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U.S. Consumption Function: An Empirical Test of the Life-Cycle Hypothesis

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Abstract

Since the outbreak of the financial crisis in 2008, high household consumption that was previously boosted by debt-financing has shrunk significantly. The validity of conventional models of consumption that are mainly based on the life-cycle hypothesis has thus been called into question. This thesis utilizes empirical analysis to test the explanatory power of a modified Keynesian consumption function that captures household balance sheet movements. In addition to a short run OLS model, a VEC model and a DOLS model are constructed to examine the long run cointegrating relationship between consumption and other macroeconomic variables. Neither the regression results of the short run model nor those of the long run models are compatible with the life-cycle hypothesis. Theories based on relative consumption perform more satisfactorily in explaining the estimating results.

Chapter 1: Introduction

Consisting of over 70% of America's Gross Domestic Product (GDP hereafter), consumption is of great importance in determining the economic performance of the country. By the end of 2011, the country's personal consumption expenditure reached $ 10,927 billion, almost triple the government expenditure ($3,708 billion), the second largest item in America's national accounts. Thirty years ago, household consumption in the United States was merely $1,992 billion. The rapid growth of consumer expenditure has attracted economists to study the behavior of consumers, both individually and in aggregate. Some have focused on producing theories that can describe and explain consumer behavior. Keynes, Friedman and Modigliani, to name a few, are among those whose work has been particularly popular in academia. Others, meanwhile, have focused more on using various techniques to analyze existing theories empirically.

While a lot of credit has been given to the economists responsible for constructing the theory of consumer behavior, it should be noted that contributions from those concentrating on empirical research are equally important. In fact, Kuznets (1952) and Goldsmith's (1955) econometric analysis, which appears to refute Keynes' consumption function, has played a crucial role in the development of the current mainstream life-cycle model of consumer spending. A lot of research has also been done to test the explanatory power of the life-cycle hypothesis. After the financial crisis initiated by the collapse of the subprime mortgage market in the United States, more doubts concerning the rationality of consumer behavior have been voiced. Since rational expectation is one of the main assumptions of the life-cycle hypothesis, the validity of this model has been called into question. To address these doubts and questions requires that we re-examine the credibility of the life-cycle model with new data and up-to-date econometric techniques.

This thesis aims to empirically test the performance of the life-cycle hypothesis as a description of consumption expenditure in the United States from 1952 to 2011. Following this introduction is a chapter that summarizes the relevant literature on consumption in chronological order. The famous Keynesian consumption function will first be presented. The development of Friedman's permanent income hypothesis and Modigliani and Brumberg's life-cycle hypothesis, along with Hall's random walk interpretation of the latter, is then discussed. Various works that are critical of basic concepts of the life-cycle model, including Mankiw and Campbell (1989), Palley (2002) and Setterfield (2010), are then analyzed before Cynamon and Fazzari's theory (2008) that originated from Duesenberry's (1949) model of relative consumption is introduced. It is found that Cynamon and Fazzari's idea of consumption and financial norms provides a consistent explanation of the consumer behavior observed both before and during the financial crisis.

Chapter 3 focuses on constructing an econometric model that can be used to examine the credibility of the life-cycle hypothesis. The null hypothesis of the model is Hall's interpretation of the life-cycle hypothesis (1978): consumption can be described as a random walk. The alternative hypothesis, on the other hand, is Cynamon and Fazzari's (2008) theory of consumption and financial norms. Income, consumer borrowing, wealth, the debt burden and consumer sentiment are the five factors included in the model. Explanation as to why these factors might influence consumption is provided. The second half of the chapter discusses what data are selected to represent these variables. Sources of the data and required adjustments are also presented.

The next chapter first briefly introduces a concept that has been widely used in time-series macroeconometrics: the existence of the unit root. Its impact on regression results and the methodology of tests for unit roots are then discussed. Since it is shown that most data series used in the test model have a unit root, it is possible to first difference these variables and analyze their relationship using simple ordinary least square (OLS) method. The regression results of this short run consumption function are then analyzed. While some variables behave as expected, it is difficult to explain the results of other variables under the framework of the life-cycle hypothesis.

However, given that the life-cycle hypothesis describes the long run behavior of consumers, a short run testing model is insufficient. Chapter 5 fixes this problem by using an error-correction model to determine the long run relationship between consumption and the independent variables listed above. After a short introduction of cointegration and error-correction techniques, various related econometric tests are conducted to examine whether there exists such a long run relationship. Since the Johansen test gives a positive result, a vector error-correction (VEC) model and a dynamic ordinary least square (DOLS) model are used to determine the explanatory power of the independent variables in the long run consumption function. Regression results indicate that some balance sheet variables are significant in the consumption function, even though they are not expected to be so under the life-cycle framework. Friedman and Modigliani's hypothesis cannot explain the results of the time-series model in a satisfactory manner.

The final chapter of the thesis summarizes regression results and draws some conclusions. After briefly discussing the innovative part of this thesis as compared to existing studies, the estimation results of the short run model in chapter 4 and those of the long run models in chapter 5 are analyzed collectively. It appears that these results are not quite compatible with the life-cycle hypothesis. Cynamon and Fazzari's (2008) theory of consumption and financial norms, on the other hand, provides a more logically consistent explanation. Limitations of the econometric techniques used in this thesis are also acknowledged in this chapter.

Chapter 2: Related Literature

Consumption has always played a crucial role in the study of macroeconomics. In the first two decades of the 20th century, an increasing number of economists began to focus on the behavior of consumers. For example, Mitchell (1913) tries to use the theory of cyclical expansion to explain the under-consumption observed in the United States. However, it was Keynes who first initiated a systematic study on how consumption is related to the macroeconomic performance of a country. In his famous *The General Theory of Employment, Interest and Money* (Chapter.8, page.90), Keynes uses a simple equation to demonstrate how expenditure on consumption can be determined:

$$C = c(Y) \tag{1}$$

where C is consumption and Y is income. While this equation only presents an implicit relationship between consumption and income, Keynes does try to describe the normal shape of the function. He argues that, based upon the knowledge of human nature and detailed facts of experience, "men are disposed to increase their consumption when their income increases, but not by as much as the increase in their income (Chapter 8, page.96)." In other words, $\frac{dC}{dY}$ is a constant that is greater than zero but less than unity. Keynes terms this constant the marginal propensity to consume. He then studies principal factors that may influence the propensity to consume and categorizes them into two categories: the objective factors and the subjective factors. Objective factors include but are not restricted to changes price level, changes in the value of capital and changes in the interest rate. Subjective factors, on the other hand, consist of eight motives to consume, like motives of enjoyment, generosity and extravagance. Keynes believes that, aside from changes in the price level, all other factors generally do not change the marginal propensity to consume in the short run. In other words, once fluctuations in the price level are eliminated, expenditure on consumption to a large extent depends on the level of income.

Various modifications of this equation have been introduced by Keynesian economists. Equation (2) is an explicit equation that makes the relationship between consumption and income linear. α_1, the coefficient of Y, represents the marginal propensity to consume. A constant is also added into the equation to reflect autonomous consumption, the amount of expenditure occurred when current income is zero. This adjustment rarely encounters objections, as consumers have to purchase necessities for subsistence even if they do not have any income. Equation (2) soon replaces equation (1) and is accepted by Keynesian economists as the standard form of consumption function.

$$C = \alpha_0 + \alpha_1 Y \tag{2}$$

Equation (3) demonstrates a more complicated variant of Keynes' consumption function. According to this equation, income is separated into two variables: labor income Y_1 and property income Y_2. Advocates of this modified equation believe that property income is observed more among the high-income consumers and thus should have lower propensity to consume. Hence, the coefficient of Y_2 should be smaller than that of Y_1 (Ando and Modigliani, 1963).

$$C = \alpha_0 + \alpha_1 Y_1 + \alpha_2 Y_2 \tag{3}$$

Keynes' consumption function was widely embraced by academia initially. However, as increasing effort was made to test the validity of Keynes' hypothesis using time-series data, conflicting evidence eventually arose. In the *General Theory*, Keynes claims that:

> "The fundamental psychological law, upon which we are entitled to depend with great confidence both a *priori* from our knowledge of human nature and from the detailed facts of experience, is that men are disposed, as a rule and on the average, to increase their

> consumption as their income increases, but not by as much as the increase in their income." (Chapter 8, page 96)

In other words, as the level of income increases, the ratio between saving and income should also increase. However, Kuznets (1952) analyzes savings in the United States from 1899 to 1949 and finds no rise in the percentage saved, even though real income in the same period rises significantly. His finding is also confirmed by works from Goldsmith (1955).

Among the economists who tried to construct new theories of consumer behavior, two different schools of thought emerged. The first group, represented by Duesenberry, believes that consumption is a social phenomenon. In his *Income, Saving and the Theory of Consumer Behavior* (1949), Duesenberry introduces a model of consumption from a psychological perspective. He argues that consumption decisions are based on learning and habit formation instead of rational planning. According to him, once the compromise between the desire for consumption and the desire for saving has been reached, "habit formation provides a protective wall against desires for higher quality goods" (Chapter 3, page 26). This habitual consumption pattern will only change when consumers are frequently exposed to goods with superior qualities. To put it another way, assuming a household's desire for saving does not change, the household's consumption expenditure will increase when the consumption of goods with better qualities by other households is frequently observed. Duesenberry also presents data in the United States to support his theory. However, for some reason the relative consumption model was not widely accepted within academia.

The second group of economists suggests that consumption is nothing but rational planning. Among them, Milton Friedman and his permanent income hypothesis (1957) receive particular attention. Unlike Keynes, Friedman begins to build up the theory from a microeconomic perspective. Attempting to maximize consumers' utility, he uses a set of three equations to describe the relationship between consumption and income for some time period.

Equation (4a) claims that permanent consumption (C_p) is a fraction of one's permanent income (Y_p), and the magnitude of that fraction (k) depends on interest rate (r), the ratio of wealth to income (w), and consumer's preference of consumption over investment in assets (u). The other two equations simply assert that both income and consumption consist of a permanent component (C_p and Y_p) and a transitory component (C_t and Y_t).

$$C_p = k(r, w, u)Y_p \tag{4a}$$

$$Y = Y_P + Y_t \tag{4b}$$

$$C = C_p + C_t \tag{4c}$$

The idea of permanent income is central to Friedman's hypothesis. While in many cases it is interpreted as the averaged value of lifetime income, he considers it more of an expected value of a probabilistic distribution that should remain unchanged over a period of years. Factors that give rise to the transitory component, on the other hand, can be treated as "accidental occurrences", like illness or a bad guess about when to buy or sell assets. Permanent and transitory components of consumption can be defined in a similar manner. Under Friedman's framework, only changes in permanent income can alter one's consumption. As he states in his *A Theory of the Consumption Function* (1957):

> "The transitory components of a consumer unit's income have no effect on his consumption except as they are translated into effects lasting beyond his horizon. His consumption is determined by longer-range income considerations plus transitory factors affecting consumption directly. The transitory components of income show up primarily in changes in the consumer units' assets and liabilities, that is, in his measured savings." (Chapter 4, page 221)

During the same period, Modigliani and his student Brumberg developed a similar model of consumer expenditure, also based on the utility function of individual consumer

(Modigliani and Brumberg, 1954). In their opinion, the consumer maximizes his/her utility subject to his/her current income, discounted future income and current net worth (Ando and Modigliani, 1963). According to this theory, there need not be any rigorous relationship between consumption and income in a given short period: consumer expenditure in any period depends on a "plan" that extends over the balance of the consumer's life. Income in that period is just one element of the life-time plan. Because Modigliani's theory considers the individual's lifespan as the appropriate time unit for planning consumption, this theory is called the "life-cycle hypothesis".

In order to make the life-cycle hypothesis applicable to empirical research, Modigliani introduces a few assumptions to relate aggregate consumption to other measurable economic variables. Two of them, as listed below, are central to the hypothesis.

Assumption 1: Consumers plan to consumer their income at an even rate throughout their lifetime.

Assumption 2: The utility function is such that the *proportion* of his/her total resources that an individual plans to devote to consumption in any given year of his/her remaining life is determined only by his/her tastes and not by the size of his/her resources.

Modigliani and Brumberg then construct an equation that relates current consumption with its determining factors:

$$C_t = C(Y, Y^e, a, t) = \frac{1}{L_t} Y + \frac{N-t}{L_t} Y^e + \frac{1}{L_t} a \tag{5}$$

In this equation, C_t represents current consumption, while Y and Y^e denote current and expected income respectively. L is the life span of a consumer and N is his/her earning span. Lastly, a represents one's assets at the beginning of the time period. Verbally, this equation states that current consumption is a linear and homogenous function of current income, expected average income and initial assets, with coefficients depending on the age of consumers (Modigliani and Brumberg, 1954). From this equation we can see that, according to Modigliani and Brumberg, current income only influences current consumption to a small degree. Since the consumer has to evenly distribute his/her income throughout his/her remaining life span, only a small portion of any change in his/her current income will be allocated for current consumption. Later Ando and Modigliani (1963) also derive an aggregate consumption function for the life-cycle hypothesis, which is very similar to equation (5).

It is not very difficult for us to see that Friedman's and Modigliani's hypotheses share many more similarities than differences. Both of them start their work from a microeconomic perspective and assume that consumers aim to maximize utility they get from both current and future consumption. Both of them believe that only changes in income that have long term effects could influence current consumption. Temporary fluctuations in income are primarily saved instead of consumed. As a result, the proportion of income saved can be considered independent of income, contradicting Keynes opinion that we will find "*a greater proportion of income being saved as real income increases* (1937)". The only major difference between the two theories is that Friedman considered the length of the consumer's planning period infinite, claiming that people save not only for themselves but also for their children. Modigliani, on the other hand, believes that consumer's planning period is just his/her life span and people save only to secure their consumption at an elder age. Nowadays the permanent income hypothesis and the life-cycle hypothesis are used interchangeably by many economists.

Studies related to the life-cycle hypothesis have been conducted by numerous economists since then, many of which produce inspiring conclusions. Robert E. Hall (1978) claims that empirical research focusing on the consumption function to a large extent fails to address the endogenous nature of income. Consequently, putting income into the consumption function as an independent variable would seriously distort the estimated function. He then provides an alternative approach by treating consumption as a random walk, which can be expressed by the following equation:

$$\mathrm{C_t} = C_{t-1} + \varepsilon \tag{6a}$$

While this equation solves the problem of endogeneity, its simplicity does raise concerns about the validity of Hall's argument: the equation basically tells us that current consumer expenditure is unrelated to any other economic variable observed in previous periods and today's consumption is all one needs to predict consumption in the future.

However, Hall believes that this is exactly what happens under the framework of the life-cycle hypothesis. Since consumers want to maximize their expected future utility, and it has been shown that the conditional expectation of future marginal utility is a function of only current consumption, then all other factors would not have any explanatory power on future marginal utility. In other words, marginal utility follows a random walk. Furthermore, since marginal utility is linearly related with consumption, it is reasonable to deduce that consumption is also a random walk. In addition, since consumption with one lag includes all relevant information of consumers' past behavior, neither including more variables nor including more lags will provide additional explanatory power to the function. Therefore, while it has been widely accepted that lagged income is an efficient predictor of current consumption, there is no reason to include it in the consumption function in addition to one-period lagged consumption.

Hall's random walk argument can also be analyzed from a different perspective. If we eliminate the stochastic component of equation (6a), the equation becomes:

$$\mathrm{C_t} = C_{t-1} \tag{6b}$$

This equation tells us that when random error is absent, consumption in the current period will be equal to consumption of the previous period. In other words, consumption is smoothed against fluctuations in income, which resonates with Modigliani's first assumption that consumers plan to consume their income at an even rate throughout their lifetime.

In order to find empirical support for his theory, Hall later uses regression techniques to estimate the relationship between America's Gross National Product (GNP) and consumption with a variable that has rarely been used: military spending (1986). The reason for picking military spending as the independent variable is sound: it is the only major exogenous influence on the American economy. Regression results indicate that consumption is not influenced by military purchases, whereas GNP increases. Hall then concludes that the behavior of consumers is independent from macroeconomic fluctuations, and that random shifts in consumption are an important source of overall fluctuations.

The life-cycle hypothesis is a relatively simple model that makes basic economic sense. Soon it became the conventional theory of consumption in academia. Considerable volume of empirical work has been done to test its credibility. Unfortunately, not all results are consistent with Modigliani and Friedman's thought. While a group of economists choose to use various econometric instruments to study consumption based on Hall's approach (sometimes called the "Euler equation approach"), Campbell and Mankiw (1989) propose an alternative by splitting the consumer body in the United States into two groups: one group follows the psychological framework of the life-cycle hypothesis and consumes based on their life-time income, whereas the other group is more Keynesian and consumes their current income. Campbell and Mankiw call the second group "rule of thumb" consumers, as they tend to consume what they have currently instead of looking forward. They use the following equation to explain their consumption model:

$$\Delta C_t = \Delta C_{t1} + \Delta C_{t2} = \gamma \Delta Y_t + (1-\gamma)\varepsilon_t \tag{7}$$

In this equation, the change in aggregate consumption ΔC_t is the sum of the change in consumption from the rule-of-thumb group (ΔC_{t1}) and the change in consumption from the life-cycle group (ΔC_{t2}). γ represents the fraction of income earned by the rule-of-thumb consumers. Since consumption in this group is determined by current income, their change in consumption is equal to $\gamma \Delta Y_t$. To the contrary, the other group follows the life-cycle hypothesis, implying $\Delta C_{t2} = (1 - \gamma)\varepsilon_t$.

Campbell and Mankiw argue that if the life-cycle hypothesis is correct, then γ should be very close if not equal to 0. After running regressions with various instrumental variables, they find that lagged consumption can efficiently forecast income growth. This finding suggests that at least some consumers are able to predict future changes in income and adjust their current consumption, as described in the life-cycle hypothesis. However, regression results also indicate that the value of γ is around 0.5, and the null hypothesis that $\gamma = 0$ is rejected even at 0.01% level of significance. In other words, half of the consumers follow the "rule of thumb" and consume their current income.

Another important result in Campbell and Mankiw's paper is related to the interest rate. Both Friedman and Modigliani and Brumberg take the interest rate into consideration when constructing their models. They suggest that current consumption will change when there is a change in the interest rate, or the cost of inter-temporal consumption substitution. For example, when there is an increase in interest rate, consumers will reduce current consumption and save more for future consumption. While for the sake of simplicity all the equations introduced above assume a zero or constant interest rate, it has been argued that life-cycle models that capture changes in the interest rate perform better in describing consumer behavior. However, from Campbell and Mankiw's (1989) regression results, the life-cycle consumers are "extremely reluctant to substitute consumption inter-temporally in response to interest rate movements". In other words, changes in interest rates appear to have no effect on consumption and can be omitted from our analysis of consumer expenditure.

The life-cycle hypothesis models not only consumption but also saving. Since saving is equal to the difference between income and consumption, equation (8) can be easily derived from equation (6):

$$S = Y - C = \frac{L-t}{L_t} Y - \frac{N-t}{L_t} Y^e - \frac{1}{L_t} a \tag{8}$$

In other words, Modigliani and Brumberg believe that saving is also a function of current income, average expected income and initial assets. To test the credence of this relationship, White (1978) utilizes simulation analysis to calculate the aggregate personal saving level and compare it with actual data. His results demonstrate that, even taking certain limitations of simulation analysis into consideration, the simulated saving level still deviates substantially from the actual figure under all different sets of assumptions. Hence White concludes that the life-cycle hypothesis does not correspond well to the aggregate saving behavior observed in America.

Figure 1 presents the ratio of consumer expenditure to disposable income in America from 1981 to 2011. We can easily see an upward trend that only stops after the outbreak of the financial crisis in 2007. What have caused Americans to consume an increasing proportion of their income for almost three decades? According to the life-cycle hypothesis, if the consumption-income ratio increases, then either consumers are expecting an increase in their future income, or there is an appreciation of their households assets. It is generally accepted that rising expected income is associated with labor productivity growth. However, data from the Bureau of Labor Statistics have shown that labor productivity growth in the United States was rather unstable until the mid-1990s. It seems that the movement in expected income is at most marginally correlated with the increasing consumption-income ratio during the period before the financial crisis.

We are left with the "wealth effect" explanation. However, the significance of the wealth effect has been questioned by numerous economists. Parker (2000) claims that at most 20%

of the rise in the consumption-income ratio can be attributed to the wealth effect. A plot of percentage changes in consumer expenditure and household total assets in Figure 2 supports Parker's argument: the movements of the two lines do not follow a similar pattern. In addition, according to Kennickell (2009), in 2007 the wealthiest 1% of households had 33.8% of total family wealth, and the richest 5% owned 60.4%. The rising consumption-income ratio, however, is observed throughout households with different financial backgrounds. Therefore, since neither the expected income approach nor the wealth effect approach works satisfactorily, it seems that the life-cycle hypothesis cannot provide us with a sound explanation of the rising consumption-income ratio before the financial crisis.

Numerous economists have provided possible explanations outside the framework of the life-cycle hypothesis. Palley (2002) claims that rising household debt and mortgage refinancing driven by disinflation help explain the consumption boom in the United States since early 1980s. Similarly, Setterfield (2010) suggests that the significant growth in consumer spending, in spite of the stagnation in working households' income, has been boosted by the accelerated pace of household debt accumulation. Their opinion is supported by Figure 3, a graph of total household liabilities as a share of disposable income. The upward trend is pretty obvious: total liabilities was only less than 70% of households' disposable income in 1981, while in 2006, the year before the outburst of the financial crisis, that figure had skyrocketed to more than 130%.

Is this observation compatible with the life-cycle hypothesis? The answer would appear to be no. Both Friedman and Modigliani suggest that consumers plan their expenditure rationally and they use savings and debts to smooth their consumption against fluctuations in their income. In other words, since debt is just an instrument for inter-temporal resource allocation, there is no reason for changes in household consumption to be correlated with changes in household liabilities. In addition, since the life-cycle hypothesis assumes all consumers to be rational planners, excessive or unsustainable debt growth should not be observed (Cynamon and Fazzari, 2008). While it can be argued that a debt-income ratio of over 130% is still not completely unreasonable, analyzing the distribution of debt by income gives us an even more shocking number: by early 2000s, the average debt-income ratio of households with income less than $50,000 (66.2% of the total population) is 298% (Palley, 2002). It is very difficult for me to accept that a debt-income ratio of around 300% is rationally planned by two-third of the American households. The sustainability of the debt growth has also been discredited during the financial crisis, when household liabilities stopped increasing and began to drop sharply. Therefore, it seems that the changes in consumer debt cannot be explained by the models in Modigliani and Brumberg's work (1954).

While some economists are trying to modify the life-cycle hypothesis, Duesenberry's relative consumption model begins to regain focus. This time, his hypothesis is reinforced by Akerlof and Kranton's (2000) innovative work on the application of identity, or the sense of self in society, into economic analysis. By incorporating the idea of identity into the utility function, they demonstrate that identity can change preferences and thus is a determining factor during the decision-making process. At the same time, Fuhrer (2000) acknowledges the importance of habit formation in economics and finds empirical support to include habit formation into the utility function. He suggests that this modification enables the permanent income hypothesis to explain "hump-shaped impulse responses of consumption to shocks". His argument is also supported by the econometric analysis of Morley (2007).

Inspired by the arguments discussed in the previous paragraph, Cynamon and Fazzari (2008) provide an explanation of consumer behavior based on the belief that "consumers are agents embedded in a world of social cues that endogenously influence their preferences". Opposing Modigliani and Brumberg's assumption that consumers have sufficient information and are fully aware of outcomes and related likelihood of uncertainties, Cynamon and Fazzari suggest that consumers in an environment of rapidly changing circumstances tend to learn consumption patterns from what they call “social reference groups”. Also, in the process of learning consumption patterns, individuals will build up their habits that, once formed, cannot be forgotten easily. In other words, decisions about consumption are made due to path dependent preferences that are in turn formed by consumers’ social circumstances. Cynamon and Fazzari define a consumption norm as “the standard of consumption an individual considers normal based on his or her group identity” and argue that a consumption norm is a powerful force that cannot be ignored in the process of modeling consumer expenditure (Cynamon and Fazzari, 2008). They also extend the idea of norms into the financial sector: since uncertainty also exists when households are to make financial decisions, it is again reasonable for them to follow what has been considered normal in their respective social groups.

Using consumption norms and financial norms as theoretical foundation, Cynamon and Fazzari provide a logically consistent explanation of the observed consumer boom. Firstly, advancements in technology, especially in integrating semi-conductors into consumer products, have substantially enhanced social interaction and hence stimulated consumer spending. Meanwhile, technological development also provides more power to the mass media. As a result, social references created by advertisements induce greater demand from consumers, regardless of whether they really need the advertised products. In addition, although a large proportion of commercials target affluent potential buyers, nothing prevents the less rich households from receiving these commercials. Consequently, consumption is stimulated throughout households with various financial backgrounds. It is worth noting that income inequality in the United States has deteriorated continuously since the 1960s. Income in many households is actually insufficient to satisfy their boosted desire for spending.

However, changing financial norms allow these low income households to finance their spending through borrowing. Greater access to borrower's information as a result of new information technology, in addition to a prolonged period of low interest rate, has made borrowing much easier than before. Consumers gradually accept the idea of credit-backed consumption without pondering whether they possess financial strength comparable to that of their reference groups. With both the desire and the "ability" for greater spending, the consumer boom in the United States seems inevitable.

Cynamon and Fazzari's (2008) work focuses on utilizing Duesenburry's theory of relative consumption (1949) to explain the consumption pattern observed in the United States during the past three decades. While multiple graphs and various data are included in their study, evidence based on econometric analysis is not provided. Hence, their argument, despite appearing reasonable and persuasive, does need more empirical support. On the other hand, even though a number of questions have been cast on the life-cycle hypothesis, it is still not prudent to completely discredit Friedman, Modigliani and Brumberg's work. It is worth noting that some of the empirical evidence against the life-cycle hypothesis comes from time-series estimations using the simple OLS approach. Recent developments in the field of econometrics indicate that applying OLS to macroeconomic data may sometimes produce spurious results. In the next chapter, I shall present a test that is compatible with modern econometric theories to re-examine the validity of the life-cycle hypothesis and the relative consumption model.

Chapter 3: Model Construction and Data Selection

Equation (9) presents the equation I will use to conduct a series of econometric estimations. On the left side of the equation is the level of consumption. On the right side, Y represents disposable income; D is a measure of household borrowing or consumer credit; W

captures the level of household wealth; B denotes consumers' debt burden; and S is an indicator of consumer confidence.

$$C = c_0 + \gamma_1 Y + \gamma_2 D + \gamma_3 W + \gamma_4 B + \gamma_5 S + \varepsilon \tag{9}$$

Income has always been one of the most important factors that affect consumption. In the *General Theory,* income is the single independent variable in the consumption function. Under the life-cycle hypothesis, the explanatory power of income on consumption is weakened in the short run. When changes in income are believed to be permanent and long run, however, its impact on consumption is still substantial. If estimation results reveal that changes in current income do significantly affect changes in consumption, then we may have additional evidence for the existence of "rule of thumb" consumers as claimed by Campbell and Mankiw (1989).

Consumer credit, household assets and the debt burden all can be categorized as "household balance sheet" variables. Mishkin (1977, 1978) conducts extensive research of the impact of changes in household balance sheets on consumption during the Great Depression and the 1973-75 recession, and concludes that weakened household financial positions severely influence consumption and hence the macroeconomic performance of the economy. Under the framework of the life-cycle hypothesis, consumer credit is just a financial instrument used by rational consumers to smooth consumption in the face of fluctuating income. Thus in the long run it should not demonstrate any significance in the consumption function. According to Cynamon and Fazzari (2008), however, consumer credit plays a crucial role in determining consumption: as advanced information technology and changing financial norms have made credit-financed consumption more accessible to consumers, they simply spend their credit on consumption without carefully thinking about their ability to re-pay the resulting debt. Therefore, in this model, consumer credit should have a significant and positive relationship with consumption.

Household wealth is another important variable in the consumption function. Case, Quigley and Shiller (2001) define the wealth effect as "the causal effect of exogenous changes in wealth upon consumption behavior". Numerous studies have been conducted to determine the impact of household wealth on consumption. Friedman believes that the wealth to income ratio determines the magnitude of the fraction of households' permanent income spent on consumption (equation 4(a)), whereas Modigliani and Brumberg treat personal assets as an independent variable in the consumption function (equation 5). However, even though the existence of the wealth effect is rarely challenged, economists still dispute what kind of wealth can affect consumption, whether the wealth effect is significant and through what mechanisms the wealth effect operates. Mishkin's studies (1977, 1978) indicate that devalued financial assets like bonds and stocks had a significant impact on consumption during the two crises he showed. However, Palley (2002) holds a different opinion and argues that equity ownership still remains concentrated at the top end of the income distribution and is unlikely to affect consumption to a large extent. Case, Quigley and Shiller (2001) estimate regressions relating consumption to income and wealth with panel data and conclude that compared to the weak stock market wealth effect, housing wealth has a strong influence on consumption.

A measure of the debt burden, unlike income or household wealth, was not originally included in Keynes' consumption function or the life-cycle hypothesis. In fact, following Modigliani and Brumberg's reasoning, since consumers rationally plan their expenditure, debt should not be viewed as a burden at all. However, the outbreak of the financial crisis several years ago has shown that consumer expenditure will plummet if the total debt is accumulated to such a level that households have to cut back their consumption to repay their debt. From Figure 3, we can see that the debt to income ratio decreases continuously after the financial crisis. Whether consumption is affected by the debt burden in normal times, on the other hand, has not been studied extensively.

The last variable, consumer sentiment, captures the degree of optimism/pessimism consumers feel about the economy, their job prospects, and their household's financial situation. This variable should have a strong positive relationship with aggregate consumption: when consumers are confident about the country's economic development and their personal income, they tend to consume more. On the other hand, if the economic situation is perceived to be pessimistic, households generally tighten their belts and cut expenditure. In other words, consumer confidence indicates whether consumers have a positive or a negative outlook on their ability to find and retain good jobs.

While the history of measuring consumer sentiment is very long, its significance in the consumption function should be least questioned. It actually captures the so called "animal spirit" in Keynes' consumption function, the permanent component in Friedman's permanent income hypothesis and the expected income factor in Modigliani and Brumberg's life-cycle model. Some economists even argue that the relationship between consumer expenditure and consumer sentiment is so robust that certain consumer sentiment indices can be used to forecast future consumption (Carroll, Fuhrer and Wilcox, 1994). Therefore, if an econometric analysis indicates that consumer sentiment is insignificant in the consumption function, then the validity of the test model should be questioned.

After deciding what variables should be included in the empirical analysis, the next step is to find data for these variables. All data used here are quarterly and are downloadable from the database of Economic Research Federal Reserve Bank of St. Louis. Data for aggregate consumption and household income are collected by the Bureau of Economic Analysis in the U.S. Department of Commerce. Consumption is the *natural log of Real Personal*

Consumption Expenditure (chained 2005 dollars), whereas income is the *natural log of Real Disposable Personal Income (chained 2005 dollars).*

Consumer borrowing is the *Consumer Credit - Liabilities - Balance Sheet of Households and Nonprofit Organizations*, provided in the Z.1 Flow of Funds Accounts of the United States. From the name of the data series we can see that the data also include consumer credit of nonprofit organizations. However, we cannot find any data that measure consumer credit of households separately. In addition, the size of borrowing of nonprofit organizations is very small as compared to that of American households. Hence it is reasonable for us to believe that including it into the series will not severely jeopardize the validity of the test results. The other problem of this data set is that it is recorded in nominal terms. To adjust the data to real terms, the *seasonally adjusted GDP deflator (Index 2005 = 100)* is used. Another choice is the consumer price index provided by the Bureau of Labor Statistics. However, that index only includes price levels for urban consumers. Moreover, the consumer price index sets the price level in 1982-1984 to be 100. Since converting unit of the index to 2005 price level involve arbitrary decisions and may cause loss of accuracy, the GDP deflator is chosen instead. The natural log of adjusted consumer credit is the final data used in the empirical analysis.

It is worth noting that this data series covers most short and intermediate-term credit extended to individuals, excluding loans secured by real estate. In other words, mortgage loans are not included in the data. From a conventional perspective, this does make economic sense, as mortgage borrowed is not traditionally used for consumption. However, since 2000 it has been observed that a number of households began to collateralize their real estates in order to consume. In this way changes in aggregate mortgage loans will affect aggregate consumption. In reality it is extremely difficult if not impossible to measure what proportion of mortgage loans are not used to finance expenditures on housing. Hence we have to assume that the impact of the “cash-out mortgage” on consumption is not significant. As this phenomenon only began to be observed in the past decade, the assumption we are making should be reasonable for the data as a whole.

As discussed in previous paragraphs, there exists a disagreement on what types of household assets should be used to measure the wealth effect in the United States. Thus two sets of data, one for financial assets and the other for total assets, are used to check which measure could yield more sound results. Financial assets is the *Total Financial Assets - Assets - Balance Sheet of Households and Nonprofit Organizations*, while total assets is the *Total Assets - Balance Sheet of Households and Nonprofit Organizations*, both of which are from Z.1 Flow of Funds Accounts of the United States. Both series are in log form after having been adjusted to real terms using the GDP deflator.

The household debt-service ratio is used to measure the debt burden of households. It is an estimate of the ratio of debt payments, consisting of the estimated required payments on outstanding mortgage and consumer debt to disposable personal income. One major problem for this data set is that it only starts from the first quarter of 1980, while all other data sets mentioned in the preceding paragraphs were first collected in early 1950s. To deal with this problem, the empirical analysis will be conducted on two different time periods. The household debt-service ratio will be included in the test covering a short period, from the first quarter of 1980 to the second quarter of 2011. Another measure of the debt burden has to be used for the longer period starting from the first quarter of 1952. The variable used is total household liability as a proportion of disposable household income. Data for household liability is found in Z.1 Flow of Funds Accounts of the United States from the Board of Governors of the Federal Reserve System. Since this data series is in nominal term, the series for household income is also not adjusted for inflation when calculating the ratio of the two series.

The two commonly used measures for consumer confidence are *the Consumer Confidence Index from The Conference Board* and the *University of Michigan Consumer Sentiment Index*. Both indices use similar methodology and are highly correlated, so there is really no preference on which measure should be chosen. The following analysis uses the Consumer Sentiment Index from the University of Michigan. If the other index is used, the test results should not be much different.

Chapter 4: Unit Root Tests and the Short Run Model

Since in this thesis we only focus on the consumption function in the United States, time-series econometrics tools are used to analyze the data. Recent developments in this field have shown that applying the commonly used OLS method to regress macroeconomic variables in level form tends to produce misleading results. Granger and Newbold (1970) notice that for regressions with strongly autocorrelated residual series, there are serious problems in interpreting the coefficients of the regressions. These regressions, usually with extremely high R^2 and low Durbin-Watson values, cannot reflect the true relationship among the variables and are thus called “spurious regressions”.

Spurious regressions are related to the idea of stationarity. In the econometrics textbook written by Asteriou and Hall (2007), a time series Y_t is said to be stationary if:

1. $E(Y_t)$ is constant for all t ;
2. $Var(Y_t)$ is constant for all t ;
3. $Cov(Y_t, Y_{t+k})$ is constant for all t and all k that are not zero.

Alternatively, we can express Y_t with an autoregressive model of order one as given below:

$$Y_t = \beta Y_{t-1} + u_t \quad (10)$$

When $|\beta| < 1$, it is guaranteed that Y_t is stationary. If we have $|\beta| > 1$, then Y_t will tend to be greater every period and the series become explosive.

What if $|\beta| = 1$? In this case the series is non-stationary and contains a unit root. Simulation results show that over any reasonably long sample, a series with unit root will either drift up or down. If we then perform a regression of one series on the other we would then find either a significant positive relationship if they are going in the same direction, or a significant negative one if they are going in opposite directions, even though they may be completely uncorrelated (Asteriou and Hall, 2007). In this way, we can see why series with unit roots will produce spurious regressions as claimed by Granger and Newbold (1974).

The idea of non-stationarity is closely related to the idea of integration. A series is said to be integrated of order one if the series becomes stationary after first differencing. Since it has been observed that most macroeconomic variables are integrated of order one, one simple way to render the variables stationary is to take the first difference. For example, if Y_t in equation (10) has a unit root, it can be re-written as:

$$Y_t = Y_{t-1} + u_t \tag{11}$$

Subtracting Y_{t-1} from both sides of the equation, we have:

$$\Delta Y_t = u_t \tag{12}$$

Because u_t is a random variable, ΔY_t is a stationary series.

Do the time series data selected for this thesis have unit roots? The easiest and most direct method is to plot the series and see if there is a drift. Figure 4 to figure 11 are the graphs of all variables in the model. It can be easily seen that, with the exception of the last two series, all other series possess an upward drift. The drift in figure 10, the plot of the ratio of debt payments to personal disposable income, is less obvious. On the other hand, the plot of the Michigan University Consumer Sentiment Index is very different from other graphs and resembles a plot of white noise. To confirm our preliminary conjecture, we need to conduct econometric tests for the existence of unit roots.

The first commonly used test for unit roots is the Dickey-Fuller test developed Dickey and Fuller (1979, 1981). In order to determine whether the coefficient β in equation (10) is equal to 1, Y_{t-1} is subtracted from both sides of the equation:

$$\Delta Y_t = (\beta - 1)Y_{t-1} + u_t \tag{13a}$$

The null hypothesis is $H_0: (\beta - 1) = 0$ and the alternative hypothesis is $H_1: (\beta - 1) < 0$. If $(\beta - 1) < 0$ then we can conclude that there is no unit root. Dickey and Fuller (1979) also suggested two additional equations that can be used to test for the existence of a unit root. Equation (13b) adds a constant into the equation whereas equation (13c) has both a constant and a deterministic time trend.

$$\Delta Y_t = \alpha_0 + (\beta - 1)Y_{t-1} + u_t \tag{13b}$$

$$\Delta Y_t = \alpha_0 + (\beta - 1)Y_{t-1} + \alpha_1 t + u_t \tag{13c}$$

Since in most cases one does not know the exact data generating process of the series, there is a question as to which of the three equations should be used to test for a unit root. Doldado, Jenkinson and Sosvilla-Rivero (1990) suggest a procedure that starts with equation (13c), the most generous estimating equation. If the null hypothesis of unit root can be rejected, we can then conclude that the series is stationary. If the null cannot be rejected, the next step is to check whether the time trend is significant. Only when the time trend is significant then can we conclude that the series has a unit root. If not, the test is conducted one more time with equation (13b). Again, rejection of the null hypothesis indicates a stationary series. The significance of the constant is examined if the null cannot be rejected. If the constant is significant, then we conclude that the series has a unit root. If not, we re-do the test once again with equation (13a). This time we only need to consider whether the null hypothesis is rejected. If the null still cannot be rejected, we then conclude that the series has a unit root.

One main problem of the Dickey-Fuller test is that it requires residual series to be statistically independent. In other words, there has to be no serial autocorrelation. To relax this requirement, Dickey and Fuller suggest an augmented version that includes extra lagged terms to eliminate autocorrelation. The number of lags is determined by either the Akaike Information Criterion (AIC) or the Schwartz Bayesian Criterion (SBC). A second test developed by Phillips and Perron (1988) also relaxes the assumption on the error process by using a non-parametric t-statistic. The augmented Dickey-Fuller (ADF) test and the Phillips and Perron (P-P) test are the most widely used tests for the existence of a unit root.

Following the procedure suggested by Doldado, Jenkinson and Sosvilla-Rivero (1990), all variables are tested for unit roots using both the ADF test and the P-P test. The software used is EViews 7. Table 1 presents the results for the 1952-2011 period and table 2 covers the 1980-2011 period. The first column of the table consists of the name of the variables. The second column indicates which test is used. The third column shows whether the unit root test is on a level or differenced series: the level test examines the existence of unit root whereas differenced test determines the order of integration. In the next column, we can see if the test includes an intercept, a time trend or both. The following three columns present test statistics. The null hypothesis will be rejected if the p-statistic is less than 5%. The last column is the order of integration determined by the unit root test.

From table 1 we can see that both the ADF test and the P-P test indicate an integration of order 1 for all variables. In table 2, both tests indicate an integration of order 1 for Ln(disposable income), Ln(total assets), Ln(financial assets) and Ln(consumer credit). For the other two series, a discrepancy is observed between the ADF test results and the P-P test results: the ADF test indicates I(2) for Ln(consumption) and I(1) for the Consumer Sentiment

Index, whereas the P-P test indicates I(1) and I(0) respectively. Since the ADF test is known for over-estimating the existence of unit roots and the P-P test is generally considered a more advanced version of the ADF test, the results of the P-P test are adopted. Therefore, the unit root test results show that series for all variables, except for the consumer sentiment index, have a unit root and are integrated of order one. The consumer sentiment index is stationary and is integrated of order zero.

Since a unit root exists in all but one data series, regression using simple OLS will produce spurious results. Granger and Newbold (1974) suggest that first-differencing will considerably improve the interpretability of the regression coefficients and make estimations more efficient. For the data series covering 1952-2011, since all variables are integrated of order one, first-differencing will render all variables stationary. The differenced variables are then regressed using OLS. One of the data series for 1980-2011, however, is stationary and should not be differenced. Hence for the shorter period, all variables except the consumer sentiment index will be differenced and then regressed with the consumer sentiment index in level form. Equations (14a) and (14b) are the estimating equations for the two data periods respectively. Since most variables in the equations are differenced, regression results actually reflect short run relationships among the variables. All variables in the equations are stationary, thus eliminating the presence of spurious regressions.

$$\Delta C = c_0 + \gamma_1 \Delta Y + \gamma_2 \Delta D + \gamma_3 \Delta W + \gamma_4 \Delta B + \varepsilon \tag{14a}$$

$$\Delta C = c_0 + \gamma_1 \Delta Y + \gamma_2 \Delta D + \gamma_3 \Delta W + \gamma_4 \Delta B + \gamma_5 S + \varepsilon \tag{14b}$$

Table 3 is a summary of the regression results. There are in total eight estimating equations, four of which use total assets (W_T) to measure the wealth effect, whereas the other four use financial assets (W_F). As previously explained, total household liability as a proportion of disposable household income (B_{1952}) is the variable representing the debt burden for the 1952-2011 period, while the household debt-service ratio (B_{1980}) is selected to measure the debt burden for the 1980-2011 period. In addition, two dummy variables ($Crisis_1$ and $Crisis_2$) are used to capture the anomalous behavior of consumption during the two major crises since the 1950s: $Crisis_1$ covers the oil crisis from the last quarter of 1973 to the first quarter of 1975, and $Crisis_2$ measures the financial crisis from the first quarter of 2008 to the second quarter of 2009. For each regression, the adjusted-R^2, the F-statistic and the Durbin-Watson statistic are also presented.

Before proceeding to coefficient analysis, we should first check whether first-differencing performs well in eliminating spurious regressions due to the presence of unit roots. Since spurious regressions are characterized by very high adjusted-R^2 values and very low Durbin-Watson statistics, we start by analyzing the test statistics at the bottom of the table. We can see that the adjusted-R^2 values for all eight regressions, ranging from 0.3334 (R1) to 0.4025 (R8), are not very high. Moreover, the lowest Durbin-Watson statistic observed is 1.9806 (R5). The upper bound value for this regression is 1.720. Since none of the regressions have extremely high adjusted-R^2 or extremely low Durbin-Watson statistics, the regression results are thus not spurious. The method suggested by Granger and Newbold (1974) functions satisfactorily.

R1 and R2 are regressions covering the 1952-2011 period, excluding the two dummies. It can be seen that results for the two regressions are very similar: the coefficients of all variables possess the same signs, and their values do not deviate much from each other. The three test statistics (the adjusted-R^2, the F-statistic and the Durbin-Watson statistic) also have similar values. Such observation can be easily explained by the extremely high correlation between the changes in financial assets and the changes in total assets in the United States during this period: the correlation coefficient between the two data series is 0.9976.

In addition to a significant constant, four out of five independent variables in R1 and R2 are significant. ΔY is significant and has relatively large coefficients in both regressions. In

R3 and R4, where two dummies are included, while the coefficient of ΔY becomes smaller, the variable still remains significant at the 5% level. Since all these regressions are short run models, a significant ΔY seems incompatible with the life-cycle hypothesis. According to Friedman (1957), "the transitory components of a consumer unit's income have no effect on his consumption". In Modigliani's model, even if changes in income are significant in the consumption function, the value of the coefficient with consumers' expected life span as the denominator should be very small. Campbell and Mankiw's (1989) argument about the existence of Keynesian "rule-of-thumb" consumers, however, can explain the observed significance of ΔY. In fact, their estimated fraction of the population that consumes its current income (about 0.5) is not far from the coefficients of ΔY in R1 and R2 (0.4461 and 0.4243 respectively).

In addition, both ΔW_F and ΔW_T are significant at the 5% level if we compare the results from R1 and R2. However, once the dummies are added, both variables become insignificant in R3 and R4. Such change implies that changes in wealth only significantly affect consumption patterns during times of crisis. If the two major crisis periods are removed from the regression, then neither changes in financial assets nor changes in total assets cause changes in consumption. In other words, the wealth effect is path-dependent: increasing wealth may not lead to higher consumption during an economic boom, but decreasing wealth causes less consumer expenditure during a crisis. A similar argument has also been made by Case, Quigley and Shiller (2001).

ΔD is not significant in any of the first 3 columns. The only exception is R4, in which ΔD is only significant at the 10% level. It seems that during the 1952-2011 period, there is not much evidence to show that consumer expenditure in the United States depends on borrowing. Obviously, rapid development of housing mortgage and other credit-financed consumption has been observed since the 1980s, but this can be reconciled with the regression results in Table 3. An insignificant ΔD only means that credit-financed consumption since the 1980s is not powerful enough to render the variable significant throughout the whole period. To put it another way, changes in consumer credit have no impact on consumption at least before the 1980s. Considering this explanation and the significant ΔY in all four regressions, it is reasonable to claim that a large portion of the American population before the 1980s consumes its current income but does not borrow to finance consumption.

Unlike ΔY and ΔD which demonstrate consistent patterns throughout the first 4 columns, the behavior of ΔB_{1952} appears unfathomable at first glance: the variable is significant at the 5% level in the first two regressions, significant at the 10% level in R3 and insignificant in R4. In other words, the debt burden is significant in the consumption function, but such significance is reduced when crisis dummies are added. It seems that, similar to the wealth variables, the debt burden's impact on consumption during this period is also path-dependent.

R5 to R8 summarize results for the 1980-2011 period. At first glance, it seems that the determining power of income on consumption is drastically reduced: ΔY is only significant at the 10% level in R5 and R6. Once the dummy for the financial crisis is included in R7 and R8, ΔY becomes insignificant. In other words, less population in the United States consumes on the basis of its current income since the 1980s. This phenomenon has been observed by Palley (2002) who claims that worsening income distribution and stagnating wages have failed to impact aggregate demand. The misalignment between real income growth and consumer expenditure has also been noticed by Setterfield (2010) and Cynamon and Fazzari (2008). To borrow Campbell and Mankiw's vocabulary, the ratio of "rule-of-thumb" consumers has decreased substantially since the 1980s.

If income growth has stagnated since the 1980s for a large section of the population, then what is the generator of the continuous growth in aggregate expenditure in the United States prior to 2008? Results from the four columns on the right hand side of the table all point to increasingly extensive credit-financing of consumer expenditure. We can see that ΔD is significant at the 5% level in all regressions for the 1980-2011 period. To the contrary, the variable is not significant in three out of four regressions for the 1952-2011 period, and is only significant at the 10% level in regression R4. The change of significance of consumer credit in the consumption function indicates a change in Americans' attitude towards debt-financed consumption. From a microeconomic perspective, the budget constraint now is not so much one's income, but one's ability to borrow.

While the less significant ΔY seems supportive of the life-cycle hypothesis, the significant ΔD cannot be easily explained under Modigliani's framework. As reasoned in Chapter 2, as consumers in the life-cycle model behave rationally and only treat borrowing as an instrument to smooth consumption against fluctuating income, consumer credit should not have any explanatory power on consumer expenditure. It appears that through comparing the regression results of two different periods, the criticism made by Cynamon and Fazzari (2008), Palley (2002) and Setterfield (2010) is empirically supported.

The wealth variables in these four columns behave analogously to the four columns on the left hand side of the table. ΔW_F is significant at the 10% level in R5, but is rendered insignificant when the dummy for the financial crisis is added in R7. Also, ΔW_T is significant at the 5% level in R6 but is insignificant in R8. The stable behavior of the two variables in different periods buttresses the argument that the wealth effect is path-dependent. In addition, the fact that ΔW_F is less significant than ΔW_T in the consumption function provides further evidence to the observation made by Case, Quigley and Shiller (2001).

The newly added consumer sentiment variable is very significant in all four regressions. The t-statistic is very high in all columns, and the value of its coefficient remains stable. However, if we compare the adjusted-R^2 of the regressions that include consumer sentiment with those that do not, it appears that the increase in explanatory power is not substantial. Lugvigson (2004) provides an overview of how consumer confidence is measured and reported, and then suggests that even though the most popular measures, including the University of Michigan Consumer Sentiment Index, do contain some information about consumer expenditure growth, much of that information can be found in other economic indicators. Her argument that this measure only provides a modest amount of additional information seems consistent with the regression results in table 3.

Last but not least, it is found that ΔB_{1980} is insignificant in all four regressions. This is an unexpected result, since the debt burden is significant at the 5% level in R1 and R2 and at the 10% level in R3. Since a different series is used to represent the debt burden for the 1980-2011 period, one may wonder whether the result is due to the misalignment of two series. If we calculate the correlation coefficient of the two series, the result is 0.8229. This indicates that a relatively strong positive relationship exists between the two measures of the debt burden. To confirm whether the discrepancies are caused by differences between the two series, regression R5 is re-estimated using ΔB_{1952} instead of ΔB_{1980}. Regression results show that the debt burden variable remains insignificant. Hence there is insufficient evidence to claim that changing data series renders the debt burden variable insignificant in the four regressions covering 1980-2011.

Why is the debt burden variable significant in the 1952-2011 period but insignificant after 1980? The initial intention to include the debt-income ratio in the consumption function is that consumers in the United States began to put effort in reducing this ratio after the outbreak of the financial crisis. However, while consumers now consider the debt-income ratio as an indicator of a debt burden, we may not automatically claim that this also applies to consumers before the financial crisis. In other words, it is possible that what is considered a measure of the debt burden now may not have played the same role many years ago.

Consider the following scenario: before the boom of credit-financed consumerism, household debt was largely mortgage debt, and mortgages were used to acquire property. During this period, ΔB_{1952}, total household liability as a proportion of disposable household income, actually measures the steady accumulation of housing wealth in the United States. According to Case, Quigley and Shiller (2001), contrary to financial assets which are concentrated in the hands of the rich, housing wealth affects most American households. Therefore, it is reasonable to argue that variations in housing market wealth have important effects upon consumption. A significant ΔB_{1952} in the consumption function for the 1952-2011 period hence reflects a positive housing wealth effect rather than a negative debt burden effect that may not be completely captured by other wealth variables.

After early 1980s, however, credit-backed consumption began to increase exponentially. Due to growing usage of credit cards and cash-out financing from housing mortgages, the correlation between the debt-income ratio and housing wealth began to deteriorate. What the "debt burden" variable measures in reality starts to change from a proxy for wealth to a genuine measure of the debt burden. However, the impact of this burden on consumption is not continuous: before the financial crisis, consumers in the United States rarely paid any attention to their debt-income ratio. Only when a major crisis is imminent and households suddenly realize that their existing consumption pattern is no longer sustainable do they start cutting expenditure on consumption and reducing debt. Since regressions using OLS cannot efficiently measure any discontinuous impact of the debt burden on consumption, the variable appears insignificant in the regressions for the 1980-2011 period.

In order for this argument to make sense, there must be a drastic change in the behavior of American consumers at the beginning of the 1980s. The Chow test is commonly used to test for structural stability. The test consists of breaking the sample into two structures, estimating the equation for each of them, and then comparing the sum of squared residuals from the separate equations with that of the whole sample (Asteriou and Hall, 2007). Results of a series of tests indicate that if any date between the third quarter of 1980 and the first quarter of 1985 is selected as the break point, the null hypothesis of no structural break is rejected at the 5% level. Therefore, some credit should be given to the explanation provided in the previous two paragraphs.

According to the regression results in table 3, consumer behavior in the United States does not exactly match the predictions of the life-cycle model. Since all regressions conducted are based on short run consumption models, neither income nor the balance sheet variables should have any significant effect on consumer expenditure. In fact, following Hall's interpretation, consumption in the short run should simply behave like a random walk. To the contrary, the regression results indicate that beginning from the early 1980s, consumers in America tend to consume according to the amount of credit available to them. In other words, these consumers seem not to plan their consumption on a life-cycle basis, but instead to follow something more like Cynamon and Fazzari's model based on consumption and financial norms, which better fits the regression results discussed above.

Chapter 5: Error-Correction and the Long Run Model

Even just from the name "permanent income" we can tell that Friedman's model for consumer behavior is a long run model. Analogously, Modigliani and Brumberg's framework, with "life-cycle" as the name, is also a long run model. Therefore, regression results from short run equations are insufficient in examining the credibility of the life-cycle hypothesis. In fact, Newbold and Granger's (1974) suggestion about first differencing when variables have unit roots is also criticized for not being able to test for the long run relationship among the variables. More advanced time-series techniques have to be implemented to explore the determinants of consumer expenditure in the long run.

The first technique that will be used is the error-correction model. The error-correction model is based on the idea of cointegration first introduced by Granger (1981) and further formalized by Engle and Granger (1987). The formal definition of cointegration given by Engle and Granger (1987) is given as follows:

> "Time series Y_t and X_t are said to be cointegrated of order d, b where $d \geq b \geq 0$, written as $Y_t, X_t \sim CI\ (d, b)$, if (a) both series are integrated of order d, (b) there exists a linear combination of these variables, say $\beta_1 Y_t + \beta_2 X_t$ which is integrated of order $d - b$."

In other words, cointegration is observed when two non-stationary series are actually related, so that it is possible to find a combination of them which eliminates the non-stationarity. Based on this concept, Engle and Granger (1987) construct an error-correction model that extracts the residual of the regression equation of two cointegrated variables and includes it in the difference equation as an "error-correction term". This model resolves the problem of spurious regression and also captures the adjustment process to the long-run relationship between the two cointegrated variables.

However, one major drawback of this approach is that the model cannot work if there is more than one cointegrating equation among the variables. In addition, the Engle-Granger method is usually used only when the testing model has two variables, even though in theory there is no limit on the number of variables included. In this case, since the number of cointegrating equations in the consumption function is still unknown, using the

Engle-Granger error-correction model thus becomes inappropriate. Instead, a VEC model developed by Johansen (1988, 1992) and Johansen and Juselius (1990) will be used to examine the dynamics between consumption, income and the balance sheet variables. The Johansen approach utilizes multiple equations instead of one simple equation, thus it is able to estimate cointegrating vectors which do not limit the number of cointegrating equations involved. A general form of the VEC model can be expressed as:

$$\Delta Z = \gamma_1 \Delta Z_{t-1} + \gamma_2 \Delta Z_{t-2} + \cdots + r_{k-1} \Delta Z_{t-k+1} + \pi Z_{t-1} + u_t \qquad (15)$$

where all variables are in matrix form. The $\boldsymbol{\pi}$ matrix contains information regarding the long run relationship.

In order to know whether the consumption function devised here consists of a long run cointegrating relationship, the Johansen cointegration test must be used. The first step of the Johansen test is to determine the optimal lag length. This is a very important step, as including the wrong number of lags may lead to omitted variable bias. The most common procedure in choosing the optimal lag length is to estimate a Vector Autoregressive (VAR) model including all variables in levels. The VAR model was first developed by Sims (1980), who argues that if there is simultaneity among a number of variables, then all these variables should be treated in the same way. Following Sims' idea, all variables in a VAR model are treated as endogenous. The general form of a VAR model can be written as:

$$\Delta Z = \gamma_1 \Delta Z_{t-1} + \gamma_2 \Delta Z_{t-2} + \cdots + r_k \Delta Z_{t-k} + + u_t \qquad (16)$$

We can see that the VEC model is developed from the VAR model by adding a matrix that contains information regarding the long run relationship.

The VAR model used to find optimal lag length should be estimated for a large number of lags, and then reduced down by re-estimating the model for one lag less until zero lags is reached. Theoretically, other econometric measures, like autocorrelation, heteroskedasticity and normality of the residuals should also be inspected to determine optimum lag length. As a generally accepted rule, however, a set of statistical criteria is used to compare the goodness of fit of a model. In this procedure, the significance of the variables and the values of their coefficients are not important.

Table 4 to table 7 summarize of the criteria of the VAR model for two different periods. Table 4 and table 5 estimate the criteria for the model covering the 1952-2011 period, using W_F and W_T respectively. Table 6 and table 7 estimate the model covering the 1980-2011 period. The maximum lag length is set to be 10. The five statistical criteria calculated are the sequential modified likelihood ratio test statistic (LR), the final prediction error (FPE), the Akaike information criterion (AIC), the Schwarz information criterion (SC) and the Hannan-Quinn information criterion (HQ).

From table 4 we can see that different criteria indicate different results: FPE, AIC and HQ indicate an optimal lag length of 6; LR indicates 9 and SC indicates 5. There is no universally agreed solution when the set of criteria indicate varied results. A commonly used method is to choose the lag length indicated by the majority of criteria. Table 5 presents identical results. This is not unexpected, considering the high correlation between W_F and W_T. Since 3 out of 5 criteria in table 4 and table 5 select 6 to be the optimal lag length, we will use this value for the Johansen test. In table 6 and table 7, only SC indicates 2 lags, whereas the rest all indicate 5 lags. Again ruling by democracy, 5 is selected to be optimal lag length for the period 1980-2011. Since all the data used in this analysis are quarterly, 5 or 6 lags in the consumption function makes some economic sense.

After setting the optimal number of lags to be 6 and 5 respectively based on the results of the VAR model, the next step is to decide whether an intercept and trend should be included in either the short-run or the long-run model, or both. The Johansen cointegration test has five possible test models, three of which are compatible with economic observations: Model 2 has an intercept in the long-run cointegration equation but does not have an intercept or trend in the short-run VAR model; Model 3 has an intercept in both the cointegrating equation and the VAR model, but a trend is not included in either model; Model 4 has an intercept in both models with a trend in the cointegration equation. Model 1 does not have intercept or trend in either the cointegrating equation or the VAR model. This is quite unlikely to occur in practice. Model 5, on the other hand, includes a linear trend in the VAR. This is also unlikely from an economic perspective, as the linear trend implies an ever-increasing or ever-decreasing rate of change. Johansen (1992) suggests that the Pantula Procedure should be applied to test which model should be used. Briefly speaking, the procedure comprises moving from the most restrictive model, at each stage comparing the trace test statistic to its critical value and stopping only when it first becomes evident that the null hypothesis of cointegration cannot be rejected.

Table 8 to table 11 contains the results of the Johansen test. Table 8 and table 9 examine the longer period, using W_F and W_T to measure the wealth effect respectively. Table 10 and table 11, on the other hand, examine the shorter time period from 1980 to 2011. Eviews 7.0 uses two types of the Johansen test, namely trace and max-eigenvalue. Depending on which type of the test is used, following the Pantula Procedure may produce inconclusive results about the test model. Taking the results of table 8 as an example: if we decide to follow on the trace test and start from the top left corner of the table, the null hypothesis cannot be rejected at the 5% level for the first time when the null claims at most two cointegrating equations under model 2. This means that model 4 should be used. If max-eigenvalue is used instead, then the null cannot be rejected at 5% for the first time under model 4 with no cointegrating equation, indicating that model 3 should be used. Similarly, results from table 9 also can be interpreted differently. Model 4 is suggested if the trace test is adopted, whereas the max-eigenvalue test indicates model 2 to be the correct one. The results of the other two tables, however, indicate the same model regardless of which type of the test is used. No matter whether financial assets or total assets are used to represent household wealth, both the trace test and the max-eigenvalue test indicate that model 2 should be used.

It seems that the procedure suggested by Johansen cannot provide an unambiguous answer on to which model should be used. After all, the Pantula Procedure is just a generalized guide that may or may not select the most appropriate model for the cointegration relationship. In this case, since it has been generally accepted that autonomous consumption is an important part of total consumer expenditure, model 2, which does not have an intercept in the short run VAR matrix, may not be the best choice. In addition, model 4 does not exactly fit the proposed model of consumption as it has a time trend in the long run cointegrating equation. Literature that argues for a permanently increasing level of consumer expenditure over time is rare, and one can hardly think of any sound explanation for such argument. Therefore, it seems that model 3, with an intercept in both the long run cointegrating equation and the short run VAR matrix, is the best choice we can make.

Once model 3 is selected to be the model for the Johansen test, we can proceed to analyze the test results. In table 8, the trace statistic shows at most 2 cointegrating equations, while the max-eigenvalue statistic indicates only 1. For table 9, the trace statistic shows 2 cointegrating equation, but the max-eigenvalue statistic indicates none. For the two tables presenting test results for the shorter period, the Johansen test fails. In other words, neither type indicates the presence of a cointegrating relationship among the variables. Admittedly, such results are not expected, as the long run cointegration relationship among the variables should not disappear when a shorter period is used. However, it should be noticed that the statistical robustness of the VEC model depends not only on degrees of freedom but also on the length of the test period. Hence it is possible that the cointegration relationship is still there, but the limited length of the test period renders the relationship statistically insignificant.

Since the Johansen tests shows that the two models covering the shorter 1980-2011 period do not have any cointegrating relationship, the VEC model is only constructed for the 1952-2011 period. We have already determined the optimal lag length and the exact model to be used. The only parameter left is how many cointegrating relationships should be included in the VEC model. As neither the two types of test in table 8 nor those in table 9 give an unambiguous answer, detailed analysis of the possible cointegrating equations is needed. Table 12 provides detailed estimates of the cointegrating equations discussed in table 8. Since the trace test indicates 2 cointegrating equations whereas the max-eigenvalue test shows 1, we have to examine which choice would yield more economically and statistically meaningful estimates. If there is only 1 cointegrating equation, the error-correction term is significant and has a negative coefficient. However, if there are 2 cointegrating equations, 1 of the 2 error-correction terms will have a positive coefficient. According to the theoretical foundation of the error-correction model, if there is a cointegrating relationship among the variables, the error-correction term must be significant. Moreover, the coefficient of the error-correction term, measuring the speed of adjustment of the model, must have a negative sign and an absolute value of less than one. The rationale is straightforward: if the adjustment coefficient is positive, then any deviation from the long run equilibrium in period *t* will not be corrected at least to some extent in the next period; if the magnitude of the coefficient is greater than 1, then excessive error-correction will result (see equation (15)). Therefore, it seems that the VEC model covering the 1952-2011 period with W_F used to measure household wealth should only have 1 cointegrating equation.

Table 13 contains detailed estimates of the cointegrating equations discussed in table 9. We can see that if there is 1 cointegrating equation, the error-correction term, albeit with a negative and less than unity coefficient, is not significant at the 5% level. On the other hand, if there are 2 cointegrating equations, 1 of the 2 error-correction term has a positive coefficient. As neither choice produces statistically meaningful estimates, the result of no cointegrating relationship suggested by the max-eigenvalue test is adopted.

As estimates in table 13 identify no cointegrating equation, the VEC model cannot be constructed using W_T. The only possible model left is the one covering the 1952-2011 period using W_F. Estimates of the VEC model using W_F are presented in Table 14. Model 3 with 1 cointegrating equation is selected and the optimal lag length is set to be 6. The first part of the table is a normalized cointegrating equation that describes the long-run relationship among the variables included. We can see that all the independent variables in the long run cointegrating equation are significant at the 5% level. In equation form, the cointegrating equation can be re-written as:

$$C + 5.2556 - 0.7334Y - 0.1360D - 0.1227W_F + 0.0853B_{1952} = 0 \quad (17a)$$

Rearranging this equation by keeping C on the left side while moving all other terms to the right side of the equation, we have:

$$C = -5.2556 + 0.7334Y + 0.1360D + 0.1227W_F - 0.0853B_{1952} \quad (17b)$$

Before analyzing whether the estimates of the VEC model support or discredit the life-cycle hypothesis, we should examine if the coefficients of the variables in equation (17b) make economic sense. Of the four variables on the right side of the equation, only B_{1952} has a negative coefficient. Since B_{1952} is supposed to measure the debt burden of consumers, the negative relationship between C and B_{1952} is expected. The positive coefficients of the remaining three variables are also compatible with common sense or observed facts. The marginal propensity to consume calculated by the VEC model is 0.7334. This value is within the expected range (greater than zero and less than one). A positive coefficient on D means that in the long run, consumer expenditure is positively related to credit given to consumers. The value of the coefficient is less than unity, which is also congruent with what has been observed in reality. Last but not least, the positive but less than unity coefficient of W_F confirms the existence of a financial wealth effect in the long run.

The second half of the table 14 presents short run estimates of the error-correction model. Since our main purpose of using the VEC model is to find the long run relationship between consumption and the listed variables, the regression results for the short run are not very relevant. Nevertheless, by scrutinizing the short run estimates we may gain insight into the overall credibility of the VEC model. The most important figure in the error-correction part of the table is the value and significance of the error-correction term. As discussed above, in an econometrically meaningful VEC model, the error-correction term should be significant, and its coefficient has to be negative and less than unity. In table 14, the error-correction term is significant at the 5% level. The speed of adjustment is -0.0928, meaning that for every unit of short run deviation from the long run equilibrium in a certain period, 9.28% of the deviation will be corrected in the next period. All the requirements for a well-behaved error-correction term are met.

The coefficients and t-statistics of the lagged short run variables are also presented in the second half of the table. For those variables that are statistically significant, most do make economic sense. The only obvious problem is the three significant lagged income variables: ΔY_{-1} has a positive coefficient while ΔY_{-4} and ΔY_{-5} have negative coefficients. While the possible feedback effect of income on consumption has been discussed, it is impossible for such effect to take place after only three quarters of a year. Despite this confusing behavior of ΔY, the overall performance of the short run regression is satisfactory.

After examining the credibility of the VEC model, the next step is to analyze whether the regression estimates of equation (17b) support the life-cycle hypothesis. Under Modigliani and Brumberg's framework, the consumption function is written as:

$$C_t = C(Y, Y^e, a, t) = \frac{1}{L_t} Y + \frac{N-t}{L_t} Y^e + \frac{1}{L_t} a \quad (5)$$

In the long run, current income should be equal to expected income. Hence the long run version of equation (5) is:

$$C_t = C(Y, a, t) = \frac{N-t+1}{L_t} Y + \frac{1}{L_t} a \tag{18}$$

Comparing equation (18) with equation (17b), we can see that the empirical estimates from the VEC model do provide some support to the life-cycle hypothesis. Both the income and the wealth variable are significant and have a positive coefficient. The magnitude of the 2 coefficients are both less than unity. In addition, as postulated in equation (18), the marginal propensity to consume in equation (17b) is much greater than the wealth elasticity of demand.

However, under the life-cycle framework, no robust explanation can be given for the significance of consumer credit and the debt burden in the consumption function. As discussed in preceding chapters, consumers in the life-cycle model are perfectly rational and plan their consumption based on their estimated permanent income. Debt, just like saving, is an instrument to smooth consumption against fluctuating income. In other words, the life-cycle type of consumers should borrow when they are young and save when they become older, thus rendering both debt and saving insignificant in the long run consumption function. Similarly, since these consumers are perfectly rational, the degree of the debt burden they will be facing should have already been taken into consideration during the planning stage. Therefore, no explanatory power of the debt burden should be found in the consumption function.

Besides the commonly used VEC method, the DOLS method also provides an effective way of estimating long run cointegrating equations. Developed by Stock and Watson (1993), the DOLS method utilizes triangular representation to produce estimates that are equivalent to the Johansen estimators. This approach can only be used when all the variables involved are integrated of order 1 and there is only 1 cointegrating equation among these variables. Here it will be used as an alternative estimating method to examine the cointegrating relationship between consumer expenditure and the listed variables. Notice that the estimating mechanism of the DOLS approach is completely different from Johansen's VEC model. Hence the optimal lag length given by the VAR test and the number of cointegrating equations calculated by the Johansen test cannot be used as inputting parameters.

Table 15 and table 16 are the estimates of long run cointegrating equations using W_F and W_T to measure the wealth effect respectively. In Eviews 7.0, three statistical criteria, namely the AIC, the SC and the HQC, can be used to find out the optimal leads and lags. Unfortunately, the 1980-2011 period is not long enough to permit such calculation, so only regressions for the 1952-2011 period are conducted. In table 15, we can see that the 3 criteria indicate different leads and lags: the AIC shows 14 leads and 11 lags; the SC indicates no lead and 4 lags; the HQC, no lead and 5 lags. Some variables like Y and W_F, are significant regardless of which criterion is used. D, to the contrary, remains insignificant in all three columns. The only variable that behaves inconsistently is B_{1952}: it is significantly negative if the regression is based on AIC, but becomes insignificant when SC or HQC is adopted. Similarly, in table 16, the two columns of estimates using SC and HQC resemble one another to a large extent. In both columns, Y and W_T are significantly positive while the other two variables are insignificant. Variables in the column following AIC, on the other hand, are all statistically significant.

In both tables, a dichotomy is observed between two groups: AIC in one and SC plus HQC in the other. The DOLS estimates from the group consisting of SC and HQC are more inclined towards the life-cycle hypothesis. However wealth is measured, income and wealth are significant in the long run consumption function and have expected signs. The two balance sheet variables also behave in the manner expected by Modigliani and are insignificant in the consumption function. The estimates given by the model following AIC, however, tell a completely different story. In the left column in table 15, we can see that D is the only insignificant variable. While the significant Y and W_F fit the life-cycle hypothesis, the significance of consumer credit in the cointegrating equation cannot be explained. In table 16, all independent variables are significant and have signs that make economic sense. In fact, if the regression results in this column are compared with those in table 14, considerable similarity is observed.

There is no basis for establishing which criterion performs best in selecting the most appropriate model. However, through analyzing how these criteria are calculated we may be able to prioritize them under certain circumstances. The AIC is constructed in such a way that the model with best fit is given more credit. The SC and the HQC, on the other hand, emphasize more the succinctness of the model and place much greater punishment on additional independent variables. In many cases, the SC is selected to be the determining criterion, because the simplicity of the resulting regression is preferred. However, in the DOLS case, the criteria are only used to determine the optimal number of leads and lags. No matter what criterion is selected, the variables in the cointegrating equation will not change. Sacrificing the accuracy of the estimates in exchange for the same number of variables may not be a wise move. Therefore, I consider the AIC a more appropriate indicator of optimal leads and lags in the DOLS regression.

This chapter concentrates on examining long run consumer behavior in the United States. Two different models, the VEC model and the DOLS model, are used to estimate the cointegrating relationship between consumption and various other variables. After using VAR models to determine the optimal lag length, the Johansen cointegration test is conducted to determine whether or not there exists a cointegrating equation. The test only gives a positive result for one of the possible testing models (the 1952-2011 period with W_F included to measure the wealth effect). A long run cointegrating equation is produced by the VEC model, and the regression results indicate that both balance sheet variables (D and B_{1952}) are significant. This result is not compatible with the life-cycle hypothesis. The regression results produced by the DOLS model, on the other hand, depend on the statistical criterion selected: estimates based on the SC and HQC support the life-cycle hypothesis while those based on the AIC are compatible with Cynamon and Fazzari's (2008) theory.

Chapter 6: Conclusion

Compared to a number of existing empirical studies that only incorporate income and wealth as independent variables in the consumption function (see Hall (1978) and Morley (2007), for example), the innovative part of this thesis is the inclusion of the two balance sheet variables (consumer credit and the debt burden). This is inspired by Mishkin's earlier studies (1977, 1978) on balance sheet movements during crisis times. As the focus of this study is the consumer expenditure in the United States, time-series techniques are used to test the credibility of the life-cycle model from an econometric perspective. Since it has been shown that unit roots are present in the data series, the simple OLS method can only be used to analyze the short run differenced model. However, both Friedman and Modigliani consider their models to apply to the long run, so using OLS alone may be insufficient. The VEC model and the DOLS model are then used to examine the long run cointegration relationship between consumer expenditure and other listed variables.

Chapter 4 of this thesis focuses on analyzing consumer behavior in America in the short run. The beginning of the chapter introduces the idea of unit roots and briefly explains why regressions using data series with unit roots may produce spurious estimates. The ADF test and the P-P test are used to examine whether the data selected have unit roots. Test results indicate that all series except the consumer sentiment index possess unit roots. Following the suggestion from Granger and Newbold (1970), the non-stationary variables are differenced and then regressed using OLS. Comparing the regression results covering two different periods, we notice a structural change in consumer behavior: in the 1952-2011 period, current income is significant in the consumption function whereas consumer borrowing is insignificant. In the 1980-2011 period, to the contrary, current income becomes substantially less significant while consumer borrowing becomes very significant. Results of a Chow test confirm the existence of a structural break in the early 1980s. However, in neither case can the regression results be well explained under the framework of the life-cycle hypothesis. Before the break, consumers tend to consume based on their current income, but Friedman argues that only changes in permanent income can affect consumption. In Modigliani and Brumberg's model (see equation 5), even though short run changes in income are significant, the value of its coefficient, after taking consumer's expected life span into account, should not be very large. Campbell and Mankiw's theory about "rule-of-thumb" consumers (1989) appears to offer a more persuasive explanation of the data. In addition, after the structural break, consumer expenditure depends less on income but more on consumer credit. Again, this is not compatible with the life-cycle hypothesis, in which rational consumers only use consumer credit as a tool to smooth consumption in the face of fluctuating income.

Estimates of the long run consumption function can be found in chapter 5. In the long run cointegrating equation produced by the VEC model (see equation 17b), all the independent variables are significant. While the significance of income and household wealth can be explained by the life-cycle hypothesis, Friedman and Modigliani's work provides no explanation for the significance of the two balance sheet variables. Estimates of the DOLS model using AIC are similar to the results of the VEC model. However, if SC or HQC is used to determine the optimal lag length, only income and household wealth are significant in the consumption function. These results are compatible with the life-cycle model.

If the life-cycle hypothesis is not supported by the majority of the regression results, which model performs more satisfactorily? Cynamon and Fazzari's (2008) theory of consumption and financial norms provides a logically consistent explanation of consumer behavior since early 1980s. Cynamon and Fazzari believe that, contrary to Friedman and Modigliani's assumptions, consumers tend to acquire consumption patterns from what they call "social reference groups". Social references created by, for example, advertisements, induce greater demand from consumers, regardless of whether the advertised products are actually needed. At the same time, due to changing financial norms, consumers have gradually come to accept the idea of credit-financed consumption without pondering whether their financial positions are comparable to that of those of their reference groups. In this way, consumer expenditure becomes dependent on consumers' borrowing and debt burden, but without any of this being necessarily sustainable, which explains the regression results presented in chapter 4 and chapter 5.

Admittedly, some of the regression results in chapter 4 and chapter 5 cannot be explained easily. For example, the scenario described in chapter 4 to explain the debt burden's loss of significance in the consumption function after the structural break is conjectured and may not be correct. In addition, no existing theory seems to be appropriate to explain why in the short run part of the VEC model, the lagged income variables are both significant but have opposite signs. For the DOLS estimation, whereas AIC is considered to be the best indicator, it is also reasonable to argue that either SC or HQC outperforms AIC in selecting optimal lag length. If either SC or HQC is used, regressions results then become supportive of the life-cycle model. Last but not least, since there is a structural break in the early 1980s, the best way to analyze consumer behavior should be to construct two different test models for two different periods, one before and the other after the structural break. However, given the fact that the robustness of both the VEC model and the DOLS model heavily depends on the length of the period covered, regressing the data for the two shorter periods may seriously jeopardize the accuracy of the estimation results.

These qualifications notwithstanding, the empirical results in this thesis are reliable and make economic sense in general. Both the regression results of the short run model in chapter 4 and the results of the long run VEC and DOLS models in chapter 5 are not compatible with the life-cycle hypothesis. Cynamon and Fazzari's (2008) theory of consumption and financial norms, meanwhile, performs more satisfactorily in explaining these empirical results.

Appendix

Figures

Figure 1 Ratio of consumer expenditure to personal disposable income, 1981-2011

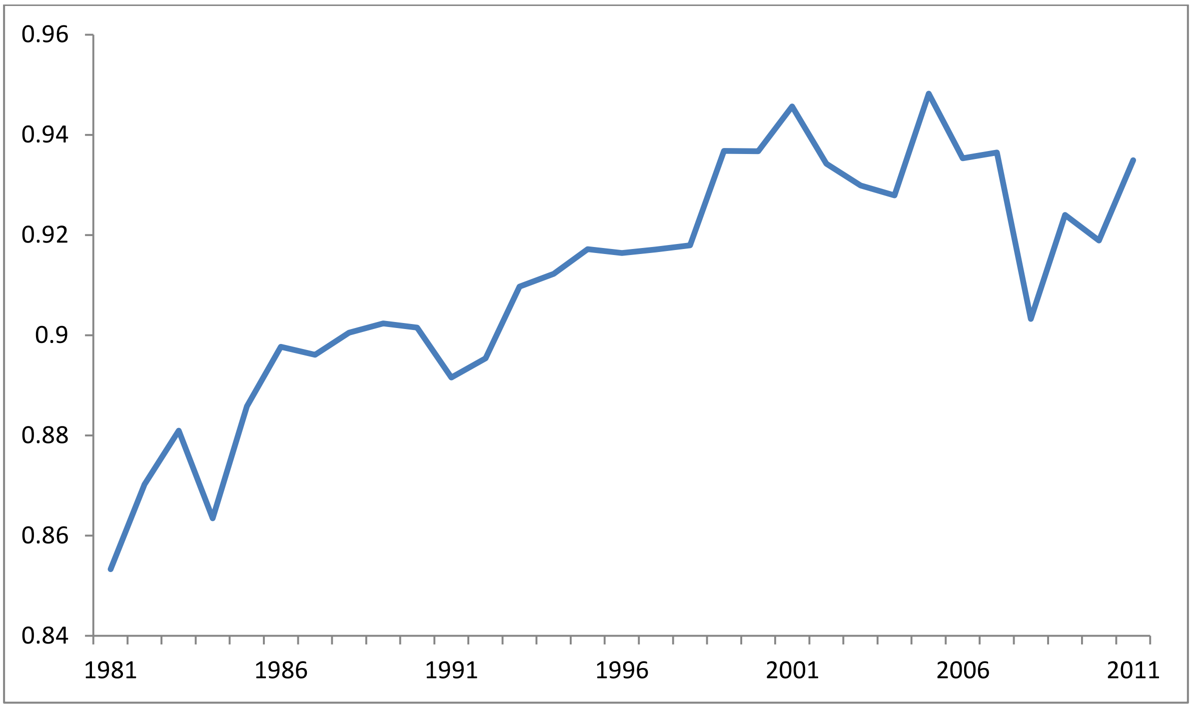


Figure 2 Percentage change in consumption and household total assets, 1981-2011

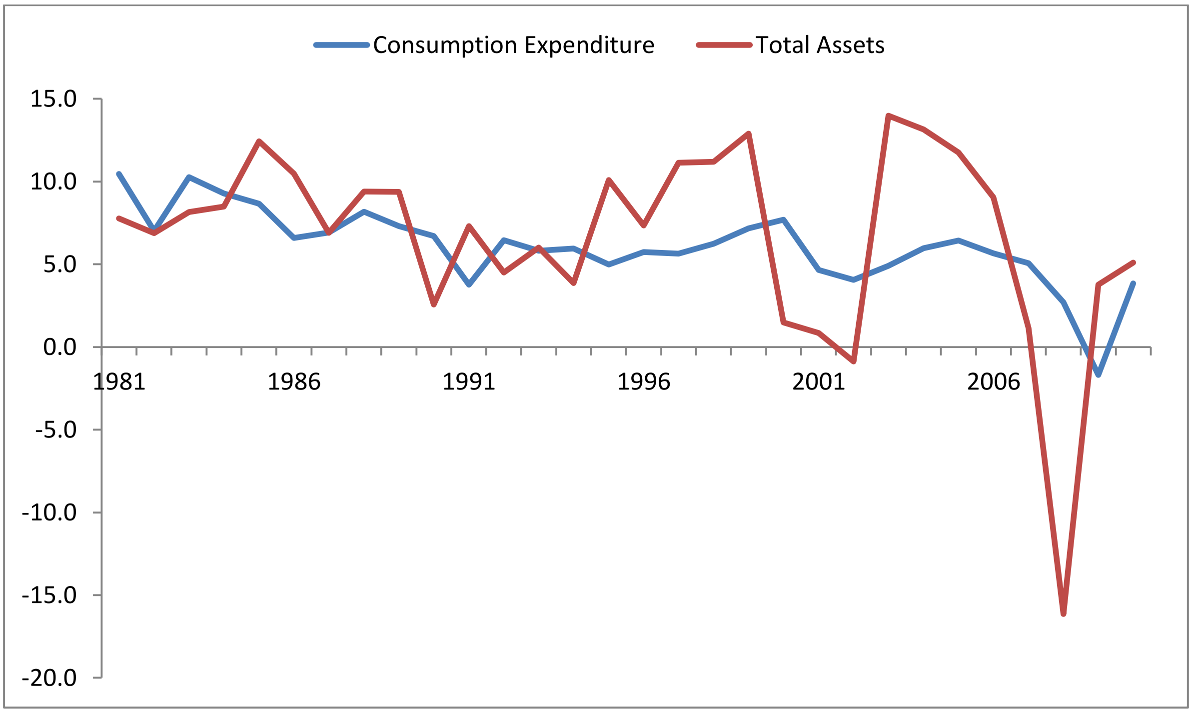


Figure 3 Total household liabilities as a share of disposable income, 1981-2011

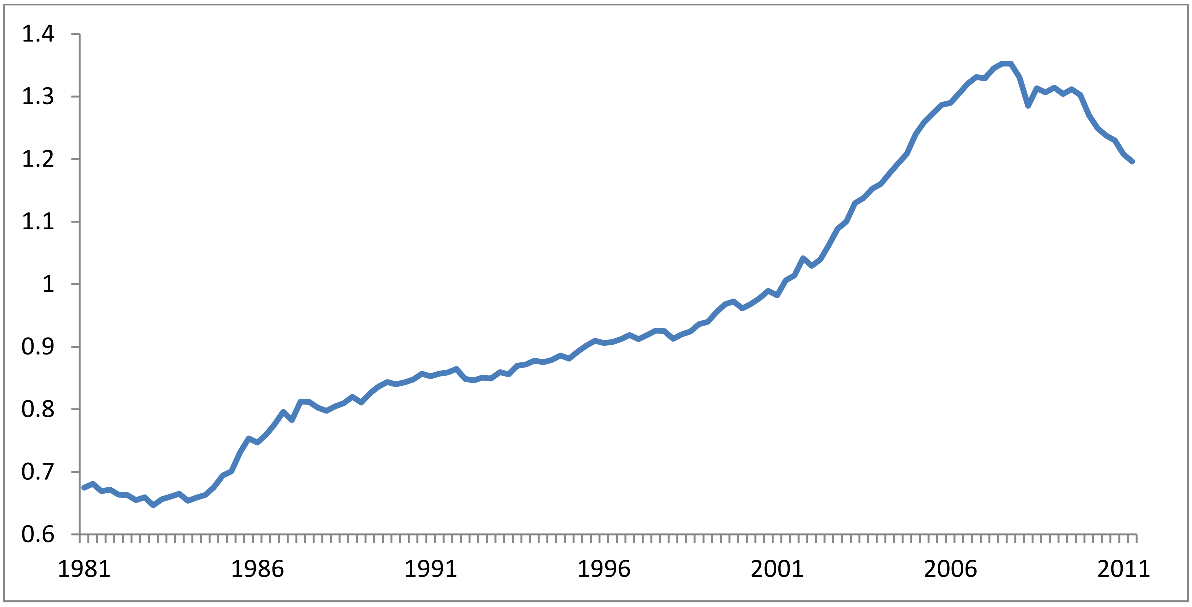


Figure 4 Real personal consumption expenditure, 1952-2011 (Natural Log of Billions of Chained 2005 Dollars)

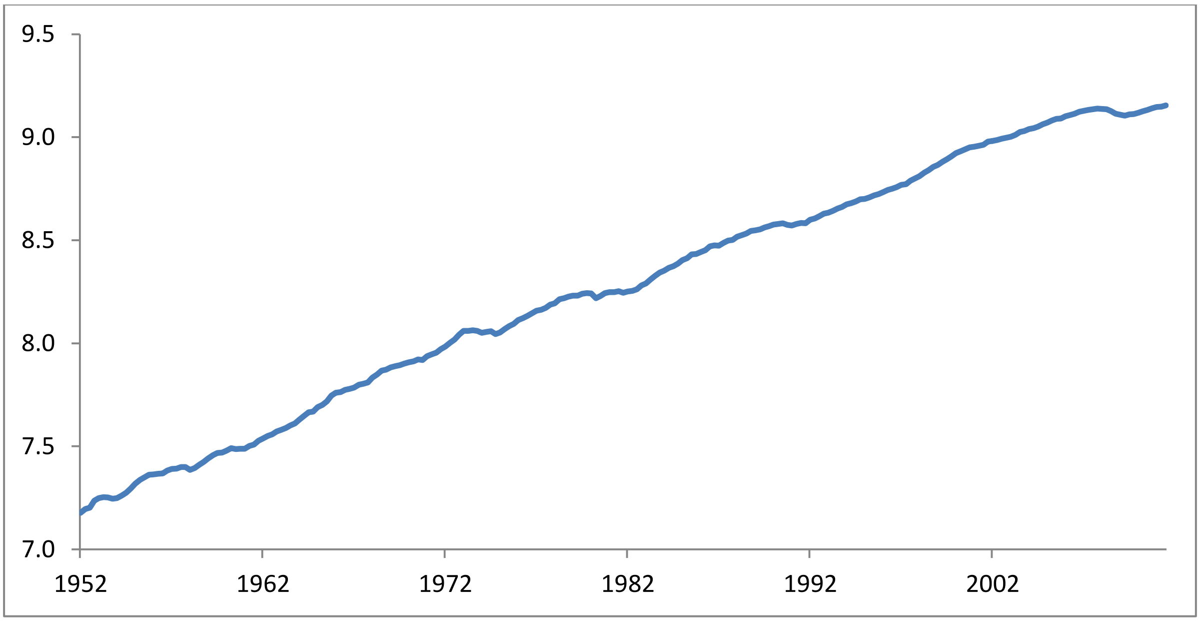


Figure 5 Real disposable personal income, 1952-2011 (Natural Log of Billions of Chained 2005 Dollars)

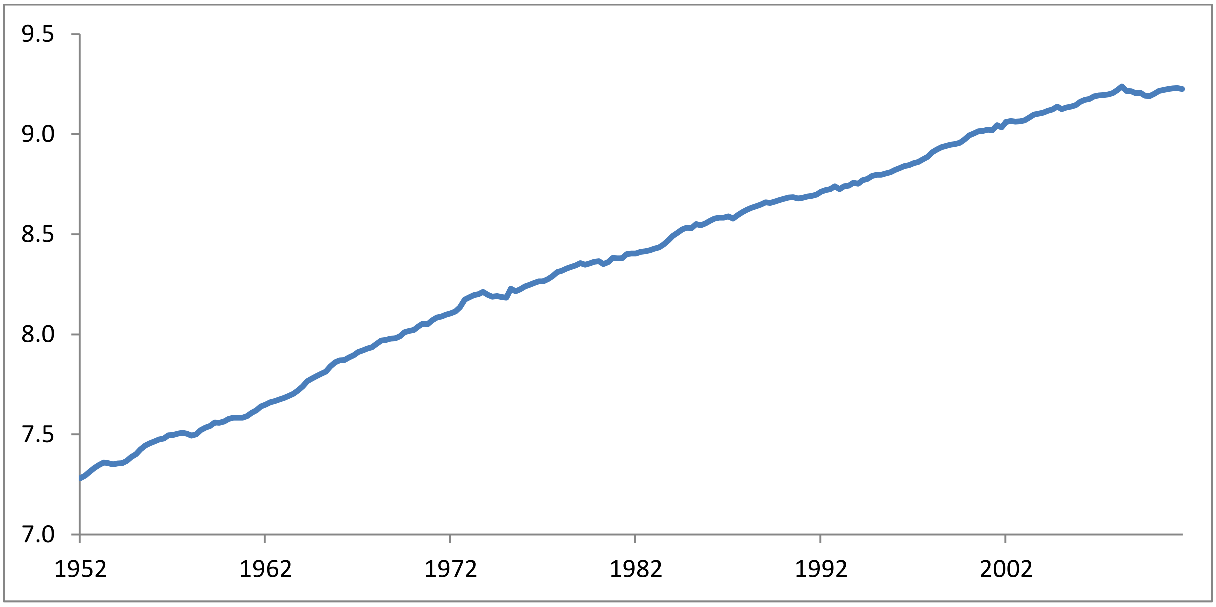


Figure 6 Consumer credit of households and non-profit organizations, 1952-2011 (Natural Log of Dollars Adjusted by GDP Deflator with Index 2005=100)

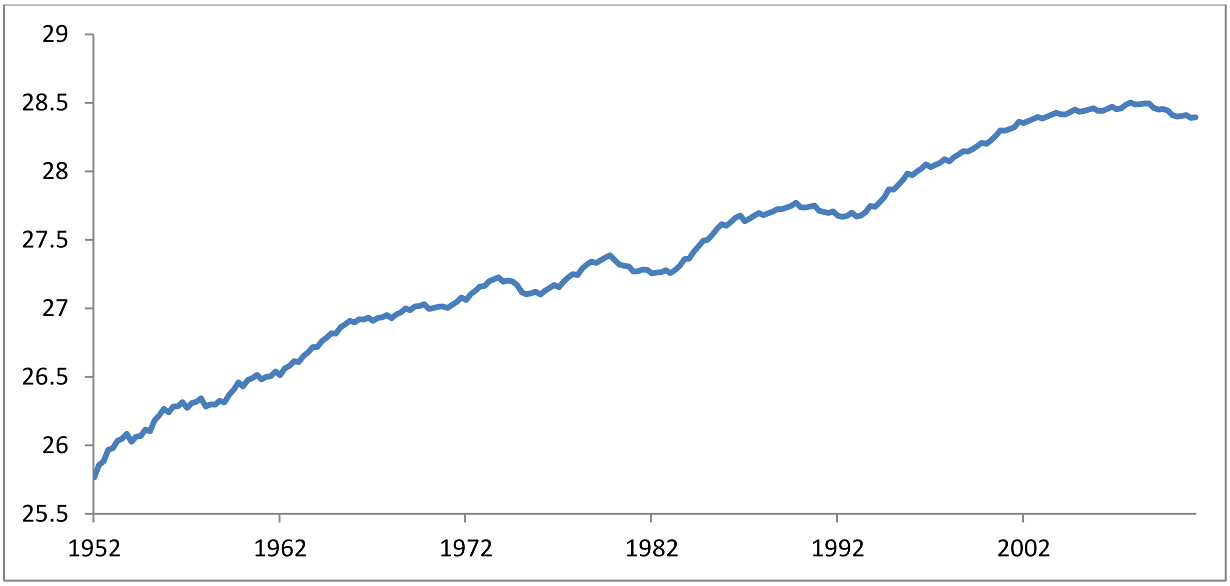


Figure 7 Total financial assets of households and non-profit organizations, 1952-2011 (Natural Log of Dollars Adjusted by GDP Deflator with Index 2005=100)

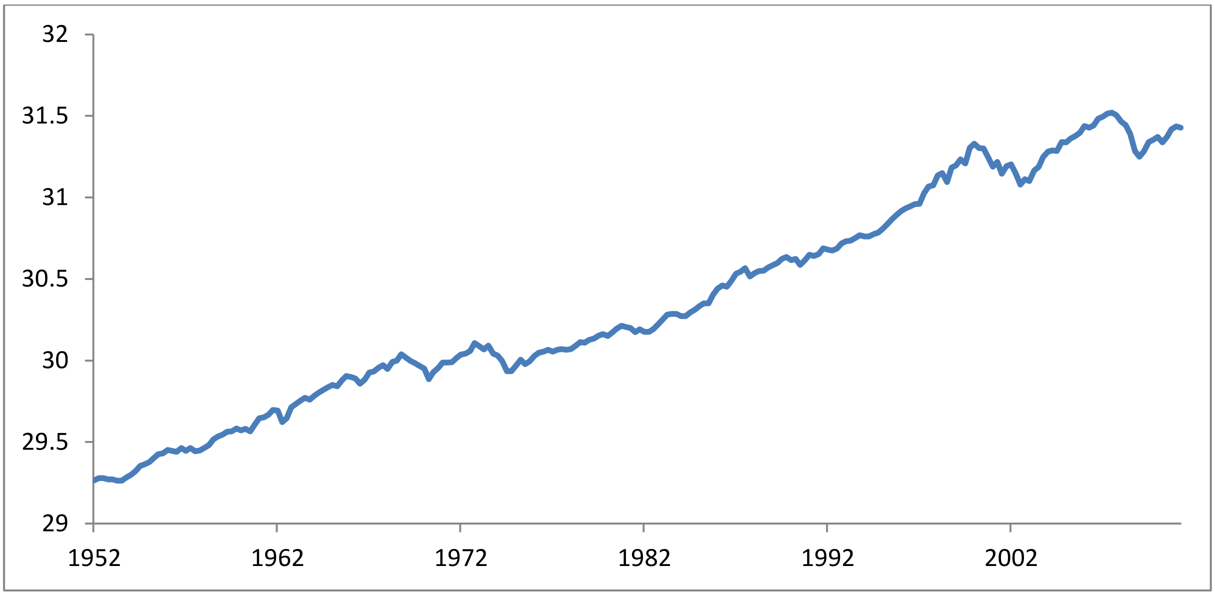


Figure 8 Total assets of households and non-profit organizations, 1952-2011 (Natural Log of Dollars Adjusted by GDP Deflator with Index 2005=100)

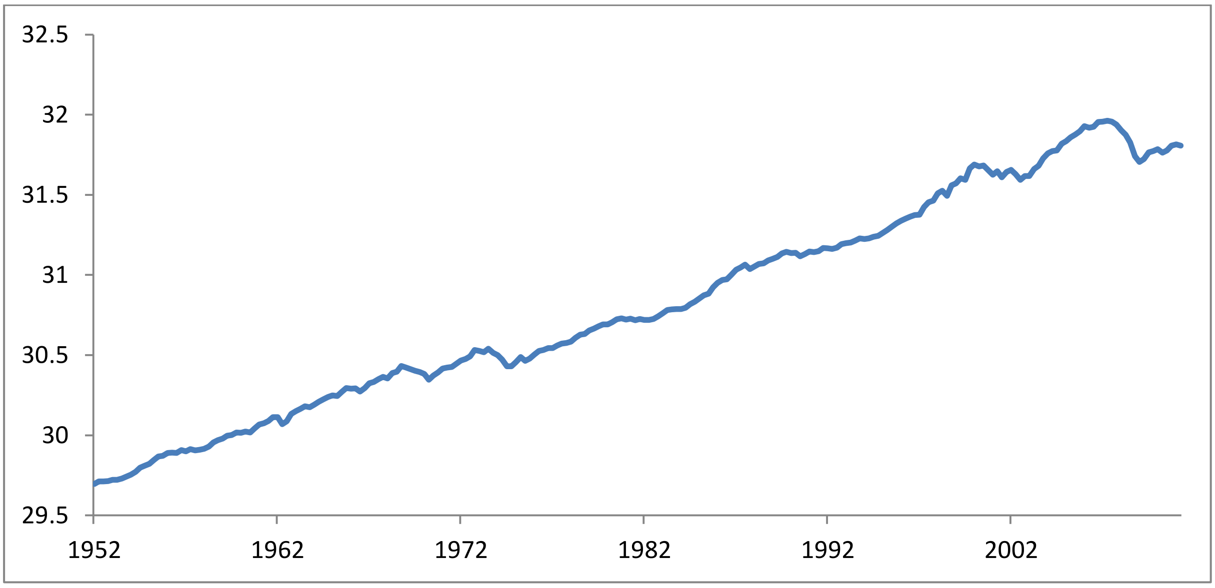


Figure 9 Total household liabilities as a share of disposable income, 1952-2011

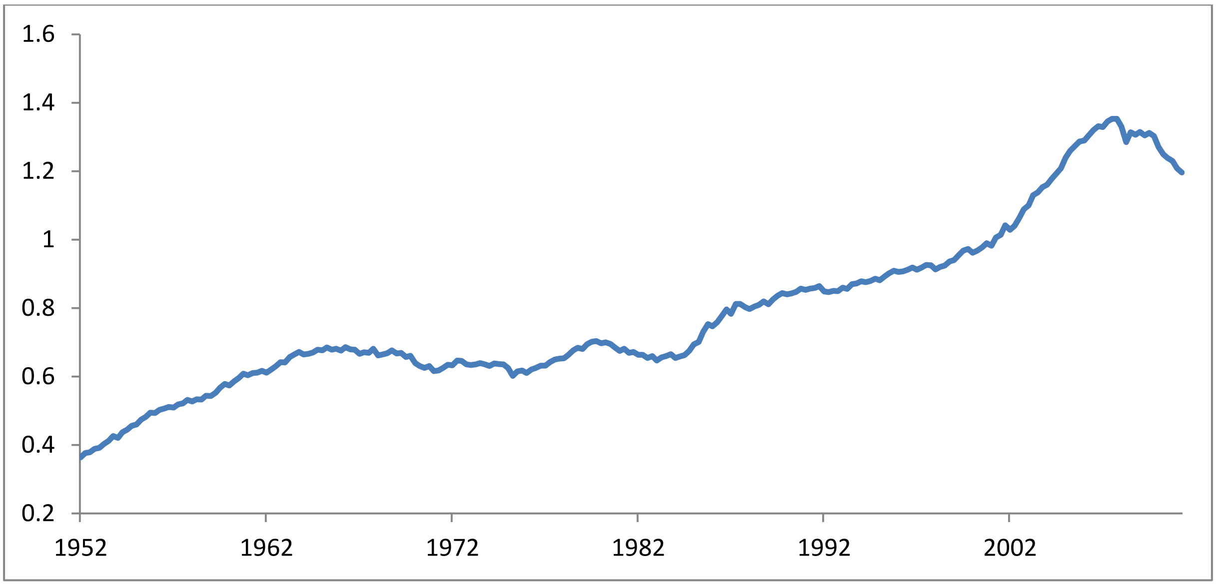


Figure 10 The ratio of debt payments to personal disposable income, 1980-2011

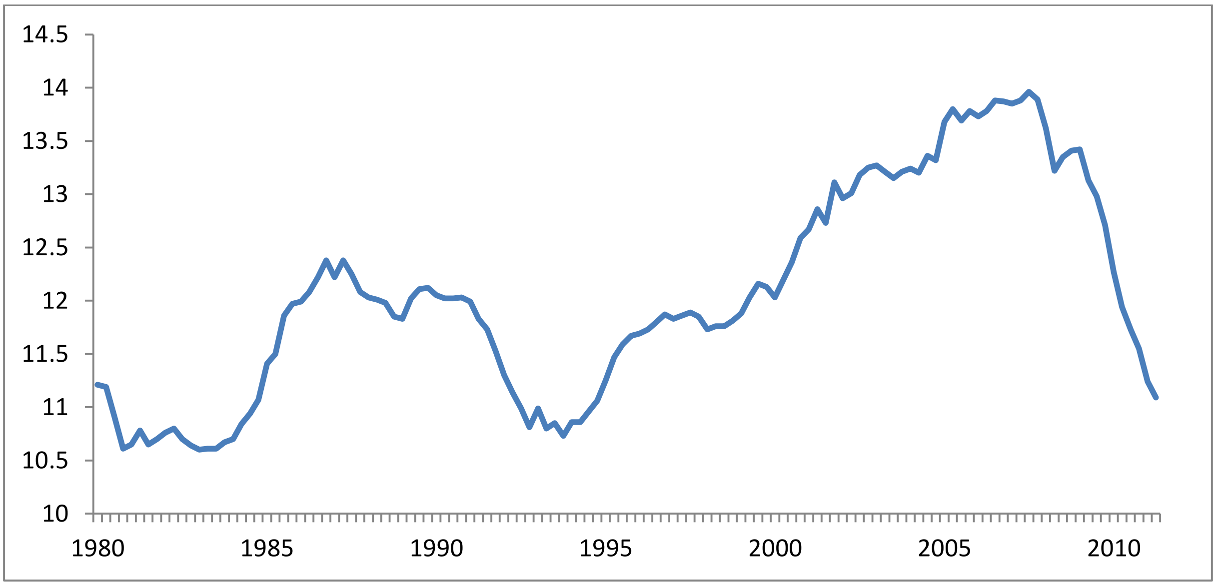
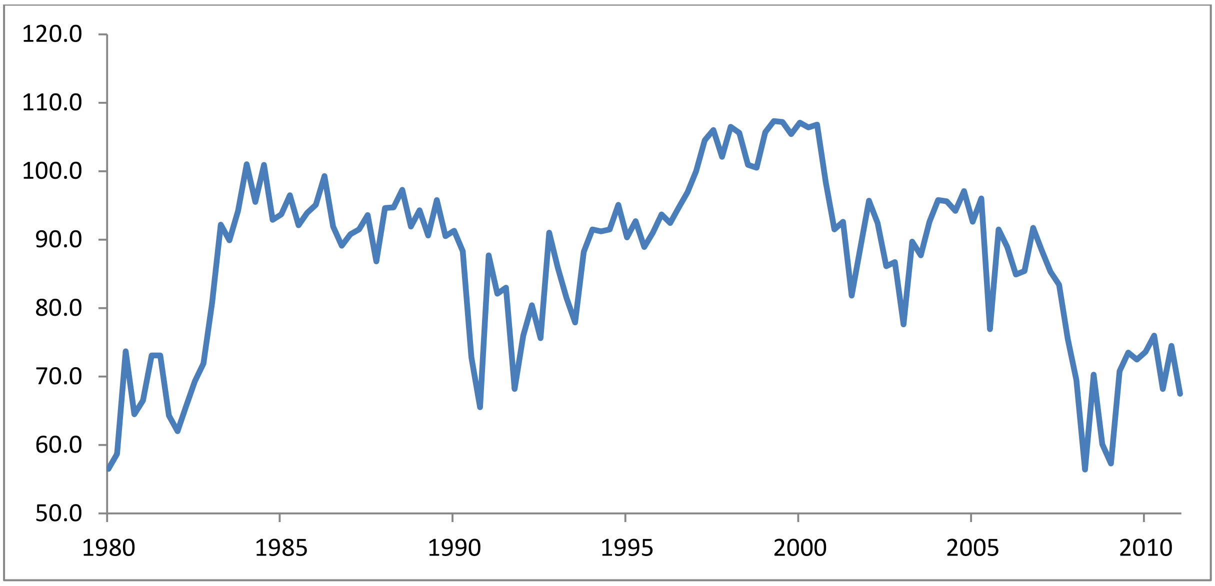


Figure 11 University of Michigan Consumer Sentiment Index, 1980-2011



Tables

Table 1 Unit root test for all variables, 1952-2011

Variable	Test	Level/Dif	Type*	P-Value#	Intercept	Trend	Integration
Ln(Consumption)	ADF	Level	With I&T	0.8585	0.1406	0.2057	I(1)
		Level	With I	0.3408	0.0121		
		1st	None	0.0004			
	P-P	Level	With I&T	0.9325	0.8304	0.8892	I(1)
		Level	With I	0.2174	0.0000		
		1st	None	0.0000			
Ln(Income)	ADF	Level	With I&T	0.9748	0.4334	0.6951	I(1)
		Level	With I	0.0512	0.0002		
		1st	None	0.0000			
	P-P	Level	With I&T	0.9618	0.4334	0.6951	I(1)
		Level	With I	0.0725	0.0002		
		1st	None	0.0000			
Ln(Total Asset)	ADF	Level	With I&T	0.5136	0.0311	0.0394	I(1)
		1st	None	0.0001			
	P-P	Level	With I&T	0.3798	0.1187	0.1493	I(1)
		Level	With I	0.8077	0.2779		
		Level	None	1.0000			
		1st	None	0.0000			
Ln(Consumer Credit)	ADF	Level	With I&T	0.1362	0.0028	0.0061	I(1)
		1st	None	0.0025			
	P-P	Level	With I&T	0.0963	0.0056	0.0218	I(1)
		1st	None	0.0000			
(Total Debt/Income)	ADF	Level	With I&T	0.3968	0.0110	0.0415	I(1)
		1st	None	0.0014			
	P-P	Level	With I&T	0.7945	0.0560	0.4154	I(1)
		Level	With I	0.8541	0.0600		
		Level	None	0.9973			
		1st	None	0.0000			
Ln(Financial Asset)	ADF	Level	With I&T	0.5855	0.0423	0.0487	I(1)
		1st	None	0.0000			
	P-P	Level	With I&T	0.3913	0.0423	0.0487	I(1)
		1st	None	0.0000			

*: I&T means intercept and trend, I means intercept

#: the null hypothesis is that the data series have a unit root

Table 2 Unit root test for all variables, 1980-2011

Variable	Test	Level/Dif	Type*	P-Value#	Intercept	Trend	Integration
Ln(Consumption)	ADF	Level	With I&T	0.7488	0.0877	0.1251	I(2)
		Level	With I	0.5564	0.1121		
		Level	None	0.9973			
		1st	None	0.0807			
		2nd	None	0.0000			
	P-P	Level	With I&T	0.9762	0.5032	0.3421	I(1)
		Level	With I	0.6371	0.0213		
		1st	None	0.0000			
Ln(Income)	ADF	Level	With I&T	0.9510	0.3486	0.4306	I(1)
		Level	With I	0.6081	0.1080		
		Level	None	1.0000			
		1st	None	0.0001			
	P-P	Level	With I&T	0.9415	0.3486	0.4306	I(1)
		Level	With I	0.5887	0.1080		
		Level	None	1.0000			
		1st	None	0.0000			
Ln(Consumer Credit)	ADF	Level	With I&T	0.1750	0.0047	0.0107	I(1)
		1st	None	0.0268			
	P-P	Level	With I&T	0.8652	0.9622	0.8201	I(1)
		Level	With I	0.7555	0.2312		
		Level	None	0.9977			
		1st	None	0.0000			
Ln(Total Asset)	ADF	Level	With I&T	0.9158	0.2479	0.3617	I(1)
		Level	With I	0.6477	0.1963		
		Level	None	0.9995			
		1st	None	0.0000			
	P-P	Level	With I&T	0.8440	0.6251		I(1)
		Level	With I	0.6593	0.1386		
		Level	None	0.9996			
		1st	None	0.0000			
Ln(Debt-Income Ratio)	ADF	Level	With I&T	0.9509	0.2902	0.8236	I(1)
		Level	With I	0.3944	0.0798		
		Level	None	0.6495			
		1st	None	0.0000			
	P-P	Level	With I&T	0.9430	0.4578	0.0531	I(1)
		Level	With I	0.5232	0.4390		
		Level	None	0.6257			
		1st	None	0.0000			
		Level	With I	0.7120	0.2343		
		Level	None	0.9995			
		1st	None	0.0000			

*: I&T means intercept and trend, I means intercept

#: the null hypothesis is that the data series have a unit root

Table 2 (continued) Unit root test for all variables, 1980-2011

Variable	Test	Level/Dif	Type*	P-Value#	Intercept	Trend	Integration
Ln(Consumer Sentiment)	ADF	Level	With I&T	0.2189	0.0030	0.1433	I(1)
		Level	With I	0.0690	0.0068		
		1st	None	0.0000			
	P-P	Level	With I&T	0.1013	0.0006	0.2811	I(0)
		Level	With I	0.0208	0.0010		
Ln(Financial Asset)	ADF	Level	With I&T	0.8296	0.1359	0.2061	I(1)
		Level	With I	0.6965	0.2343		
		Level	None	0.9999			
		1st	None	0.0000			
	P-P	Level	With I&T	0.6036	0.1359		I(1)
		Level	With I	0.7120	0.2343		
		Level	None	0.9995			
		1st	None	0.0000			

*: I&T means intercept and trend, I means intercept

#: the null hypothesis is that the data series have a unit root

Table 3 Short run OLS regression results

	1952- 2011				1980- 2011			
	R1	R2	R3	R4	R5	R6	R7	R8
c_0	0.0035** [5.6640]	0.0035** [5.6815]	0.0045** [6.6304]	0.0045** [.6.5294]	-0.0121** [-2.6490]	-0.0108** [-2.3007]	-0.0090* [-1.979]	-0.0085* [-1.8440]
ΔY	0.4461** [7.5395]	0.4243** [7.0107]	0.3907** [6.4728]	0.3818** [6.2384]	0.1425* [1.7362]	0.1425* [1.7582]	0.1118 [1.3952]	0.1128 [1.4178]
ΔD	0.0310 [1.3623]	0.0342 [1.5039]	0.0358 [1.5990]	0.0371* [1.6574]	0.0552** [2.0642]	0.0555** [2.0940]	0.0582** [2.2480]	0.0583** [2.2573]
ΔW_F	0.0390** [1.9733]		0.0161 [1.0839]		0.0271* [1.7045]		0.0131 [0.8158]	
ΔW_T		0.0546** [2.5051]		0.0306 [1.3468]		0.0596** [2.1238]		0.0244 [0.9983]
ΔB_{1952}	0.1453** [2.6092]	0.1254** [2.2040]	0.0995* [1.7726]	0.0913 [1.6033]				
ΔB_{1980}					-0.0002 [-0.0410]	-0.0002 [-0.0439]	-0.0021 [-0.4119]	-0.0020 [-0.4067]
S					0.0003** [3.5838]	0.0002** [3.1951]	0.0002** [3.1425]	0.0002** [2.9589]
$Crisis_1$			-0.0040 [-1.5585]	-0.0039 [-1.5094]				
$Crisis_2$			-0.0086** [-3.2600]	-0.0081** [-2.9971]			-0.0072** [-2.9868]	-0.0069** [-2.7606]
adj-R^2	0.3334	0.3401	0.3607	0.3624	0.3609	0.3692	0.4008	0.4025
F-Stat	30.5089	31.4026	23.1890	23.3590	15.0058	15.5168	14.8241	14.9203
D-W	2.1723	2.1883	2.1678	2.1721	1.9806	2.0010	2.0348	2.0362

*: Significant at 10% **: Significant at 5% []: t-statistic

Table 4 Test for optimal lag length using VAR model with W_F, 1952-2011

Lag	LR	FPE	AIC	SC	HQ
0	NA	1.55e-11	-10.69790	-10.62270	-10.66756
1	4470.930	3.47e-20	-30.61793	-30.16670	-30.43587
2	119.8591	2.49e-20	-30.95098	-30.12372	-30.61720
3	73.04526	2.20e-20	-31.07623	-29.87295	-30.59074
4	37.89805	2.28e-20	-31.04001	-29.46071	-30.40281
5	323.7479	5.73e-21	-32.42343	-30.46810*	-31.63451
6	75.50076	4.88e-21*	-32.58738*	-30.25603	-31.64675*
7	16.98677	5.59e-21	-32.45656	-29.74918	-31.36421
8	27.59957	6.05e-21	-32.38485	-29.30145	-31.14079
9	57.74499*	5.53e-21	-32.48283	-29.02340	-31.08706
10	27.63856	5.95e-21	-32.41968	-28.58423	-30.87219

*: Lag order selected by the criterion

Table 5 Test for optimal lag length using VAR model with W_T, 1952-2011

Lag	LR	FPE	AIC	SC	HQ
0	NA	6.50e-12	-11.57018	-11.49497	-11.53983
1	4432.276	1.73e-20	-31.31609	-30.86486	-31.13403
2	127.8691	1.19e-20	-31.68605	-30.85879	-31.35227
3	84.26385	9.99e-21	-31.86422	-30.66094	-31.37873
4	37.53809	1.04e-20	-31.82626	-30.24696	-31.18906
5	323.9786	2.61e-21	-33.21082	-31.25549*	-32.42190
6	76.22875	2.21e-21*	-33.37847*	-31.04712	-32.43784*
7	18.73513	2.51e-21	-33.25675	-30.54937	-32.16441
8	28.37128	2.71e-21	-33.18917	-30.10577	-31.94511
9	59.44084*	2.45e-21	-33.29647	-29.83704	-31.90070
10	28.01209	2.63e-21	-33.23543	-29.39998	-31.68794

*: Lag order selected by the criterion

Table 6 Test for optimal lag length using VAR mode with W_F, 1980-2011

Lag	LR	FPE	AIC	SC	HQ
0	NA	3.32e-11	-9.939944	-9.821255	-9.891763
1	1767.457	5.37e-18	-25.57670	-24.86456	-25.28761
2	133.0254	2.33e-18	-26.41257	-25.10699*	-25.88258
3	55.33467	2.08e-18	-26.53488	-24.63586	-25.76399
4	59.48277	1.73e-18	-26.72998	-24.23751	-25.71818
5	162.0440*	4.48e-19*	-28.09944*	-25.01352	-26.84673*
6	29.13121	5.03e-19	-28.01112	-24.33176	-26.51751
7	27.28255	5.72e-19	-27.92112	-23.64831	-26.18660
8	26.47043	6.53e-19	-27.84302	-22.97677	-25.86760
9	35.11265	6.53e-19	-27.91360	-22.45389	-25.69727
10	26.30553	7.34e-19	-27.88727	-21.83411	-25.43003

*: Lag order selected by the criterion

Table 7 Test for optimal lag length using VAR mode with W_T, 1980-2011

Lag	LR	FPE	AIC	SC	HQ
0	NA	1.44e-11	-10.77582	-10.65713	-10.72764
1	1777.032	2.13e-18	-26.49962	-25.78749	-26.21054
2	132.2132	9.34e-19	-27.32776	-26.02218*	-26.79777
3	55.86471	8.27e-19	-27.45537	-25.55635	-26.68448
4	67.56744	6.32e-19	-27.73558	-25.24310	-26.72377
5	151.8109*	1.84e-19*	-28.99133*	-25.90541	-27.73862*
6	29.44977	2.05e-19	-28.90676	-25.22740	-27.41315
7	26.08669	2.37e-19	-28.80181	-24.52900	-27.06729
8	25.70327	2.73e-19	-28.71349	-23.84723	-26.73806
9	37.62933	2.64e-19	-28.82001	-23.36031	-26.60369
10	24.95831	3.03e-19	-28.77295	-22.71980	-26.31572

*: Lag order selected by the criterion

Table 8 P-value for the Johansen cointegration test using W_F, 1952-2011

No. of CEs	Model 2		Model 3		Model 4	
	Trace	Max-Eigen	Trace	Max-Eigen	Trace	Max-Eigen
0	0.0000	0.0005	0.0014	0.0480	0.0005	0.1283
At most 1	0.0125	0.0802	0.0177	0.0625	0.0028	0.0359
At most 2	0.0771	0.3485	0.1422	0.2713	0.0432	0.2119
At most 3	0.0974	0.1356	0.2577	0.3886	0.1102	0.1802

Variables included: $C,\ Y,\ D,\ W_F, B_{1952}$

Table 9 P-value for the Johansen cointegration test using W_T, 1952-2011

No. of CEs	Model 2		Model 3		Model 4	
	Trace	Max-Eigen	Trace	Max-Eigen	Trace	Max-Eigen
0	0.0001	0.0026	0.0057	0.1338	0.0009	0.0395
At most 1	0.0210	0.1182	0.0291	0.1053	0.0157	0.0902
At most 2	0.0930	0.3482	0.1495	0.2678	0.1048	0.3294
At most 3	0.2473	0.1914	0.1088	0.4358	0.1847	0.2938

Variables included: $C,\ Y,\ D,\ W_T, B_{1952}$

Table 10 P-value for the Johansen cointegration test using W_F, 1980-2011

No. of CEs	Model 2		Model 3		Model 4	
	Trace	Max-Eigen	Trace	Max-Eigen	Trace	Max-Eigen
0	0.0003	0.0006	0.0831	0.1916	0.0236	0.2289
At most 1	0.0856	0.3713	0.2832	0.3583	0.0817	0.2014
At most 2	0.1377	0.1974	0.5157	0.6179	0.2618	0.3461
At most 3	0.3503	0.6489	0.5326	0.4752	0.4778	0.5254

Variables included: $C,\ Y,\ D,\ W_F, B_{1980}$

Table 11 P-value for the Johansen cointegration test using W_T, 1980-2011

No. of CEs	Model 2		Model 3		Model 4	
	Trace	Max-Eigen	Trace	Max-Eigen	Trace	Max-Eigen
0	0.0002	0.0007	0.0668	0.2145	0.0244	0.1463
At most 1	0.0560	0.3586	0.2146	0.4112	0.1211	0.3512
At most 2	0.0887	0.1961	0.3464	0.4288	0.2454	0.3098
At most 3	0.2188	0.5876	0.4736	0.4135	0.4879	0.5078

Variables included: $C,\ Y,\ D,\ W_T, B_{1980}$

Table 12 Normalized cointegrating equation and adjustment coefficient, following table 8

No. of CEs	Adjustment Coefficient	Normalized cointegrating equation				
		C	Y	D	W_F	B_{1952}
1	-0.0928** (0.0349)	1.0000	-0.7334** (0.0441)	-0.1360** (0.0415)	-0.1227** (0.0293)	0.0853** (0.0383)
2	-0.1864** (0.0555)	1.0000	0.0000	-0.8801** (0.0939)	-0.0663 (0.1279)	0.5271** (0.1432)
	0.1620** (0.0504)	0.0000	1.0000	-1.0146** (0.1052)	0.0769 (0.1432)	0.6023** (0.1604)

**: Significant at 5%   (): Standard error

Table 13 Normalized cointegrating equation and adjustment coefficient, following table 9

No. of CEs	Adjustment Coefficient	Normalized cointegrating equation				
		C	Y	D	W_T	B_{1952}
1	-0.0295 (0.0232)	1.0000	-0.5360** (0.0848)	-0.2979** (0.0632)	-0.1345 (0.0634)	0.1483** (0.0689)
2	-0.1401** (0.0529)	1.0000	0.0000	-0.8803** (0.1202)	-0.0506 (0.1527)	0.4750** (0.1367)
	0.1104** (0.0426)	0.0000	1.0000	-1.0867** (0.1509)	0.1566 (0.1917)	0.6096** (0.1716)

**: Significant at 5%   (): Standard error

Table 14 VEC model estimates using W_F, 1952-2011

Variable	Coefficient [t-statistic]	Variable	Coefficient [t-statistic]	Variable	Coefficient [t-statistic]
Cointegrating Equation					
C	1.0000	Constant	5.2559	W_F,	-0.1227** [-4.1941]
Y	-0.7334** [-16.6479]	D	-0.1360** [-3.2798]	B_{1952}	0.0853** [2.2295]
Error-Correction					
Correction Term	-0.0928** [-2.6633]	Constant	0.0059** [4.5394]		
ΔC_{-1}	0.0539 [0.6258]	ΔC_{-3}	0.2386** [2.8427]	ΔC_{-5}	-0.0549 [-0.6425]
ΔC_{-2}	0.1090 [1.2680]	ΔC_{-4}	-0.0887 [-1.0664]	ΔC_{-6}	0.0449 [0.5871]
ΔY_{-1}	0.3216** [3.6706]	ΔY_{-3}	-0.0184 [-0.2064]	ΔY_{-5}	-0.1621* [-1.8331]
ΔY_{-2}	-0.0307 [-0.3439]	ΔY_{-4}	-0.2307** [-2.6618]	ΔY_{-6}	-0.0010 [-0.0115]
$\Delta W_{F_{-1}}$	0.0382** [2.4076]	$\Delta W_{F_{-3}}$	0.0051 [0.3084]	$\Delta W_{F_{-5}}$	0.0033 [0.2054]
$\Delta W_{F_{-2}}$	0.0386 [2.3801]	$\Delta W_{F_{-4}}$	0.0273 [1.6482]	$\Delta W_{F_{-6}}$	0.0089 [0.5532]
ΔD_{-1}	-0.0703 [-1.5411]	ΔD_{-3}	-0.0082 [-0.2696]	ΔD_{-5}	0.0241 [0.5458]
ΔD_{-2}	-0.0221 [-0.5345]	ΔD_{-4}	0.0725** [2.3933]	ΔD_{-6}	-0.0204 [-0.4957]
$\Delta B_{1952_{-1}}$	0.2825** [3.6244]	$\Delta B_{1952_{-3}}$	0.0564 [0.6729]	$\Delta B_{1952_{-5}}$	-0.1577* [-1.8970]
$\Delta B_{1952_{-2}}$	0.0710 [0.8638]	$\Delta B_{1952_{-4}}$	-0.2056** [-2.4703]	$\Delta B_{1952_{-6}}$	-0.0268 [-0.3096]
Adjusted R^2:	0.3248	F-Statistic:	4.5690		

**Significant at 5% *Significant at 10%

Table 15 DOLS estimates using W_F, 1952-2011

Criteria	AIC	SC	HQC
No. of Leads	14	0	0
No. of Lags	11	4	5
Constant	-5.8494** [-5.169]	-2.3750** [-5.9107]	-2.5501** [-6.2806]
Y	0.7764** [13.9613]	0.9088** [43.7376]	0.8988** [42.1828]
D	0.03848 [0.6636]	-0.0265 [-1.3554]	-0.0178 [-0.8785]
W_F	0.2215** [6.5123]	0.1238** [8.3569]	0.1246** [8.5300]
B_{1952}	-0.1781** [-2.6998]	0.0009 [0.6297]	0.0020 [0.1075]
Adjusted R^2	0.9998	0.9998	0.9998
D-W Statistic	0.5761	0.4360	0.4295

**: Significant at 5% []: t-statistic

Table 16 DOLS estimates using W_T, 1952-2011

Criteria	AIC	SC	HQC
No. of Leads	14	0	0
No. of Lags	11	4	1
Constant	-8.5064** [-4.8753]	-3.9124** [-6.7567]	-3.7120** [-6.5800]
Y	0.5920** [8.0793]	0.8237** [30.9579]	0.8406** [33.0259]
D	0.1567** [2.5646]	0.0100 [0.5190]	-0.0095 [-0.5268]
W_T	0.2496** [4.6778]	0.1629** [7.5707]	0.1688** [7.8979]
B_{1952}	-0.1653* [-1.8927]	-0.0051 [-0.2376]	-0.0013 [-0.0619]
Adjusted R^2	0.9998	0.9998	0.9998
D-W Statistic	0.4785	0.4128	0.4532

**: Significant at 5% *: Significant at 10% []: t-statistic

Data Sources

1. U.S. Bureau of Economic Analysis (BEA)
   www.bea.gov/
2. Federal Reserve Board Flow of Fund (FED)
   http://www.federalreserve.gov/releases/z1/Current/data
3. Bureau of Labor Statistics (BLS)
   http://www.bls.gov
4. the Thompson Reuters/University of Michigan Surveys of Consumers (TR)
   http://www.sca.isr.umich.edu/

Time-Series Data	Source
Consumer Expenditure	BEA
Disposable Income	BEA
Consumer Credit	FED
Household Total Assets	FED
Household Financial Assets	FED
Household Liabilities	FED
Debt Service to Income Ratio	FED
GDP Deflator	BEA
Consumer Sentiment Index	TR

Consumer Expenditure: *Real Personal Consumption Expenditures (chained 2005 dollars)*
Disposable Income: *Real Disposable Personal Income (chained 2005 dollars)*
Nominal Disposable Income: *Disposable Personal Income*
Consumer Credit: *Consumer Credit - Liabilities - Balance Sheet of Households and Nonprofit Organizations*
Household Total Assets: *Total Assets - Balance Sheet of Households and Nonprofit Organizations*
Household Financial Assets: *Total Financial Assets - Assets - Balance Sheet of Households and Nonprofit Organizations*
Household Liabilities: *Total Liabilities - Balance Sheet of Households and Nonprofit Organizations*
Debt Service to Income Ratio: *Household Debt Service Payments as a Percent of Disposable Personal Income*
GDP Deflator: *Gross Domestic Product: Implicit Price Deflator*
Consumer Sentiment Index: *University of Michigan: Consumer Sentiment*

Data Sources (Continued)

$C = \ln(Consumer\ Expenditure)$

$Y = \ln(Disposable\ Income)$

$D = \ln(\frac{Consumer\ Credit}{GDP\ Deflator})$

$W_T = \ln(\frac{Household\ Total\ Assets}{GDP\ Deflator})$

$W_F = \ln(\frac{Household\ Financial\ Assets}{GDP\ Deflator})$

$B_{1952} = \frac{Household\ Liabilities}{Nominal\ Disposable\ Income}$

$B_{1980} = Debt\ Service\ to\ Income\ Ratio$

$S = Consumer\ Sentiment\ Index$

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