumption and/or saving in a particular period depends on expectations about lifetime income. Modigliani and Brumberg (1954, p.430) argued there are two major purposes of saving:

1. *That the major purpose of saving is to provide a cushion against the major variations in income that typically occur during the life cycle of households as well as against less systematic short term fluctuations in income and needs.*

2. *That the provisions the household would wish to make, and can afford to make,*

for retirement as well as for emergencies, must be basically proportional, on the average, to its basic earning capacity, while the number of years over which these provisions can be made is largely independent of income level.

From the propositions quoted above Modigliani and Brumberg (1954) derived their basic life cycle model, which can be written as follows:

$$SHR_t = f\,(GY_t,\ ADEP_t,\ WL_t) \qquad (1.2)$$

Where:

1. *SHR* is the household saving rate,
2. *GY* is the growth rate of real household disposable income,
3. *ADEP* is elderly dependency measured as the ratio of the population over 60 to the working age population,
4. *WL* is household wealth as a ratio of household disposable income,
5. *t* is a time subscript.

Modigliani and Brumberg also emphasised that because their basic LCH model is a simplified model, it may be reliable only under three assumptions: First, in addition to having no inherited assets at the beginning of its life, a household does not receive any inheritance at any other period of its life; the household can only accumulate assets through their own saving. Second, the proportion of total resources that a household plans to devote to saving is determined only by its tastes and not by the size of its resources. Third, the interest rate is zero.

1.4.2 The extended life cycle equation

In 1986, Modigliani extended the basic life cycle model by including two more influences on household saving; the real interest rate and social security payments. However, the effect of real interest rate on saving and/or consumption in the model is ambiguous. As Athukorala and Tsai (2003) argued, a higher interest rate increases the present price of consumption relative to its future price, therefore providing an incentive to increase saving (the Substitution Effect). On the other hand, an interest rate rise also raises lifetime income, and thus tends to increase consumption and decrease saving (the Income Effect). Consequently, an increase in real interest rate will drive household saving to rise only if the substitution effect is stronger than the income effect.

Social security is not mentioned in previous studies very often, but Modigliani (1986) pointed out that wealth is postulated to have a negative impact on household saving. He also suggested that the smaller coverage of the social security system and of pension schemes is likely to provide an added incentive for thrift and saving.

The discussion so far implies the following life cycle equation:

$$SHR_t = f\,(GY_t,\ ADEP_t,\ RID_t,\ SSP_t,\ WL_t) \tag{1.3}$$

Where:

1. *SHR* is the household saving rate,
2. *GY* is the growth rate of real household disposable income,
3. *ADEP* is elderly dependency measured as the ratio of the population over 60 to the

working age population,

4. *RID* is the real interest rate,
5. *WL* is household wealth as a ratio of household disposable income,
6. *SSP* is social security payments measured as a ratio of household disposable income,
7. *t* is a time subscript.

1.4.3 The adjusted life cycle equation

Another important determinant of Chinese household saving that is often discussed is income uncertainty. Zhang and Wan (2004) state that: "*when income uncertainty occurs……consumers will increase precautionary savings.*" (p, 2228) Their earlier work (2002) points out that since 1995, uncertainty has been exacerbated by the government's determination to restructure SOEs. As result, 69.6% of households considered saving for retirement as one of the top three motivations (Yuan & Song, 1999 cited in Zhang & Wan, 2004). Qin (2003) also showed that in both urban and rural areas, there has been a significant motive to save more as a precautionary measure against rising income uncertainty and; household saving potential would increasingly decline if income uncertainty stops growing.

A useful proxy for income uncertainty is unemployment. Thus, our research used the unemployment series as an explanatory variable in order to capture the income uncertainty factor. This gives rise to an adjusted life cycle equation as follows:

$$SHR_t = f\,(GY_t,\ ADEP_t,\ RID_t,\ WL_t,\ SSP_t,\ UEM_t) \qquad (1.4)$$

Where:

1. *SHR* is the household saving rate,
2. *GY* is the growth rate of real household disposable income,
3. *ADEP* is elderly dependency measured as the ratio of the population over 60 to the working age population,
4. *RID* is the real interest rate,
5. *WL* is household wealth as a ratio of household disposable income,
6. *SSP* is social security payments measured as a ratio of household disposable income,
7. *UEM* is the unemployment rate,
8. *t* is a time subscript.

Based on previous research, GY and UEM are expected to have a positive relation while ADEP, SSP, and WL are expected to have negative relations to the Chinese household saving function. However, there are some arguments regarding the sign of RID. The possible coefficient signs of these variables are summarised in following Table 1-3:

Table 1-3. Possible Signs of Research Variables

Variables	**possible sign**
GY	+
ADEP	-
SSP	-
WL	-
RID	?
UEM	+

1.5 Research Objectives

Our main interest in this research is focused on the post reform period after 1978, when China decided to reform its economy to a market oriented economy. To the best of my knowledge, no empirical studies to date have adopted the life cycle model in estimating Chinese household saving functions. The closest example is applied in Wakabayashi and Mackellar's (1999) research paper.

Wakabayashi and Mackellar adopted the basic Absolute Income Model (AIM) and Permanent Income Model, but added demographic variables in estimating Chinese household saving functions. In their research, Wakabayashi and Mackellar found that both youth and elderly dependency ratios have negative impacts on saving, which is consistent with the life cycle model's prediction. However, as mentioned above, the life cycle model predicts that consumption and/or saving in a particular period depends on expectations about lifetime income, and not on current income, as the Keynesian absolute income model suggests. Therefore, the model Wakabayashi and Mackellar adopted is not the full life cycle hypothesis.

The major differences between this study and Wakabayashi and Mackellar's (1999) study are: 1) The focus is on the period 1978 to 2003, which is much longer than Wakabayashi and Mackellar's (1999) research period of 1995 to 1997; 2) With the exception of demographic variables, a different set of explanatory variables are used to model the Chinese household function; 3) the econometric method involved in this study is different and more advanced.

The specific objectives of this research are:

1. To test the explanatory power of Modigliani and Brumberg's original life cycle hypothesis (equation 1.2) in understanding household saving behaviour in post

reform China.

2. To test the explanatory power of Modigliani's extended life cycle hypothesis (equation 1.3) in understanding household saving behaviour in post reform China.
3. To analyze the determinants of Chinese household saving in post reform China, using the adjusted life cycle hypothesis (equation 1.4).
4. To estimate to what degree these determinants could affect household saving behaviour in post reform China.

1.6 Outline of the Thesis

This thesis is organised as follows: Chapter 2 presents a literature review of savings in China followed by some empirical findings in previous research. Chinese domestic saving structural changes after the economic reform are discussed in detail as well as repressed inflation and forced saving before the economic reform in China. In addition, some arguments on the important determinants of Chinese household saving are reviewed.

Chapter 3 presents the variables involved in the study, including data sources. The augmented Dickey Fuller test is used to test for unit roots in each variable.

Chapter 4 first investigates the basic life cycle model and the extended life cycle model. After testing whether the former model's variables are cointegrated, autoregressive distributed lag models and error correction models are explained and then applied to Chinese data. Moreover, Chapter 4 also focuses on the adjusted life cycle model. It finds that adding the income uncertainty variable does not improve the previous life cycle models.

Chapter 5 summarises the main finding of the research. It discussed limitations of this research and offers suggestions for future research on the topic of determinants of Chinese household saving behaviour.

Chapter 2: Literature Review of Savings in China

2.1 Introduction

As mentioned in Chapter 1, there are a few well-known models often employed to analyze saving behaviour in different economies. These models are the Keynesian absolute income model; Duesenberry's relative income model; Friedman's permanent income model, and Modigliani-Brumberg's life cycle model. Like many other economic subjects, these modern theories and models originated from studies of saving behaviour in western, developed economics. Unfortunately, there have been relatively few studies on saving behaviour in developing countries. More importantly, empirical studies on household saving behaviour in China did not start until early 1983. After that, a number of studies on Chinese household saving have been published.

Before discussing their empirical findings in detail, some general background information about Chinese household saving are necessary. Table 2-1 summarises the twelve most important previous studies on household saving behaviour in China. The table includes research time period, research models, and research variables of the studies (See Table 2-1).

Table 2-1. Previous Studies on Household Saving Behaviour in China			
Studies	**Research Time Period**	**Research Models**	**Research Variables**
Qian (1988)	Urban:1955-1985 Rural: 1980-1984	Absolute-Income Model	Current Income
	Urban:1955-1985 Rural: 1982-1984	Permanent-Income Model	Permanent Income and Transitory Income
	Urban:1955-1985 Rural: 1981-1984	Asset-Adjust Model	Wealth and Income
Main Findings	MPS (Marginal Propensity to Saving) is virtually zero form 1955 to 1978. After 1978, MPS is 0.26 in urban areas and ranges from 0.41 to 0.58 in rural areas.		
	Before 1978, MPS out of transitory income is higher than MPS out of permanent income in both urban and rural areas. After 1978, MPSs are identical in urban areas but not in rural areas.		
	After 1978, MPS out of assets in -0.29 and -0.20 in urban areas and rural areas respectively. MPS out of income is 0.32 and 0.87 in urban areas and rural areas.		
Jefferson (1990)	Cross Sectional Data (1987)	Simultaneous Equation Model	Wage, Death rate, Inflation Rate, Location, and Economic Structure
Main Findings	Households employed in state industry whose savings rates lie significantly below those of the non industrial rural sector.		
Feltenstein et al. (1990)	1955-1983	Permanent-Income Model	Real Disposable Income (divided into permanent and transitory components)
	1955-1983	Asset-Adjust Model	Wealth and Income
	1955-1983	Absolute-Income Model	Current Income
	1955-1983	Permanent-Income Model	Permanent Income, Transitory Income, Interest rate, Investment, and Government Expenditure
Main Findings	MPSs out of income are much larger in the official price model than in the virtual price model, and MPSs out of transitory income is much higher than that out of permanent income.		
	Nominal interest rate has considerable importance in influencing saving behaviour.		
Wang & Chern (1992)	1981-1987	LA/AIDSRD Model	Income and Ration Level
Main Findings	Rationing of housing has positive spillover effect on household saving, but rationing of other goods like food grains does not affect household saving significantly. Also, income level has effect on household saving.		
Ma (1993)	1949/1952-1990	Absolute-Income Model	Current Income
	1949/1952-1990	Permanent-Income Model	Permanent Income and Transitory Income

Main Findings	MPS out of current income for Guizhou and Shanxi are 0.225 and 0.428. In both provinces, the highest MPSs appear in the first period (1950s), not in the reform episode of the 1980s.		
	The recent (1980s) high saving propensity of rural Chinese households has caused unexpected rises in peasant income.		
Wang & Kinsey (1994)	1981-1987	LA/AIDSRD Model	Income and Ration level
Main Findings	Rationing of housing has positive spillover effect on household saving, but rationing of other goods like food grains does not affect household saving significantly. Also, income level has effect on household saving.		
Li (1997)	1952-1992	Disequilibrium Model with Rational Expectations	Income, Consumption Spending, Aggregate Price Index, Labor Restriction and Interest Rate
Main Findings	Household normal (voluntary) savings can be clearly explained by the official real interest rate, while forced savings are a direct result of the worsening market situation, and have nothing to do with the interest rates.		
Wakabayashi & Mackellar (1999)	Urban:1995-1997 Rural: 1995-1997	Absolute-Income Model	Current Income and Dependency
	Urban:1995-1997 Rural: 1995-1997	Permanent-Income Model	Permanent Income, Transitory Income and Dependency
Main Findings	MPS out of current income is 0.2076 in urban areas and 0.3674 in rural areas.		
	In urban areas, MPS out of permanent income and transitory income are 0.1919 and 0.286 respectively. In rural areas, MPS out of permanent income and transitory income are 0.3463 and 0.455.		
Chen (2002)	1952-1999	Vector Autoregression Model	Saving, Interest Rate, and Income
Main Findings	There exists a long run equilibrium relationship between saving, income and interest rate, but no robust, solid interest rate effect on saving.		
Zhang & Wan (2002)	1966-1998	Consumption Model	Consumption Expenditure, Income, and Interest Rate
Main Findings	Because savings are mainly driven by delayed consumption on durables resulting from liquidity constraints, the interest rate effect is thus likely to be small.		
Qin (2003)	1983-1999	Consumption Model	Consumption Expenditure, Income, Interest Rate, Bank Deposits, and Income Uncertainty
Main Findings	Income level has significant effects on household savings, while interest rate effects are largely offset by disposable income growth and income uncertainty.		
Zhang & Wan (2004)	1961-1998	Consumption Model	Liquidity and Uncertainty
Main Findings	In the post reform period, the effects of liquidity constraint more than doubled and uncertainty emerges as an important determinant of consumption and saving.		

2.2 Studies on Chinese Domestic Saving Structural Changes

A large number of empirical studies show that the structure of domestic saving in China has changed significantly since the start of the economic reform in 1978.

Qian (1988) illustrates that total domestic saving constitutes government saving, business saving, and household saving. The structure of the saving is then the proportion of these three parts in total. Qian found that the percentage of government saving to total national saving decreased considerably from 51% in 1978 to only 20% in 1984, while the percentage of household saving increased to 46% in the same period.

This finding is confirmed by other empirical studies. Liu and Xu (1996) argued that unlike the pre-reform period, household saving has replaced government saving as the main saving source. Not only has the relative share increased, the absolute magnitude has risen as well. Liu and Xu state that prior to the economic reform, domestic saving in China predominantly originated from government revenues taken in taxes and enterprise profits in excess of government expenditures. Since 1978, as a result of the economic reform, households have replaced the government as the main source of domestic saving. Liu and Xu finally concluded that there is a strong positive relationship between the household saving rate increases and the rise in Chinese households' disposable income. Besides Qian (1988) and Liu and Xu (1996), other studies on Chinese household saving behaviour draw similar conclusions, for example: Feltenstein et al. (1990) as well as Aaberge and Zhu (2001).

According to Liu and Xu (1996), what is more striking is that in the post reform era, household saving is no longer kept to limited channels, but has diversified into a variety of new financial instruments. Liu and Xu investigate the household saving diversification phenomenon in their research paper. They assert that unlike the pre-reform period, household saving is no longer limited to bank deposits, cash, and the mandatory allocation of Treasury bonds; households may now diversify their portfolios into deposits indexed for price changes, enterprise bonds, financial bonds, stocks, and short-term financial instruments. This is consistent with Jefferson's (1990), and Wang and Kinsey's (1994) findings.

1.3 Repressed Inflation and Forced Saving Prior to 1978

Some commentators have argued that household savings before 1978 were often "forced". The controversy can be illustrated through the famous "Equation of Exchange", $MV=PT$, where M is the money stock, V is the velocity of money, P is the price level, and T is the total real transactions. Suppose that T is exogenous to P, M and V; V is determined by institutional factors and considered to be predictably stable; and, P is flexible. Then, an increase in M will produce a proportional rise in P. That is to say, persistent inflation is caused by excessive money growth.

In the context of China's economy, however, there are at least two possible variations of the above scenario. Ma (1993) points out that in the first case, because P was controlled to a large extent before the economic reform, a surge in M, given T, might not lead to a proportional change in P, and instead would result in a decline in V. Such a possibility is further reinforced by widespread rationing in the consumer goods markets. The resultant decreases in V under such circumstances should not be viewed as changes of velocity toward the equilibrium. The increased money balances represent monetary overhang not voluntarily held by consumers at the observed price level, giving rise to repressed inflation and so-called forced savings.

Some empirical researchers such as Feltenstein and Ha (1988) choose this explanation to explain Chinese household saving. Their idea is to take the observed decreases in *V* as a sign of excessive monetary build up in the presence of state rationing and limited price flexibility. Their econometric evidence suggests the existence of repressed inflation, no obvious regime shift caused by the economic reform, and trivial monetization impacts.

Other papers also suggest that rationing systems may have induced repressed inflation and forced savings in China. Feltenstein et al. (1990) mentioned that prior to the economic reform, householders received wage payments in currency. Although they were free to use their cash balances, the absence of financial assets forced them to distribute their income between currency expenditure and saving deposits. A later research paper presented by Wang and Kinsey (1994) points out that the increase in the household saving rate in the mid-1980s can be attributed to forced saving, that is, the saving was forced because of a monetary overhang and a shortage of consumer goods. Another researcher, Li (1997), holds a similar opinion.

As mentioned earlier, however, Ma (1993), gave an alternative explanation in the same paper. Ma states that if the economy is experiencing significant transformation, *V* may be quite unstable. Consequently, an increase in *M* may not necessarily cause a proportional rise in *P*.

Qian (1988) chooses this possible explanation in his research. Qian argues that over recent decades, the scope of rationing rapidly declined while the range of free choice available for Chinese consumers increased. The growth rates of consumer goods supply and households' disposable income are also compatible. Finally, increased demand for luxury goods and consumer credit constraint provided strong motives for Chinese households to save. Qian's statistical testing supports the household behavioural changes induced by new institutional factors, emphasizing the role of monetization.

Qian's finding is well supported by many other empirical studies too. It is well known that after 1978, the main factor likely to influence Chinese household saving behaviour is the ongoing economic reform. One result of the economic reform in China is the sharp increase in both households' disposable income and savings. As a result, most empirical researchers seem to agree with one explanation of the high saving rate during the post reform era: the present high household saving rate in China is the result of the rapid growth of disposable income, rather than the lack of consumer goods as was the case earlier.

Liu and Xu (1996) show that after 1978, an eye-catching growth in their income enabled Chinese households to accelerate savings after their daily basic needs are met. Moreover, they also believe that because purchase of stocks was made available to the public after the economic reform in 1991, an anticipated high return from stock and real estate markets also gave a very strong stimulus to household savings. Liu and Xu (1996) also point out that both the health care and housing reforms have been contributing to a strong incentive to save as a precautionary measure.

2.4 Empirical Findings about Chinese Household Saving

Empirically, there has been in general two ways of modelling Chinese household saving behaviour. Previous researchers like Qian (1988) and Chen (2002) adopted income and other related variables in explaining Chinese household saving behaviour directly. Another, more indirect, route has been to determine motivation for saving by modelling household consumption. Both Zhang and Wan (2002, 2004) and Qin (2003) use this method in their studies.

As Qin notes, because both methods stem from the same theoretical framework of optimizing budget-constrained household utility over consumption in long run equilibrium, no matter which method is adopted, the following determinants often are considered as main determinants of Chinese household saving:

1. Chinese households' income level.
2. Chinese households' income growth rate.
3. Demographic structure of population.
4. Income uncertainty.
5. Precautionary motivation.
6. Interest rates.

With the exception of the above six important determinants, previous reports have agreed that because of China's unique culture, traditional family ideas about saving, the virtue of thrift, past experience of low income, and provision for children's education and marriages have also had strong impacts on Chinese household saving behaviour.

2.4.1 Differences between urban and rural Chinese household saving

Because the determinants of household saving in urban areas and rural areas are not exactly the same, previous researchers have divided their studies into two different areas: urban and rural. Similarly, due to the significant changes of motives for saving after the economic reform, many researchers have divided their researches into two time periods as well.

There is abundant evidence suggesting that compared with urban counterparts, rural Chinese households usually have a stronger motivation to save. Qian (1988) points out that in China population movement from countryside to cities has been controlled, so that the per capita income of urban residents was kept two times higher than that of rural residents for about thirty years. He also argues that unlike urban wage earners, rural households' income largely depends on the weather and the price of agricultural products.

Qian (1988) also points out that because rural households are not covered by the state and/or enterprise welfare plan (in other words, other funds like housing funds, education funds and medical care funds are provided by farmers themselves), this also gives Chinese rural households strong motivation for precautionary savings. Thus, saving for a pension is the most important motive for Chinese farmers. In contrast, before the economic reform urban householders did not save for retirement and housing, but saving for consumer durables was the most important motivation. In addition, saving for children's marriages was also common in both rural and urban cases (Qian, 1988).

2.4.2 Empirical findings regarding income factor

Qian (1988) estimated three basic models: the Absolute Income Model (AIM), the Permanent Income Model (PIM), and the Asset Adjustment Model (AAM) to estimate the MPS (Marginal Propensity to Save) from various kinds of income.

The AIM is based on Keyesian theory in which saving is expressed as a liner function of current disposable income. From the Absolute Income Model, Qian estimated the urban MPS (Marginal Propensity to Save) to be virtually zero for the period 1955 to 1978. After 1978, the MPS was estimated to be 0.26 in urban areas and ranged from 0.41 to 0.58 in rural areas.

The PIM model separates disposable income into permanent portion and transitory income. In observing the PIM, no significant difference in MPS was observed for urban areas. However, an interesting phenomenon was found in rural areas, that is, the MPS out of permanent income was still low while the MPS out of transitory income was substantially high, and quite notably exceeded 1. Qian believes this result may be interpreted in the following way. Because China is a low income country, for many years households were essentially struggling to meet basic needs: "*Saving was then considered a kind of luxury good, and not a realistic option when income was below a certain level.*" (p, 598) That is to say, during the pre-reform period household incomes were so low that households saved almost nothing from permanent income, hence, only transitory increments of income were saved.

Later research by Feltenstein et al. (1990) strongly supported this finding. They used both official price and virtual price to estimate MPS out of permanent income and transitory income. They found that savings propensities from income were much larger in the official price model than in the virtual price model. They also found in both cases the propensity to save out of transitory income is higher than that out of permanent income.

Finally, the dynamic perspective of Qian's AAM model is that saving may be viewed as a means of accumulating assets. The general reduced form of the asset-adjust model is:

$$S_t = aS_{t-1} + b \Delta Y_t \tag{2.1}$$

Qian's AAM model was based on Houthakker and Taylor (1966), who derived their model from applying a general dynamic demand model to the case where saving is viewed as the acquisition of non depreciating assets. The continuous-time behavioural equations they formulated are:

$$S(t) = A+BW(t)+CY(t) \tag{2.2}$$

$$S(t) = \Delta W(t) \tag{2.3}$$

Where *W(t)* is wealth at time t; *Y(t)* is income at time t; *S(t)* is savings at time t; *B* is MPS of assets and *C* is MPS of income. Since S_t is the savings accumulated in a discrete time period, equation (2.1) can be derived from equation (2.2) and (2.3) with:

$$a = \frac{1+(1/2)B}{1-(1/2)B} \qquad b = \frac{C}{1-(1/2)B}$$

$$B = \frac{2(a-1)}{a+1} \qquad C = \frac{2b}{a+1}$$

Qian found that after the economic reform in 1978, in Chinese urban areas: $S_t = 0.75S_{t-1}+0.28\Delta Y_t$; and in rural areas: $S_t = 0.82S_{t-1}+0.56\Delta Y_tD+0.79\Delta Y_t(1-D)$ where *D* is a dummy variable for 1981 and 1982.

Referring to the methodology of Houthakker and Taylor (1966), Qian calculated that the MPS of assets as *B* = 2*(0.75-1)/(0.75+1) = -0.29 in Chinese urban areas and *B* = 2*(0.82-1)/(0.82+1) = -0.20 in rural areas.

2.4.3 The impact of demographic structure

Similar to Qian's viewpoint, Wakabayashi and Mackellar (1999) also found that before the economic reform, Chinese urban households had less need for saving than rural households. However, since the 1990s, urban and rural households saving rates were not significantly different. They explain this by giving two possible answers:

1. The increase in urban households' income was larger than the increase in rural households' income.
2. Following the economic reform, urban areas had a greater expansion of saving opportunities and financial infrastructure than rural areas.

Wakabayashi and Mackellar also analyzed the impact of demographic structure on Chinese households' savings. As discussed in Table 2-1, Wakabayashi and Mackellar adopted the Absolute Income Model (AIM) and Permanent Income Model specifications employed by Qian, but added demographic variables. Table 2-2 shows the impact of demographic structure on MPS (Marginal Propensity to Save) estimated by Wakabayashi and Mackellar (1999).

Table 2-2. The Impact of Demographic Structure on MPS

Region	Time Period	MPS out of Current Income	
Current Income (AIM Model)			
		Including Dependency	Excluding Dependency
Urban	1995-1997	0.2528	0.2076
Rural	1995-1997	0.4538	0.3674
Permanent Income (PIM Model)			
Region	Time Period	MPS out of Permanent Income	
		Including Dependency	Excluding Dependency
Urban	1995-1997	0.2282	0.1919
Rural	1995-1997	0.4657	0.3463
Transitory Income (PIM Model)			
Region	Time Period	MPS out of Transitory Income	
		Including Dependency	Excluding Dependency
Urban	1995-1997	0.3651	0.286
Rural	1995-1997	0.432	0.455

Source: International Institute for Applied Systems Analysis IR-99-057

2.4.4 Studies on precautionary motivation and income uncertainty

Apart from income and the demographic structure of population, other important determinants of Chinese households' saving include liquidity constraints, limited investment opportunities, precautionary motivation, and income uncertainty.

Two empirical studies by Aaberge and Zhu (2001) and Zhang and Wan (2004), have analyzed the impact of liquidity constraints and limited investment opportunities on Chinese household saving. These studies demonstrated that until the late 1980s, there was no access to commercial credit for Chinese families. They note that because of that credit constraint, it is natural to assume that household saving would play an important role in the acquisition of consumer durables.

A more recent study by Zhang and Wan (2004) also points out that China's financial system is still dominated by the four state owned banks, and not until very recently did the banks start extending consumer credit. When the Chinese consumer consumption basket extends to luxury goods, where purchases usually involve a large cash outlay, they may be forced to put off consumption until enough liquid assets have been accumulated. This kind of forced saving is not due to a shortage of consumer goods as in the pre-reform period, but is owing to a shortage of liquidity.

Zhang and Wan (2004) report that "*when income uncertainty occurs……consumers will increase precautionary savings.*" (p, 2228) Their earlier work of 2002 illustrates that since 1995, uncertainty has been exacerbated by the government's determination to restructure SOEs. As result, 69.6% of households named saving for retirement as one of their top three motivators (Yuan & Song, 1999, cited in Zhang & Wan, 2004). Zhang and Wan note that although saving for retirement is a kind of life cycle behaviour, it was modeled in their work as stemming from precautionary considerations.

Qin (2003) adopted an indirect route to analyze households' savings through estimating Chinese household consumption. Qin found that in both urban and rural areas, there had been a significant motive to save more as a precautionary measure against rising income uncertainty.

Qin modeled this uncertainty in urban and rural districts by averaging per capita income variables in her model. Cross-section data were utilized to construct a pair of variables, YD_u and YD_r for. The specific data used for 30 provinces were urban and rural household income y_{ij} $(i=u,\ r;\ j=1...30)$, and average wage for government agencies, party agencies, and social organizations, w_j $(j=1...30)$ and the ratios of provincial to total population, po_{ij} $(i=u, r; j=1...30)$. To construct YD_u and YD_r, the deviation of w_j from the national average, W, was used as a proxy of the recognized regional income disparity. These deviations were adjusted by W/Y_i $(i=u, r)$ to make them comparable to household income. YD_u and YD_r were then defined as standard deviations of provincial household income net of regional income disparity:

$$YD_i = \sqrt{\sum_{i=1}^{30} PO_{ij}\{[y_{ij}-\frac{wj-W}{W/Yi}]-Y_i\}^2} \qquad i=u,r; j=1...30$$

Qin (2003) pointed out that household saving potential would increasingly decline if income uncertainty stops growing. An additional finding of interest was that compared to urban counterparts, rural households were less sensitive to the real interest rate but far more responsive to income uncertainty. This implies that Chinese rural households have a stronger precautionary saving motive and a weaker sense of maximizing money assets.

2.4.5 Arguments on the interest rate

As for other possible determinants of household saving, the interest rate is often discussed in relation to savings in the relevant literatures. However, the effect of the interest rate on saving and/or consumption is quite contentious. A higher interest rate increases the present price of consumption relative to the future price, and therefore provides an incentive to increase saving (the Substitution Effect). On the other hand, an interest rate rise also raises lifetime income, and thus tends to increase consumption and decrease saving (the Income Effect). Hence, whether interest rates change Chinese household saving behaviour or not is open to debate.

Feltenstein et al. (1990) point out that an increase in real interest rates leads to an increase in savings, and a decrease in consumption. They also note that the real interest rate has considerable importance in influencing saving behaviour, so that macroeconomic policy in China may be more effective than had been previously thought.

However, this contradicts a widely held belief among Chinese economists that most Chinese households are unresponsive to interest rate signals, as evident from the sluggish response of household bank deposits to the severe and consecutive cuts in the interest rate during the period 1996 to 1999 (Qin, 2003). Qin shows that Chinese households are not insensitive to interest rate changes, but their savings response has been offset by indirect assets effects. She argues that the apparently lower savings response is caused by the rapid growth in both disposable income and income uncertainty which could further offset the savings effect of interest rates.

Zhang and Wan (2004) also hold a similar viewpoint. They emphasise that in neither the pre-reform era nor in the post reform era does the interest rate appear to influence household savings. The effect of interest rate changes is largely dominated by those of liquidity constraint and income uncertainty. They finally conclude that "*unless cuts in interest rates can improve credit conditions and reduce income uncertainty, much of the central bank's effort is in vain.*" (p, 2228)

Chen (2002) also investigated the long run relationship between real interest rates, savings, and income. His finding confirms the noticeable impression of previous reports that there is no robust, solid interest rate effect on savings, since the effect of interest rates on savings is ambiguous, as the income effect might offset the substitution effect.

This poses an interesting empirical research question that should not be ignored. Unlike the above two opposite beliefs, Li (1997) points that Chinese household voluntary saving can be clearly explained by real interest rates; only forced saving has a significant affect on market prices. He asserts: "*By distinguishing between savings with different economic natures ……household normal (voluntary) savings can be well explained by the real interest rate……while forced savings are directly the result of worsening of market situation and have nothing to do with the real interest rates.*" (p, 1414)

Li believes that without such a distinction, it is difficult to say whether or not links exist between interest rates and household savings, since normal savings and forced savings are major components of household savings.

2.5 Conclusion

This chapter reviewed the empirical findings about Chinese household saving behaviour. Section 2.1 summarised the twelve most important previous literatures on household saving in China. Section 2.2 reviewed Chinese domestic saving structural changes. Section 2.3 presented "forced saving" prior to the economic reform.

The important determinants of Chinese household saving were discussed in detail in section 2.4. Section 2.4.2 reviewed the impact of income factor on Chinese household saving, while other important determinants including demographic structure of population, precautionary motivation and income uncertainty, as well as interest rates were represented in section 2.4.3, section 2.4.4, and section 2.4.5 respectively.

The next chapter will detail the variables chosen and the data sources. Chapter 3 will also explain the ADF test that is used to test for the unit root and order of integration for all time series variables.

Chapter 3: Variables Chosen and Data Sources

3.1 Introduction

As discussed in Chapter 1 three models are employed in our study to analyze Chinese household saving function; namely the basic life cycle model, the extended life cycle model, and the adjusted life cycle model. This chapter explains the variables chosen and the data sources.

3.2 Variables Involved in the Basic Life Cycle Equation

The econometric variables involved in the basic life cycle (LCH) equation are: income growth rate (GY), elderly dependency ratio (ADEP), and household wealth (WL).

According to LCH, a household is predicted to accumulate assets during the prime working years, and then draw them down after retirement. The model then predicts that consumption and/or saving in a particular period depends on expectations about lifetime income. In this study, per capita income growth rate is used, and the coefficient sign of this variable should be positive.

Because the legal retiring age is 60 in China, the elderly dependency variable in our study is measured as the ratio of the population over 60 to the working age population from 19 to 60. As one of the major determinants of household saving rate, age structure of the population can be treated as uniquely related to population growth under the assumption of "balanced population growth" (Modigliani, 1986).

In the case of China, the effects of the above two determinants are very ambiguous. On the one hand, because China has a rapidly growing economy, active people (savers) in China are generally richer than the retired people (dissavers). On the other hand, a decrease in population growth rate caused by the "single child policy" may drive the number of savers related to the number of dissavers downward. That is to say the fast economic growth in China may encourage a higher aggregate saving rate while the decreasing population growth may have a negative impact on the aggregate saving rate.

Another determinant of household saving suggested by the life cycle hypothesis is wealth. Wealth is postulated to have a negative effect on Chinese household saving. Accumulated wealth reduces a household's dependence on current income sources, because households can draw on accumulated assets to maintain their consumption level. Ideally, household wealth series should be used here, but there are no estimates of total household wealth in China. As Athukorala and Tsai (2003) suggested, financial wealth measured as the sum of M2 is therefore used as a proxy for household wealth.

3.3 Variables Involved in the Extended Life Cycle Equation

Modigliani (1986) extended the basic life cycle model by including two more influences on household saving: the real interest rate (RID), and social security payments (SSP).

As mentioned earlier, the effect of real interest rates on saving and/or consumption in the model is ambiguous. As Athukorala and Tsai (2003) argued, a higher interest rate increases the present price of consumption relative to its future price, therefore providing an incentive to increase saving (the Substitution Effect). On the other hand, an interest rate rise also raises lifetime income, and thus tends to increase consumption and decrease saving (the Income Effect). Consequently, an increase in real interest rate will drive household saving to rise only if the substitution effect is stronger than the income effect.

Modigliani (1986) suggested that the availability of social security payments impact on saving through changing household's perceived lifetime income. The smaller coverage of the social security system and of pension schemes is most likely to provide an added incentive for thrift and saving (Modigliani & Sterling, 1983; Feldstein, 1974).

3.4 Variables Used in the Adjusted Life Cycle Equation

The adjusted life cycle equation is the final equation of our study. The variables involved in this equation are income growth rate variable (GY), elderly dependency variable (ADEP), real interest rate variable (RID), household wealth variables (WL), social security payments variables (SSP) and unemployment rate variable (UEM).

Comparing the adjusted model with the more traditional life cycle models, it is clear the unemployment variable (UEM), which captures income uncertainty, is newly introduced. The purpose of introducing an unemployment variable into our model is to proxy income uncertainty. Income uncertainty is often discussed as another determinant in previous studies. As discussed above, researchers such as Yuan and Song (1999), Qin (2003), and Zhang and Wan (2002, 2004) assert that the precautionary motive related to macroeconomic uncertainty can be an important consideration behind saving. Guided by these previous studies, the rates of unemployment should thus be employed in a Chinese household saving function analysis model.

3.5 Data Sources

We use annual data with the sample period 1978 to 2003. As discussed above, the variables used are income growth rate (GY), elderly dependency rate (ADEP), household wealth (WL), real interest rate (RID), social security payments (SSP), and unemployment rate (UEM). Each variable will be discussed in detail in the following sections. The major source of the data is *The Statistical Year Book of China*, various issues, while the M2 series is obtained from the International Monetary Fund's International Finance Statistics. All data are presented in Appendix 1.

3.5.1 Income growth rate (GY)

The income growth rate variable is defined as the growth rate of Chinese household disposable income. As discussed before, this variable is one of the core variables of the life cycle hypothesis. The disposable income data are sourced from *The Statistical Year Book of China*, various issues, and then, the income growth rate (GY) series is calculated by the author.

3.5.2 Elderly dependency rate (ADEP)

We defined the elderly dependency rate as the ratio of the population over 60 to the working age population from 19 to 60, because the legal retiring age in China is 60. During the research period 1978 to 2003, the elderly dependency ratio in China increased gradually from 14.27% in 1978 to 20.12% in 2003. The elderly dependency ratio (ADEP) data is sourced from *The Statistical Yearbook of China*, various issues.

3.5.3 Household wealth (WL)

The household wealth variable measures household wealth as a ratio of household disposable income. This proxy has to be used due to data limitations. Ideally, the household wealth series should be used here, but there are no estimates of total household wealth in China. Financial wealth measured as the sum of M2 will therefore be used as a proxy for household wealth. The financial wealth data are sourced from International Financial Statistics (IFS). Notice that because our proxy for household wealth captures only financial wealth, it may not be a safe proxy to measure total Chinese household wealth.

3.5.4 Real interest rate (RID)

We defined the real interest rate (RID) as the nominal interest rate minus the inflation rate. Both nominal interest rate data and inflation rate data are sourced from *The Statistical Yearbook of China*, various issues.

3.5.5 Social security payments (SSP)

The social security payments variable (SSP) is defined as a ratio to household disposable income. The social security payments series constitutes three parts which are: employees' security payments paid by SOEs, social welfare payments, and social security payments. As with other data series, these three series are sourced from *The Statistical Yearbook of China*, various issues, as is the household disposable income data.

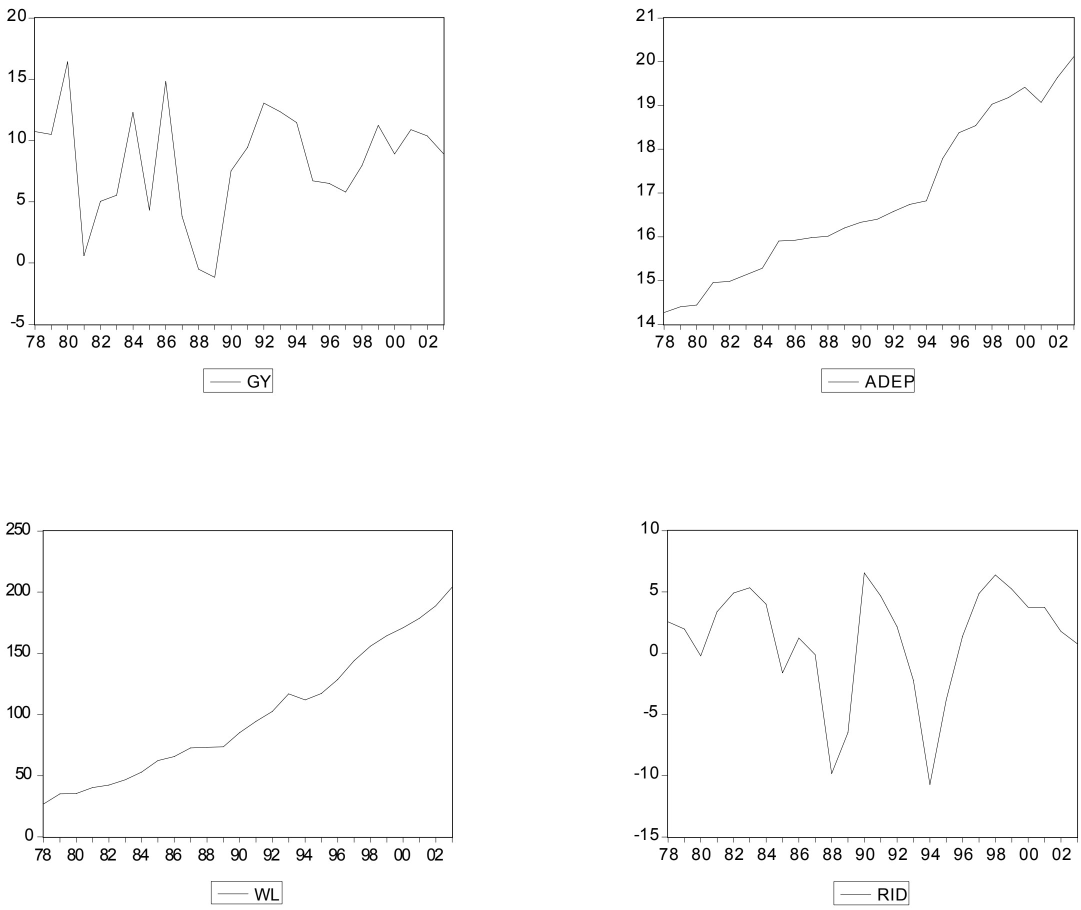
3.5.6 Unemployment rate (UEM)

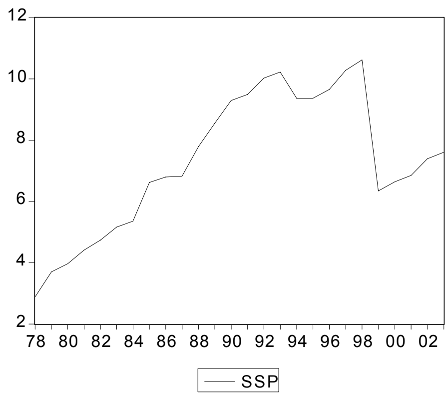
Empirically, there are many different ways to capture income uncertainty outlined in previous literatures. In this present study, the income uncertainty variable, UEM is defined as the unemployment rate. The unemployment rate (UEM) data are the same as other data, sourced from *The Statistical Yearbook of China*, various issues.

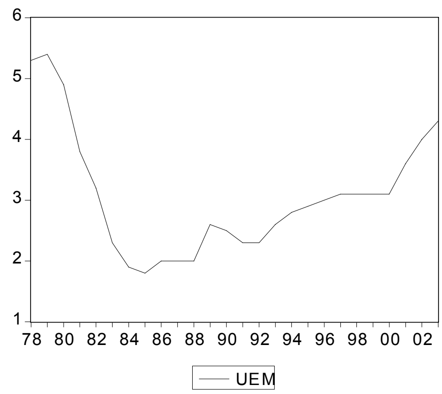
3.6 Time Plots of the Variables

The following graph plots these six variables in our models, See Graph 3-1:

Graph 3-1. Time Series in Our Models







3.7 Testing for Unit Roots

Before the econometric analysis in the following Chapter, it is necessary to test for unit roots in the data. When a time series has one or more unit roots, the series is said to be nonstationary. It is well documented that macroeconomic time series variables are usually nonstationary, which raises important econometric issues (Nelson & Plosser, 1982).

A time series, Y_t, is stationary if its probability distribution does not change over time; that is, if the joint distribution of (Y_s, Y_{s+1},……Y_{s+T}) does not depend on the starting date, s (Stock & Watson, 2003). A stationary series tends to revert to its constant mean (Enders, 1995). The following equations (3.1 to 3.3) present the requirements for a "weakly stationary" series (Verbeek, 2004, p. 259).

$$E(Y_t) = E(Y_{t+i}) = \mu < \infty \quad (3.1)$$

$$E[(Y_t - \mu)^2] = E[(Y_{t+i} - \mu)^2] = \delta^2 < \infty \quad (3.2)$$

$$E[(Y_t - \mu)(Y_{t+i} - \mu)] = E[(Y_{t+j} - \mu)(Y_{t+j+i} - \mu)] = \Upsilon_i \quad (3.3)$$

where E stands for unconditional expectations operator and Υ_i is dependent on the time interval between variable Y_t and variable Y_{t+i} rather than on the time point t.

If a time series variables is nonstationary and must be differenced n times before it becomes stationary, then it contains n unit roots, indexed as I(n) (Harris, 1995). In that case, conventional OLS-based statistical inferences (hypothesis tests) can be misleading (Stock & Watson, 2003; Enders, 1995; Harris, 1995). In particular, models containing nonstationary variables will often lead to a problem of spurious regression. This means that the results obtained from the model may suggest that there are statistically significant relationships between the variables; however, those findings are typically evidence of contemporaneous correlations rather than meaningful causal relations.

3.7.1 Augmented Dickey Fuller tests

There are several methods that can be used to test for unit roots, including the Augmented Dickey-Fuller (ADF) test (Dickey & Fuller, 1979, 1981), the Phillips-Perron test (Phillips and Perron, 1988), and the Kwiatkowiski-Phillips-Schmidt-Shin (KPSS) test (Kwiatkowiski, Phillips, Schmidt & Shin, 1992). De Jong et al. (1992) note that the ADF test is more useful in practice because of its high explaining power, which is about 0.33 compared to less than 0.1 in Phillip-Perron test. Harris (1995) agrees that although there are other tests, the ADF test tends to be more popular either because of its simplicity or its more general nature. This is the test used in this thesis.

The ADF test is known as a parametric approach, which keeps adding higher-ordered lagged terms to the model until the auto correlated errors are corrected (Hwa, 2002). The ADF regressions must allow for the possibility of a constant mean with trend and of a constant mean with no trend.[1] The respective regressions are based on the following equations:

$$\Delta y_t = a + \gamma y_{t-1} + \sum_{i=2}^{p} \gamma_i \Delta y_{t-i+1} + \beta t + \varepsilon_t \tag{3.4}$$

$$\Delta y_t = a + \gamma y_{t-1} + \sum_{i=2}^{p} \gamma_i \Delta y_{t-i+1} + \varepsilon_t \tag{3.5}$$

where $\gamma = -\left(1 - \sum_{i=1}^{p} \alpha_i\right)$;

$\beta_i = \sum_{j=i}^{p} \alpha_j$;

ε_t is the white noise error term.[2]

Table 3-1 shows a summary of the ADF test procedure.

Table 3-1. ADF Test Procedure

Steps	Null Hypothesis Versus Alternative Hypothesis	Result
1. Using Equation 3.4 (with constant and trend)	H_0: $\gamma = 0$ (y_t has a unit root)	a. reject H_0, y_t is stationary, I(0);
	H_1: $\gamma < 0$ (y_t is stationary)	b. accept H_0, proceed to step 2.
2. Using Equation 3.5 (with constant)	H_0: $\gamma = 0$ (y_t has a unit root)	a. reject H_0, y_t is stationary, I(0);
	H_1: $\gamma < 0$ (y_t is stationary)	b. accept H_0, y_t has a unit root, I(1) or higher.

When a time series variable has a unit root, the above ADF test procedure is repeated

[1] There is a third possibility of no constant mean and no trend, but this is rarely used in practice (see Verbeek, 2004, p. 271, fn.4).

[2] When ε_t is white noise, $E(\varepsilon_t) = 0$, $E(\varepsilon_t \varepsilon_t^{'}) = \sum_{\varepsilon}$ and $E(\varepsilon_t \varepsilon_s^{'}) = 0 \ (t \neq s)$, where E is the unconditional expectations operator, $\sum_{\varepsilon}$ is the covariance matrix for the shocks expressed as a $n \times n$ diagonal positive definite matrix.

to test for a unit root in the first difference level of that variable based on the equation:

$$\Delta^2 y_t = a + \lambda \Delta y_{t-1} + \sum_{i=2}^{p} \varphi_i \Delta^2 y_{t-1+i} + bt + \varepsilon_t \qquad (3.6)$$

Where Δ denotes the first difference operator. The testing procedure continues until the null hypothesis is rejected and I(p) is determined.

3.7.2 Critical value of the ADF statistic

The test of null hypothesis, $\gamma = 0$ in equations (3.4), (3.5) and (3.6), depends on whether the t-ratio is greater or less than the critical value at conventional significant level. Dickey and Fuller (1979) pointed out that under the null hypothesis of a unit root, the ADF statistics do not have a normal distribution, even in larger samples. Because its distribution is nonstandard, the usual critical values from the normal distribution cannot be used when using the ADF test. A special set of critical values, based on the distribution of the ADF statistics under the null hypothesis, must be used instead. The critical values in the ADF test depend on the sample size. The critical values for the ADF test for T=25 are given in Table 3-2 (Fuller, 1976, p.373).

Table 3-2. Critical Value of the ADF Statistic (T=25)

Deterministic Regressors	**5%**	**1%**
Constant Only	-3	-3.75
Constant and Trend	-3.6	-4.38

3.7.3 Determining the number of lags to be included

To determine the order of the AR process, one strategy is to include lags whose coefficients are significantly different to zero; another more common strategy is to use a lag selection criterion such as the Akaike information criterion (AIC) or the Hannan-

Quinn information criterion (HQ). In this study, the Hannan-Quinn information criterion is used to choose the number of lags to be included.

3.8 Determining the Integrating Order of Variables

Following the procedure in Table 3-1, we apply the ADF unit root tests in equation (3.4) and (3.5) to the level data of each variable. Eviews software was used to produce the results reported in Table 3-3 and Table 3-4 respectively.

Table 3-3. ADF Test With Constant and Trend

	Variables	SHR	GY	ADEP	WL	SSP	RID	UEM
Level I(0)	ADF Statistics	-2.5396	-1.7692	-1.7824	1.3282	-1.3401	-3.6338	-3.7898
	Lag Length	0	0	0	5	0	1	1
	P-value	0.3081	0.6812	0.6828	0.9999	0.8534	0.0452	0.0352

Table 3-4. ADF Test With Constant

	Variables	SHR	GY	ADEP	WL	SSP	RID	UEM
Level I(0)	ADF Statistics	-2.2931	-1.2406	-0.5833	5.2393	-2.0701	NA	NA
	Lag Length	0	0	0	5	0	NA	NA
	P-value	0.1817	0.6353	0.9862	1.0000	0.2574	NA	NA

Table 3-3 applies the ADF test with constant and trend. The P-values for RID and UEM are 4.52% and 3.52%, so that we are able to reject the null hypothesis at the 5% level that these two variables have a unit root. These series are assumed to be stationary.

Table 3-4 applies the ADF test with constant and no trend to the remaining five variables. As in Table 3-3, their P-values are all great than 5%, suggesting that they have at least one unit root, and so are integrated of order one or higher.

The results of Table 3-3 and 3-4 are consistent with the graphs of the variables (see Graph 3-1). The series all show an apparent trend, except for RID and UEM. To determine if the order variables are I(1) or I(2) (or higher), we apply the ADF test to the first differenced data (the model is presented in equation 3.6), to test the null hypothesis that the differenced data have a unit root. The results are summarised in Table 3-5.

Table 3-5. ADF Test For First Differenced Data

	Variables	SHR	GY	ADEP	WL	SSP
First Difference I(1)	ADF Statistics	-6.1158	-5.2077	-4.9221	-5.1932	-4.7473
	Lag Length	0	0	0	4	0
	P-value	0.0002	0.0025	0.0032	0.0025	0.001

As with the previous procedure, the choice of lag length is based on the Hannan-Quinn information criterion (HQ). The ADF test for the first difference data includes the constant and trend for all other variables. We reject the null hypothesis at the 5% level of significant for the first-differenced data of all variables. Therefore, we conclude that the SHR, the GY, the ADEP, the WL, and the SSP are all I(1).

Note that the ADF test results suggest that the variables in the extended life cycle model and the adjusted life cycle model are not integrated in the same order. Consequently, regarding these two models, cointegration econometric procedures that are appropriate for I(1) variables are not applicable. This is because "if two series are not integrated in the some order, then these two series cannot possibly be cointegrated as the I(0) series has a constant mean while the I(1) series trends to drift over time" (Harris & Sollis, 2003). For the basic life cycle model in equation 1.2, all of the variables are I(1).

The next chapter explores the power of the life cycle hypothesis for explaining savings behaviour by Chinese households after 1978.

Chapter 4: Estimation of the Life Cycle Models

Recall from equation (1.2) that the basic life cycle hypothesis involves the household saving rate (SHR), the income growth rate (GY), the elderly dependency ratio (ADEP), and household wealth (WL). According to the ADF test results in the previous Chapter, all four variables are integrated of order one. Estimation of the basic life cycle model therefore can begin by testing for cointegration.

4.1 Cointegration Test

When Modigliani proposed his life cycle models, econometric methods generally involved regressing the dependent variable against the independent variables and testing for significance. Such a model is shown in equation 4.1.

$$SHR_t = \alpha + \beta_1 GY_t + \beta_2 ADEP_t + \beta_3 WL_t + \varepsilon_t \quad (4.1)$$

Where:

1. *SHR* is the household saving rate,
2. *GY* is the growth rate of real household disposable income,
3. *ADEP* is elderly dependency ratio of the population over 60 to the working age population,
4. *WL* is household wealth as a ratio of household disposable income,
5. *t* is a time subscript.

As explained in the previous section, that technique is now recognised as inappropriate, since if the variables are all integrated of order one (as they are in this example), then this can produce spurious correlation.

There is, however, one circumstance under which it is appropriate to test the model in (4.1), and that is when the variables are cointegrated. The basic idea of cointegration is that if there is a long run relationship between the variables in (4.1), so that the variables all share a common trend, then we can find an integrating vector such that the residuals, ε_t, in the equation are I(0); see, for example, Verbeek (2003, p. 314-317). Consequently, this chapter begins with a test of whether the variables in equation (4.1) are cointegrated.

The test applied here is drawn from Verbeek (2003, p. 316). It is an augmented Dickey Fuller test applied to an equation with one dependent variable and three explanatory variables. The critical values for a model with four variables are -4.64 (1% level), -4.10 (5%) and -3.81 (10%) (Davidson & MacKinnon, 1993, cited in Verbeek, 2003, p. 316). Eviews software was used to estimate (4.1) using ordinary least squares, and the ADF test was applied to the residuals. The value of the ADF statistic was -3.28, and so the null hypothesis of no cointegration was not rejected. Note that non rejection of the null hypothesis does not necessarily imply that the variables are not cointegrated (due to the low power of the test against close alternatives). Nevertheless, the non rejection of no cointegration means that it would be inappropriate to estimate equation (4.1) due to spurious regression problem. Instead, the following sections test the model using the autoregressive distributed lag model to cointegration and the error correction modelling. These models avoid the problem of spurious regression by including lagged values of the dependent variable as explanatory variables.

4.2 The ARDL Model and the ECM Model

The general form of the autoregressive distributed lag model (ARDL) is shown in equation (4.2)

$$Y_t = a + \sum_{i=1}^{m} A_i Y_{t-i} + \sum_{i=0}^{m} B_i X_{t-i} + u_t \tag{4.2}$$

Note that it includes previous values of Y_t on the right hand side of the equation (and so is autoregressive), and includes lagged values of Y_t and X_t.

Part of the procedure of estimating an ARDL model requires determining an appropriate lag structure for the model. Let p be the number of lags for the dependent variable and q be the number of lags for the independent variable. Choosing p and q involves trade-offs between omitting information and adding estimation error through overspecification. There are formal techniques available for choosing p and q, such as the Akaike Information Criterion and the Hannan-Quinn Information Criterion (as discussed earlier in this thesis; see, for example, Stock & Watson, 2003). The method adopted in this thesis is to use the latter technique, the Hannan-Quinn Information Criterion (HQ).

The ARDL model gives the long run equilibrium relationship in the equation being tested. It can also be reformulated as an error correction model (ECM) to highlight the role of short term adjustments towards a long term equilibrium in the equation. Consider, for example, the following ARDL model, which involves one independent variable and single lags for both p and q.

$$Y_t = \delta + \alpha_1 Y_{t-1} + \beta_0 X_t + \beta_1 X_{t-1} + \mu_t \quad (4.3)$$

This equation can be rewritten as:

$$\Delta Y_t = \delta + (\alpha_1 - 1) Y_{t-1} + \beta_0 \Delta X_t + (\beta_0 + \beta_1) X_{t-1} + \varepsilon_t \quad (4.4)$$

Collecting the two lagged terms together then produces the following specification:

$$\Delta Y_t = \beta_0 \Delta X_t + (\alpha_1 - 1)[Y - \{\delta/(1-\alpha_1) + (\beta_0+\beta_1)/(1-\alpha_1)X\}]_{t-1} + \varepsilon_t$$

$$= \beta_0 \Delta X_t + \lambda[Y - (\Upsilon_0 + \Upsilon_1 X)]_{t-1} \quad (4.5)$$

This specification is known as the error correction model. It shows a long run relationship between Y_t and X_t, plus a mechanism for moving the variables towards that relationship in the short term (Verbeek, 2004, p. 311; Ward, 2005). The next two subsections apply the ARDL and the ECM to the basic and extended life cycle models introduced by Modigliani and Brumberg (1954) and Modigliani (1986).

4.3 The Basic Life Cycle Model Estimation

4.3.1 Determining the lag length of ARDL and diagnostic test

Since the long run equilibrium is obtained from the ARDL model, the lag length of the ARDL model has to be decided first. As discussed before, the choice of lag length is based on the Hannan-Quinn information criterion.

Annual data is being used, and therefore the initial lag length is set on all variables in the general ARDL equation for two periods. This is the established practice in modelling with annual data (Athukorala & Tsai, 2003). To confirm the choice of two lags to be included in the ARDL, we perform Hannan-Quinn information criterion, which minimises: $-2(l/T) + 2k\log(\log(T))/T$, where l is the sum of squared residuals.

We used Microfit software to estimate the ARDL model for our basic life cycle equation (1.2). The outputs are summarised in Table 4-1.

Table 4-1. ARDL Estimates for the Basic Life Cycle Model

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
SHR(-1)	0.42779	0.15835	2.7015[0.014]
GY	0.24475	0.089025	2.7492[0.013]
ADEP	-2.2878	1.3731	-1.6662[0.112]
WL	0.084749	0.047042	1.8016[0.088]
C	54.8182	21.9913	2.4927[0.022]

From the above table, it is clear that an ARDL (1,0,0,0) model is selected. The P-values of GY, ADEP, and WL are 1.3%, 11.2%, and 8.8% respectively, showing that the income growth rate variable is statistically significant as well as the household wealth variable (at the 10% level), while the demographic dependency variable does not significantly affect Chinese household saving rates.

The diagnostic test results for our basic life cycle model are given in Table 4-2. The null hypothesis of the autocorrelation LM test is that there is no autocorrelation. According to the Microfit outputs, shown in the first row of Table 4-2 the P-value is 60.1% and, the LM statistic for our basic life cycle model was 0.27347. We thus conclude that there is no autocorrelation problem of residuals existing in our basic life cycle model, since the P-value of the LM test is greater than 5%.

The null hypothesis of the normality test is that the residuals are multivariate normal. For our basic life cycle model, the Microfit outputs suggest that the P-value of the normality test is 99.2%. Consequently, it is safe to conclude that the residuals are multivariate normal in our ARDL estimation, since the P-value of the normality test is greater than 5%.

The null hypothesis of the heteroscedasticity test is that there is no heteroscedasticity in the residuals. As with other diagnostic tests, the Microfit outputs represent that the P-value of the heteroscedasticity test is 9.3%, which is greater than the critical value of 5%. We thus conclude that the heteroscedasticity does not exist in the residuals.

Table 4-2. Diagnostic Tests for the Basic Life Cycle Model

Tests	**P-values**
Serial Correlation	0.601
Normality	0.992
Heteroscedasticity	0.093

From the above table, it is clear that our basic life cycle equation comfortably passed the diagnostic tests, reflecting the reliability of our basic life cycle equation.

4.3.2 The long run coefficients and ECM model

Based on the selected ARDL (1,0,0,0) model, we can obtain the long run coefficients and the ECM model, as the following tables show.

Table 4-3. Estimated Long Run Coefficients

Regressor	**Coefficient**	**Standard Error**	**T-Ratio[Prob]**
GY	0.42772	0.2125	2.0128[0.059]
ADEP	-3.9982	2.3504	-1.7011[0.105]
WL	0.14811	0.079731	1.8576[0.079]
C	95.8013	32.1582	2.9791[0.008]

From table 4-3, we can conclude that the long run coefficients of income growth rate and household wealth are significant at the 10% level.

Table 4-4. Error Correction Representation

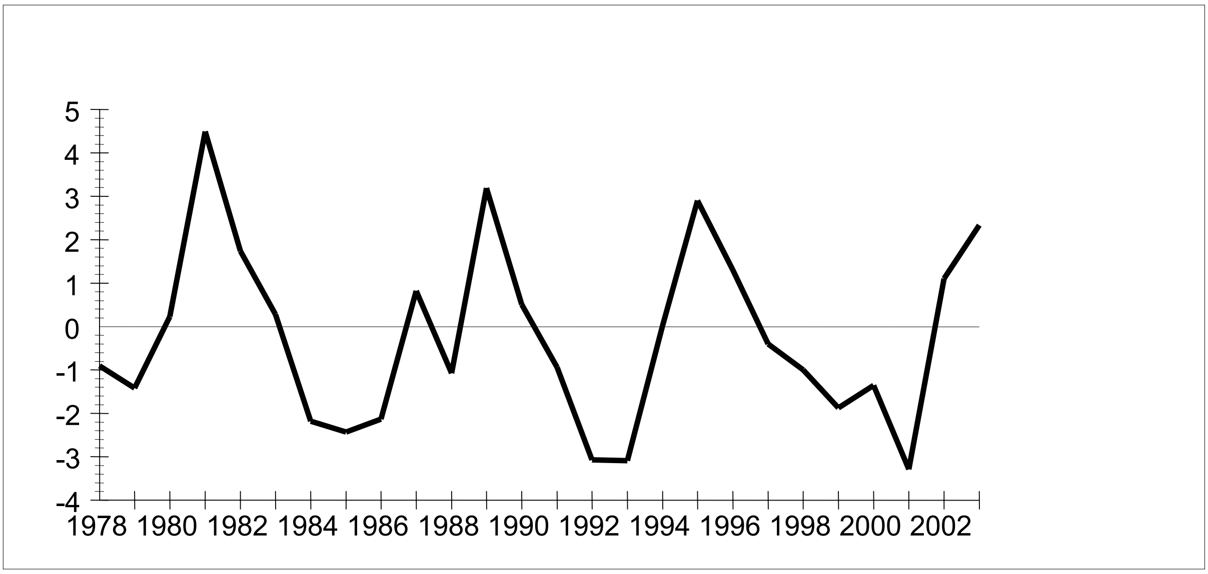
Regressor	Coefficient	Standard Error	T-Ratio[Prob]
DGY	0.24475	0.089025	2.7492[0.013]
DADEP	-2.2878	1.3731	-1.6662[0.112]
DWL	0.084749	0.047042	1.8016[0.088]
DC	54.8182	21.9913	2.4927[0.022]
ECM(-1)	-0.57221	0.15835	-3.6135[0.002]

Similar to the long run coefficients, the coefficients of the changes in the income growth rate variable and the household wealth variable are also statistically significant. However, the coefficient of changes in the demographic variable is again statistically insignificant.

The T-test is not appropriate to test whether the ECM parameter is significant, instead we can use the critical value derived from Banerjee et al (1998), which for 3 regressors and 25 observations at the 10% level is -3.46 and at the 5% level is -3.91. The null hypothesis that the parameter = 0 can be rejected at the 10% level (but not the 5% level).

The representation theorem of Granger (1983) and Engle and Granger (1987) means that if the variables are all I(1) and have an error correction representation, then the variable are necessarily cointegrated (Verbeek, 2003, section 9.2.3). Further evidence that the variables are cointegrated comes from Graph 4-1, which plots the implied residuals from the dynamic model in Table 4-1. Thus, contrary to the weak power test used in section 4.1, this section has provided evidence that the variables are cointegrated according to Modigliani and Brumberg’s original model.

Graph 4-1. Implied Residuals from Dynamic Model



4.3.3 Comparison with Modigliani and Brumberg (1954)

Modigliani and Brumberg (1954) introduced their original model to explain the saving behaviour of United States households. The model estimated here for Chinese households fifty years later has some interesting features.

First, the coefficient on the income growth variable is positive (as expected) and statistically significant. This confirms the basic insight of the life cycle hypothesis.

Second, the coefficient on the demographic dependency variable is of the correct sign, although not statistically significant.

Third, and most interesting, the coefficient on the household wealth variable is significant and positive. The expected relationship is that as wealth rises relative to income, the household saving rate will decline. Instead, this analysis of China saving behaviour suggests the opposite. This could help to explain the very high rates of economic growth in China in recent years.

4.4 The Extended Life Cycle Model Estimation

4.4.1 ARDL approach and diagnostic test

The above procedure was repeated in order to determine the lag length of the ARDL model for equation (1.3). Again, the choice of lag length was based on the Hannan-Quinn information criterion. To be acceptable, the estimated equation must satisfy various diagnostic tests.

Compared to the basic life cycle model, Modigliani's (1986) extended life cycle model has two more variables: the real interest rate (RID) and social security payments (SSP). Because of the limited sample size in our study, the lag number of three or more is not allowed in estimating ARDL, and the initial lag length was therefore set on all variables in the general ARDL equation at two periods.

After including two more variables, the life cycle hypothesis works much better in explaining Chinese household saving behaviour. The outputs estimated by using ARDL approach are summarised in the following Table 4-5.

Table 4-5. ARDL Estimates for the Extended Life Cycle Model

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
GY	0.13003	0.058968	2.2051[0.046]
ADEP	-3.1208	0.91468	-3.4120[0.005]
ADEP(-1)	-5.313	0.95744	-5.5492[0.000]
WL	0.16758	0.067943	2.4664[0.028]
WL(-1)	0.36984	0.095346	3.8789[0.002]
WL(-2)	-0.23362	0.079659	-2.9328[0.012]
RID	0.24264	0.076737	3.1620[0.007]
RID(-1)	-0.3883	0.09262	-4.1924[0.001]
RID(-2)	-0.15015	0.059774	-2.5120[0.026]
SSP	-0.739	0.16253	-4.5467[0.001]
C	161.2884	13.7402	11.7385[0.000]

From the above table, it is clear that an ARDL (0,0,1,2,2,0) model has been selected. The P-values of all variables are highly significant at the 5% level, showing that all these predictors are closely related to the Chinese household saving rate.

The long run coefficients of these variables are statistically highly significant at the 1% level, expect the long run coefficients on the income growth rate variable. The P-value of the income growth rate variable (GY) is 4.6%, which is still significant at the 5% level (see Table 4-6).

Table 4-6. Estimated Long Run Coefficients			
Regressor	**Coefficient**	**Standard Error**	**T-Ratio[Prob]**
GY	0.13003	0.058968	2.2051[0.046]
ADEP	-8.4338	0.99253	-8.4973[0.000]
WL	0.3038	0.033271	9.1309[0.000]
SSP	-0.739	0.16253	-4.5467[0.001]
RID	0.29581	0.095747	3.0894[0.009]
C	161.2884	13.7402	11.7385[0.000]

We repeat various diagnostic tests in the extended life cycle model, to test its reliability (see Table 4-7). Recalling the autocorrelation LM test, the normality test and the heteroscedasticity test that from the basic life cycle model, the null hypotheses of these three diagnostic tests are there is no autocorrelation, the residuals are multivariate normal, and there is no heteroscedasticity in the residuals. To pass these diagnostic tests, the P-values of these diagnostic tests must be greater than the margin level, otherwise, the null hypotheses is rejected.

For our extended life cycle model, the LM statistics are 1.9946, while the P-value is 15.8%. It is thus concluded that there is no autocorrelation problem of residuals existing in our basic life cycle model, since the P-value of the LM test is greater than 5%.

The normality test reports that the P-value of the normality test is 22.4%. Consequently, it is quite safe to conclude that the residuals are multivariate normal in the ARDL estimation, since the P-value of the normality test is greater than 5%.

Finally, the P-value of the heteroscedasticity test is 22.8%, which is also greater than the critical value of 5%. We thus conclude that the heteroscedasticity problem does not exist in the residuals. Since our extended life cycle model passed various diagnostic tests comfortably, there is no reason to doubt the reliability of the extended life cycle model.

Table 4-7. Diagnostic Tests for the Extended Life Cycle Model

Tests	**P-values**
Serial Correlation	0.158
Normality	0.224
Heteroscedasticity	0.228

4.4.2 Empirical findings from the extended life cycle model

This life cycle model was extended by Modigliani in explaining American household saving rates.

We replicated this extended life cycle model in our study, to test whether it can successfully explain Chinese household saving behaviour or not. Compared with the basic life cycle model, the extended life cycle model was much better at explaining Chinese household saving behaviour.

The extended life cycle model suggests that income growth rate, real interest rate, and social security payments have significant impacts on Chinese household saving. This statistical evidence suggests that:

1. As Chinese household income grows faster, their saving rate increases.
2. During the post reform period, Chinese households are very sensitive to real interest rates.
3. The absence of significant government emphasis on the provision of social welfare appears to have been a key factor in the rapid expansion of household saving in China.
4. An increase in the age dependency ratio tends to lower saving rates (although note that the parameter is statistically insignificant in the basic life cycle model).
5. Contrary to the hypothesis suggested by Modigliani's work, saving rates in China tend to increase as the ratio of household wealth to income rises.

4.5 Testing the Adjusted Life Cycle Model

The previous sections estimated the traditional life cycle models, however, both the basic life cycle model and the extended life cycle model ignore the income uncertainty factor which is often considered as another important determinant of Chinese household saving rate in many previous literatures. Consequently, in this section, the income uncertainty variable (UEM) is introduced into the adjusted life cycle model.

The adjusted life cycle model is now considered here. In this model a new unemployment rate variable (UEM) is included, for the purpose of capturing how income uncertainty affects Chinese household saving rates. A useful proxy for income uncertainty is unemployment, Athukorala and Tsai (2003) used the unemployment series as an explanatory variable in order to capture the income uncertainty factor in a Taiwanese household saving function analysis model. They found that there is no evidence of a long term impact of unemployment on the Taiwanese household saving rate, but the coefficient on the change in unemployment is statistical significant. Guided by this previous study, the unemployment rate variable (UEM) is added to the extended life cycle model.

Again, we set the initial lag length on all variables in the general ARDL equation at two periods. The ARDL estimation results are given in Table 4-8.

Table 4-8. ARDL Estimation for the Adjusted Life Cycle Model			
Regressor	**Coefficient**	**Standard Error**	**T-Ratio[Prob]**
GY	0.14168	0.062047	2.2835[0.041]
ADEP	-2.965	0.95446	-3.1065[0.009]
ADEP(-1)	-4.7938	1.2005	-3.9933[0.002]
WL	0.14657	0.074745	1.9610[0.074]
WL(-1)	0.32035	0.11782	2.7190[0.019]
WL(-2)	-0.18858	0.10135	-1.8608[0.087]
SSP	-0.59282	0.25752	-2.3021[0.040]
RID	0.21405	0.087122	2.4569[0.030]
RID(-1)	-0.3355	0.11819	-2.8386[0.015]
RID(-2)	-0.13644	0.063595	-2.1454[0.053]
UEM	0.3427	0.46268	.74069[0.473]
C	150.6247	20.0713	7.5045[0.000]

Table 4-8 represents that there is no previous value on the dependent variable SHR, and therefore no longer an ECM model and also, the P-value of the income uncertainty variable (UEM) is statistical insignificant and it is the only variable that is insignificant, thus, we conclude that Modigliani's (1986) extended life cycle model is our preferred model in analysing Chinese household saving function.

4.6 Conclusion

This chapter applied the cointegration test, the ARDL approach, and the ECM approach to analyse the basic life cycle model and the extended life cycle model. Based on the ARDL approach, we obtained the long run coefficients of the predictors involved in our analysis. The signs of the estimated equations are generally consistent with the theory, except for household wealth (WL). Household wealth is positively related to the Chinese household saving rate. That is during the post reform period, Chinese households' wealth increased, and householders became richer, but their saving rate also increased. This behaviour helps to explain the very fast rate of capital accumulation and economic growth experienced in China since 1978.

In addition to the traditional life cycle models, we added the income uncertainty variable to the extended life cycle model. However, the statistical evidences suggest that adding the income uncertainty variable does not improve the previous life cycle models.

Chapter 5: Summary and Conclusions

5.1 Overview of the Research

The principal research question in this study was to ascertain the determinants of Chinese household saving. Since the life cycle model is often employed to analyze household saving function in many other countries, but not in China, this study explored whether the life cycle model can contribute to understanding Chinese household saving behaviour.

The study first reviewed some background information about Chinese household saving in Chapter 1, where different household saving function analysis models were reviewed, providing reasons as to why the life cycle model was employed to analyze the household saving behaviour in China. In Chapter 2, some empirical findings about savings in China were considered. Chinese domestic saving structural changes after the economic reform were discussed in detail as well as repressed inflation and forced saving in China before 1978. In addition, some arguments on the important determinants of Chinese household saving were considered.

Following this, Chapter 3 explained the variables chosen and the data sources. The ADF test was also used in Chapter 3 to analyse the stationarity of the variables. In Chapter 4, the cointegration test, the ARDL approach, and the ECM approach were clearly described. Cointegration was found in the basic life cycle model. By applying the Hannan-Quinn information criterion and the ARDL approach, we found the appropriate lag orders of explanatory variables in our models. Based on the results estimated by the ARDL model, the long run equilibrium was defined. Submitting the long run equilibrium to the ECM approach, both short run and long run effects of the determinants were explored and the research questions were thus answered. The results of the empirical tests were discussed in Chapter 4.

5.2 Main Findings of the Research

The estimated equations provide some information for policymakers. The basic life cycle model shows that the coefficients of income growth rate variable (GY) and household wealth variable (WL) are statistically significant. However, the household saving rate appears to be insensitive to the demographic variable (ADEP). In addition, the coefficient of the household wealth variable (WL) is positively signed, which is inconsistent with the initial prediction, reflecting that during the post reform period, as Chinese householders become richer their saving rate also increased.

Compared with the basic life cycle model, the extended life cycle model includes two more variables which are real interest rate variable (RID), and social security variable (SSP). Variables involved in the extended life cycle model are income growth rate variable (GY), household wealth variable (WL), demographic variable (ADEP), real interest rate variable (RID), and social security variable (SSP).

Similar to the basic life cycle model, both GY and WL are statistically significant, while the household wealth variable (WL) still has a positive sign. However, an interesting phenomenon shown by the extended life cycle model is that, unlike the basic life cycle model, the coefficient of demographic variable (ADEP) is statistically significant with the expected (negative) sign, supporting the life cycle model's prediction.

Unlike some previous empirical results, our extended life cycle model suggests that the real interest rate variable (RID) is statistically significant in explaining household saving. This is probably because our sample period covers only the post reform era. During this period, Chinese household saving was no longer "forced", and thus voluntary household saving is influenced by the real interest rate (Li, 1997).

There is strong empirical support for the hypothesis that social security contribution exerts a negative impact on the savings rate. In the extended life cycle model, the coefficients on both the short run and long run of social security variables are significant with negative signs. This suggests that the absence of significant government emphasis on the provision of social welfare has been a key factor in the rapid expansion of household saving in China.

As discussed earlier in this thesis, the variables included in the adjusted life cycle model are income growth rate (GY), real interest rate (RID), elderly dependence rate (ADEP), household wealth (WL), social security payments (SSP), and unemployment rate (UEM).

Regarding the income uncertainty variable (UEM), the coefficient is statistically insignificant and it is the only insignificant variable in the adjusted life cycle model. Note that our proxy for the income uncertainty factor is only an official unemployment rates series; therefore, the insignificant coefficient of the unemployment variable does not necessarily imply that there is no impact of income uncertainty on the Chinese household saving rate after 1978.

5.3 Limitations and Suggestions for Future Research

Clearly the primary limitation of this research is the lack of data. The Chinese government reformed the economy to a market oriented economy in 1978, and thus the possible sample period of our study is less than thirty years. Furthermore, the quarterly data for most of the economic variables are only available after the mid 1990s. Thus, if quarterly data is used, an extremely short research period would be available, providing very little economic meaning. However, if only annual data is used, fewer observations are possible. A final decision was made to use annual data with the sample period from 1978 to 2003, with only twenty six observations, which is a small sample. This limitation makes the empirical test results less precise and robust.

Because of the data constraints in this study, the post reform period was the only focus, and no attention was given to the "forced saving" period before 1978. Since voluntary saving and forced saving are major components of household savings, it is suggested that future research should include both the post reform and the pre reform periods.

In the adjusted life cycle model, the income uncertainty variable (UEM) appeared statistically insignificant. Although it may be caused by the proxy constraints, but this contradicts a widely held belief among previous researchers that most Chinese households are sensitive to income uncertainty.

As discussed previously, the proxy for the household wealth, the WL variable, has an unexpected sign in our analysis. Although this is consistent with recent high rates of economic growth in China, an alternative proxy for household wealth is suggested for future research.

Finally, the determinants of the Chinese household saving rate are not uncontroversial. Different studies employed different fundamental variables to explain Chinese household saving functions (see Table 2-1). This study has shown that future studies of determinants of Chinese household saving behaviour should take into account the life cycle model introduced by Modigliani and Brumberg (1954).

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Appendix 1 The Data

Year	Household Saving Rate	Real Income Growth Rate	Elderly Dependency Ratio	Household Wealth	Social Security Payments	Real Interest Rate	Unemployment Rate
1978	46.41%	10.72%	14.27%	26.92%	2.89%	2.57%	5.30%
1979	46.51%	10.50%	14.40%	35.17%	3.70%	1.97%	5.40%
1980	50.58%	16.44%	14.44%	35.45%	3.96%	-0.23%	4.90%
1981	46.73%	0.60%	14.95%	40.18%	4.41%	3.38%	3.80%
1982	46.07%	5.03%	14.98%	42.33%	4.74%	4.91%	3.20%
1983	44.86%	5.52%	15.13%	46.69%	5.16%	5.34%	2.30%
1984	45.63%	12.29%	15.28%	52.95%	5.35%	4.01%	1.90%
1985	40.87%	4.31%	15.90%	62.31%	6.62%	-1.61%	1.80%
1986	46.09%	14.85%	15.92%	65.64%	6.80%	1.23%	2%
1987	45.12%	3.81%	15.98%	72.64%	6.82%	-0.12%	2%
1988	41.34%	-0.51%	16.01%	73.21%	7.79%	-9.84%	2%
1989	44.61%	-1.16%	16.20%	73.48%	8.55%	-6.48%	2.60%
1990	46.83%	7.52%	16.33%	85.03%	9.29%	6.55%	2.50%
1991	47.31%	9.43%	16.40%	94.43%	9.49%	4.66%	2.30%
1992	47.20%	13.06%	16.58%	102.45%	10.02%	2.15%	2.30%
1993	48.36%	12.35%	16.74%	116.81%	10.22%	-2.22%	2.60%
1994	50.06%	11.46%	16.82%	111.98%	9.37%	-10.72%	2.80%
1995	47.79%	6.71%	17.79%	117.09%	9.37%	-3.82%	2.90%
1996	45.42%	6.49%	18.38%	128.49%	9.66%	1.38%	3%
1997	45.08%	5.80%	18.54%	144.01%	10.28%	4.88%	3.10%
1998	45.22%	7.95%	19.03%	155.96%	10.62%	6.39%	3.10%
1999	46.40%	11.24%	19.18%	164.38%	6.34%	5.24%	3.10%
2000	45.91%	8.90%	19.42%	170.82%	6.64%	3.74%	3.10%
2001	47.39%	10.89%	19.07%	178.66%	6.85%	3.75%	3.60%
2002	50.78%	10.38%	19.64%	188.78%	7.39%	1.78%	4%
2003	51.74%	8.90%	20.12%	204.19%	7.61%	0.76%	4.30%