The Wealth Effects of Stock Market on Consumption: A Time-Series Analysis of the US from 1952 to 2014

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Abstract

This paper uses time-series analysis techniques to examine the wealth effects of the stock market in the US over the period 1952 to 2014. The data used in this paper are from the Federal Reserve Bank of St. Louis (FRED). To separate the wealth effects of the stock market from other forms of wealth, the total wealth of households are divided into stock wealth and non-stock wealth. Three aspects of the wealth effects of the stock market are analyzed in this paper: how large are the wealth effects, how fast do households adjust to the wealth effects and are the wealth effects stable over this long period? By applying a cointegration test, this paper finds a long-run relationship between consumption, income and wealth. However, the estimated error correction model (ECM) suggests that the fluctuations in the stock market will not affect consumption in the short-run. The results of ECM also show that households will adjust their consumption in the short-run in order to restore their long-run equilibrium level. Nevertheless, the adjustment speed is found to be quite slow. In the last section of this paper, several potential issues about quantifying the wealth effects of the stock market are discussed and some suggestions for future studies are given.

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Introduction

In the last two decades we have seen a dramatic expansion of the US economy. According the Bureau of Economic Analysis of the US (2016), the consumption expenditure per capita has increased from 15082 dollars in 1990Q1 to 37600 dollars in the 2015Q1; about 250 percent as much as the consumption in 1990. Meanwhile, the stock market also experienced a huge increase. Fluctuations in the stock market have profound effects on the economy. During the 1990s, the stock market boom greatly increased the average family’s wealth and stimulated consumption in the US. The wealth effect of the stock market is an interesting economic research topic and has motivated numerous studies to quantify its scale. In this paper, I also seek to investigate how fluctuations in the stock market will affect the consumption of households.

There are two different aspects of the wealth effects of the stock market. The first one is how much a representative consumer will spend given a one-dollar appreciation in his/her portfolio. Due to the volatility of the stock prices in the short-run, households may not consider the appreciation of their stock portfolios to be sustainable. What's more, the existence of commission, capital gains tax and other transaction costs might prevent the household from cashing his/her portfolios. They might also prefer to hold the portfolio for a longer time, hoping for further appreciation in their portfolios. Therefore, there are many different forces affecting the wealth effects of the stock market simultaneously.

The second aspect of the wealth effects is to see how fast the average households will adjust to the changes in their stock wealth. Due to adjustment costs, the changes in the wealth effects will not affect the consumption level of households all at the same time. There might be time lags for people to realize the appreciation of their stock portfolios. In addition, it also takes time for households to decide what they want to buy. Therefore, it is important to investigate whether the stock market has long-lasting effects on the consumption of households.

Most of the previous literature has focused on evaluating the scale of the wealth effects on consumption. This paper makes some additional contributions by investigating both the how large the wealth effects of stock market are and how fast households will adjust to the changes in their stock wealth. By setting a restriction on the coefficients of the regression, I am able to estimate the long-run multiplier as well as the adjustment speed of the wealth effects of the stock market.

Previous literature has suggested that none of consumption, income and wealth is a stationary process and each contains a unit root process. Traditional ordinary least square methods might bring about some problems like the non-normal distribution of the estimators. However, in this paper I use the residual based cointegration test to investigate if these three variables share a same stochastic trend in the long run. If consumption, income and wealth are cointegrated, then the OLS estimator of the marginal propensity to consume out of wealth will be "superconsistent". Then I analyze the short-run wealth effects of the stock market on consumption using the error correction model (ECM). I find that the fluctuations in the stock market do not contribute to the changes in consumption. The reason for this is not that the stock market does not have wealth effects on consumption, but fluctuations in the stock market in the short run are usually transitory.

This paper is divided into six sections. The following literature review provides the theoretical background of this paper as well as other previous empirical studies. The data and variables section provide information about the source of the data used in this paper and how each variable is defined. In the model and methodology section I derived the models that will be applied in this paper. The empirical results section presents the statistical results of these models and some explanation. The last part is conclusion and discussion, where I make a brief conclusion and present some final thoughts about the choice of model and some potential problems.

Literature Review

Theoretical Linkage Between Stock Market Wealth and Consumption

Various economic theories have suggested the potential relationship between wealth and consumption. Among them, the two most frequently used models are Friedman's permanent income hypothesis and Modigliani's life-cycle model. According to the life-cycle model, the current level of consumption is determined by income and the level of total wealth. The increase of consumption in response to a one-dollar increase in wealth is called the marginal propensity to consume out of wealth. Stock equity is an important part of the total wealth that households hold and therefore, an increase in the stock market should spur households to consume more. However, in light of Friedman's permanent income hypothesis, income is divided into two parts-permanent income and transitory income. Between them, only changes in permanent income will significantly affect consumption. Changes in transitory income will only slightly affect consumption because households will try to smooth their consumption through saving and borrowing. For example, if a man lost 100 dollars on the way home, he will not change his consumption patterns because he knows this change in his income is just transitory: he will not lose 100 dollars every day. However, if there is a recession and his salary is decreased by 100 dollars every week, he might try to tighten his belt because this change has affected his permanent income. Since the fluctuations in the market value of stock are usually considered as transitory, the permanent income hypothesis argues that the wealth effects of the stock market will be relatively small. Therefore, according to these two theories, the marginal propensity to consume (MPC) out of the stock market wealth will be positive, but relatively small.

Empirical Linkage Between Stock Market Wealth and Consumption

A considerable amount of research has been done to examine the relationship between wealth, income and consumption. Most of this research found a significantly positive but small value of the MPC out of stock wealth. The value of MPC is between 0.03 and 0.08, which suggests that the household will consume three to eight cents in response to a one-dollar increase in stock market wealth. But, the MPC seems to vary over time. These changes in the MPC will be explained in more detail in the latter part of this paper.

Macklem (1994) divided wealth into two parts: human wealth and non-human wealth, where human wealth is just a measure of education, health etc. and non-human wealth includes wealth in the form of financial assets like equity and other non-financial assets like real estate etc. Using an error correction model (ECM), he found that the consumption of non-durable goods and services will increase by 3.5 cents for one-dollar increase in non-human wealth for Canada. The reason for not including durable goods into consumption is that the consumption of durable goods usually represents additions and replacements to the capital asset, which has different incentives with the consumption of non-durable goods and services. Pichette (2004) used a similar methodology and estimated the long-run MPC out of stock wealth to be 0.02 for Canada.

He separated the stock wealth and real estate wealth, and found that changes in house prices have stronger wealth effects on consumption than changes in stock prices. The reason for this difference is that housing wealth is less concentrated among the richest people than stock wealth, and changes in house prices are less likely to be reversed than stock prices.

Ludvigson and Steindel (1999) estimated the MPC out of stock wealth for the US. Using an updated approach, they found that the MPC for the US is about 0.046. One interesting fact they found is that the MPC out of stock wealth seems to be unstable across different time periods, with the MPC to be much lower in the 1990s when the economy was experiencing an economic bubble. In the short run, the results of the Granger causality tests are very insignificant and therefore the fluctuations in the stock market do not change the consumption level of households. Though the number 0.046 looks small, when multiplied by trillion-dollar fluctuations of the stock market the wealth effects are considerable even compared with the whole economy. Using panel data for 16 OECD countries, Ludwig and Sløk (2004) found that the long-run MPC out of stock wealth to be ranged from 0.015 to 0.05 in these countries. However, the short-run MPC is much smaller compared with the long-run MPC, which indicates that the stock market plays a less important role in the short run.

Data and Variable

The data used in this paper are from Federal Reserve Bank of St. Louis (FRED). As is shown in the literature, durable goods are usually excluded when analyzing the wealth effects of stock market because the incentives for the consumption of durable goods are different from that of non-durable goods and services. However, I am still very interested in estimating the overall wealth effects on total consumption expenditures so use the total consumption expenditure as the consumption variable used in this paper.[1] The first independent variable is disposable income, which measures how much income the households have after accounting for taxes. The second independent variable is total wealth. I use the net worth of households for the total wealth because the net worth equals the total assets of the household minus his/ her total liabilities and correctly captures the definition of wealth. The total wealth is then divided into two parts, stock wealth and non-stock wealth. The stock market wealth is measured by the total market value of corporate equity held by households.[2] I use the difference of total wealth and stock wealth for the non-stock wealth. The reason for using the difference of total wealth and stock wealth is that non-stock wealth incorporates all the other forms of asset except stock, including both non-financial assets like real estate and other forms of financial assets like bonds and bank deposits. Therefore, it will be incomplete if I just use the data about some certain types of assets. All of these data have been adjusted to 2009 US dollars so the influences of the price level changes are eliminated. The data are from 1952Q1 to 2014Q4 and are divided into several subperiods because I want to examine whether there are any structural changes during this long period.

[1] The consumption data used is consumption expenditure per capita, which includes the consumption of durable goods, non-durable goods and services.

[2] The stock wealth is described as the amount of corporate equities held by households in the dataset.

The Model and Methodology

The Wealth Effects on Consumption: Koyck Model Approach

According to the permanent income hypothesis and lifetime-cycle model, income and wealth both affect the level of consumption. Therefore, the traditional linear aggregate consumption function takes the following form:

$$C_t = \beta_0 + \beta_1 PI_t + \beta_2 SW_t + \beta_3 NSW_t + u_t \qquad (1)$$

where C_t is the consumption at the current period, PI_t is permanent income at the current period; SW_t is the stock market wealth and NSW_t is non-stock wealth which could include real estate and other forms of financial assets. u_t is the error term that captures the effects of other effects on consumption. In some literature u_t is also called transitory consumption because it measures the transitory disequilibrium consumption from its equilibrium level.

Due to the unobservability of the permanent income, there is a need to modify the consumption function and replace the permanent income with some variables that can be observed. A commonly used replacement for the permanent income is the current disposable income. Suppose wealth and income has a long-lasting effect on consumption. This is plausible because households want to smooth their consumption across different time periods. For example, if one's portfolio appreciates by ten thousand dollars in period t, this will affect his/her consumption not only in period t but also in the following periods t+1, t+2 etc. Furthermore, suppose that the effects of a change in current income or wealth on consumption attenuate at a rate λ. This means that after one period the effects will be λ as much as the last period. If the attenuation rate is less than 1, the effects of a change in current wealth in the future will be 0 at last. This restriction on the parameter is plausible since the effect of a change in the distant past on the current period will not be as important as a change in the current period.

Given the above two assumptions, the model specification is as the following:

$$C_t = \beta_0 + \sum_{i=1}^{\infty} \beta_1 \lambda^i PI_{t-i} + \sum_{i=1}^{\infty} \beta_2 \lambda^i SW_{t-i} + \sum_{i=1}^{\infty} \beta_3 \lambda^i NSW_{t-i} + u_t \qquad (2)$$

At first glance, it is not possible to estimate equation (2) because there are infinite parameters needed to be estimated. However, if we lag (2) by one period and multiply it by the attenuation rate λ, we can get

$$\lambda C_{t-1} = \lambda\beta_0 + \sum_{i=1}^{\infty} \beta_1 \lambda^{i+1} PI_{t-i-1} + \sum_{i=1}^{\infty} \beta_2 \lambda^{i+1} SW_{t-i-1} + \sum_{i=1}^{\infty} \beta_3 \lambda^{i+1} NSW_{t-i-1} + u_{t-1} \qquad (3)$$

If we subtract (3) from (2) we can get

$$
\begin{aligned}
C_t - \lambda C_{t-1} &= \alpha_0 + \beta_1 PI_t + \beta_2 SW_t + \beta_3 NSW_t + v_t \\
C_t &= \alpha_0 + \lambda C_{t-1} + \beta_1 PI_t + \beta_2 SW_t + \beta_3 NSW_t + v_t
\end{aligned} \tag{4}
$$

where $\alpha_0 = \beta_0(1-\lambda)$ and $v_t = u_t - \lambda u_{t-1}$.

Equation (4) is called the Koyck model, which was first proposed by Koyck in 1954. Though the Koyck model is essentially just a simple first-order autoregressive regression, it is a very powerful tool. By applying restriction to the parameters we can get a lot of useful information about the dynamics of the wealth effects of stock market on consumption in the long-run. β_1, β_2 and β_3 are just the impact effects on the consumption. To acquire the long-run cumulative dynamic multiplier of the stock wealth (l_{sw}), we need to add up the following geometric series:

$$
l_{sw} = \beta_2 + \beta_2\lambda + \beta_2\lambda^2 + \cdots = \frac{\beta_2}{1-\lambda} \tag{5}
$$

The same procedure can be applied to income and non-stock wealth to get the long-run multipliers of them.

Another usage of the Koyck model is that we can get the adjustment speed of consumption in response to changes in income and wealth. The median lag is the time required for the first half, or 50 percent, of the total changes in the dependent variable following a unit sustained change in the independent variable. For the Koyck model, the median lag is as follows:

$$
\text{median lag} = -\frac{\log(2)}{\log(\lambda)} \tag{6}
$$

The lower the attenuation rate λ, the faster the adjustment will be and the lower the median lag which means that it takes less time to accomplish the first 50 percent of the total change.

The Wealth Effects of Stock Market on Consumption: Error Correction Model Approach

Though the Koyck model can give us much useful information about how stock wealth affects households' consumption, it neglects some potential short-run deviation of consumption from the long-run trend. The long-run dynamic multipliers in the Koyck model tell us how changes in wealth will affect the consumption in the long run, but in the short run the wealth effects might be quite different. What's more, it has been widely recognized that all of the above variables (consumption, income and wealth) follow deterministic and stochastic trends. This means that these variables are nonstationary and might cause problems to the OLS estimators. The unit root test in the next part will show that each variable contains a unit root and is integrated of order one, I (1), which means that the series itself is not stationary but its first difference is. Returning to equation (2), if consumption, income and wealth are all integrated of the same order, then we can investigate if they share a same stochastic trend. If they do, then they are said to be cointegrated.

A simple way to examine the cointegration between them is to check if the error term u_t is stationary. The stationarity of error term indicates that there is a long-run relationship between these variables because though they each contains a unit root and is non-stationary, they never drift too far from each other. It seems like there is an intangible economic force that will drive the variables back from the disequilibrium level. The cointegration between consumption, income and wealth reveals the long-run relationship among them. The error term:

$$u_t = C_t - \beta_0 - \beta_1 PI_t - \beta_2 SW_t - \beta_3 NSW_t$$

is also called the equilibrium error because it measures the deviation of consumption, income and wealth from the long-run cointegration relationship. The long-run relationship is about the equilibrium relationship between these variables. However, the relationship between consumption, income and wealth can be more complicated in the short run. The household might not correctly estimate his/her income or total wealth because it is very difficult for ordinary people to accurately estimate his/her income and wealth. What's more, an emergency might cause the household to spend a large amount of money in the current period but we have reasons to believe that the household will tighten his/her belt in several following periods. Therefore, the deviation of the consumption from its long-run trend in the current period should be alleviated in future periods.

A good and commonly used model to estimate the short-run relationship between time series variables is error correction model (ECM). According to the Granger representation theory, if several variables are I(1) and cointegrated, then there is an error correction representation between these variables:

$$\Delta C_t = a + \gamma_0 Z_{t-1} + \gamma_1 \Delta PI_t + \gamma_2 \Delta SW_t + \gamma_3 \Delta NSW_t + e_t \tag{7}$$

where $Z_{t-1} = u_{t-1} = C_{t-1} - \beta_0 - \beta_1 PI_{t-1} - \beta_2 SW_{t-1} - \beta_3 NSW_{t-1}$.

This is the error correction model (ECM) and it can tell us the short-run relationship between consumption and wealth. The variable Z is the error correction term, which measures the short-run deviation of the consumption from its long-run equilibrium level in the previous period. The expected sign of γ_0 is negative. If Z_{t-1} is positive, which means that the consumption in the last period is higher than its equilibrium level, the product of Z_{t-1} and γ_0 will be negative. Therefore, the error correction term will push consumption back towards its long-run equilibrium level. The higher the error correction coefficient γ_0 is in absolute value, the faster the adjustment process. However, the error correction term Z is unknown so it cannot be used directly in the error correction model and has to be estimated first. A simple and commonly used method is the Engle-Granger two-step procedure: first run a regression of consumption against income and wealth to acquire the cointegration coefficients and equilibrium error, and then use the estimated equilibrium error to run the second regression of the error correction model to get the short-run dynamic relationship.

One problem associated with this approach is that the statistical inference about these variables cannot be carried out using the conventional t-statistics because these coefficients do not follow normal distribution even in a large sample. Therefore, some correction is needed to modify the conventional OLS estimators. Here, I adopt the dynamic OLS procedure (DOLS), which was first proposed by Stock and Watson (1993). The dynamic OLS specification for our consumption function takes the following form:

$$C_t = \beta_0 + \beta_1 PI_t + \beta_2 SW_t + \beta_3 NSW_t + \sum_{i=-k}^{k} \beta_{1i} \Delta PI_{t+i} + \sum_{i=-k}^{k} \beta_{2i} \Delta SW_{t+i} + \sum_{i=-k}^{k} \beta_{3i} \Delta NSW_{t+i} + v_t \qquad (8)$$

By adding the leads and lags of the first difference of the independent variables, the dynamic OLS estimators are asymptotically normally distributed. Therefore, the standard statistical inference can be carried out here.

One issue arises in the course of the estimation for the consumption. The permanent income cannot be directly observed. A simple approach I will follow in this paper is to assume that the permanent income is proportional to the current disposable income. This is reasonable because households cannot directly observe their lifetime income so they have to make rational expectations about their lifetime income based on the information that they have in the current period. By replacing $PI_t = \alpha DI_t$ with the permanent income in (7) and (8) we can now estimate the effects of income on consumption.

Empirical Results

Koyck Model

Table 1 shows the regression results for the Koyck model. Data are divided into three subperiods. The reported standard errors in the parentheses are heteroskedasticity and autocorrelation consistent standard error (HAC) because in time series data serial correlation is very common. Therefore, using a HAC standard error to account for that correlation, column (1) shows the coefficients for the whole 1952-2014 period. The attenuation rate λ, which is the slope coefficient of the lagged consumption (C_{t-1}), is 0.829. The long-run multiplier is calculated by equation (5), which adds up the geometric series of the impact of the variable on consumption. The long-run multiplier of stock wealth is 0.057. Households will consume roughly six cents for every one dollar earning in the stock market. Though six cents is a small number, when multiplied by trillion-dollar fluctuation in the stock market, the wealth effects are still considerable. This value is in line with previous literature. The long-run multiplier of income is 0.85, indicating that households will consume 85 percent of their income. Using equation (6) mentioned in the methodology, we can get the median lag for the wealth effects of the stock market on the consumption. The median lag equals to 3.7, which means that it takes 3.7 periods to complete half of the wealth effects of the stock market on consumption. Considering that quarterly data are used here, 3.7 periods is about one year, indicating that the adjustment speed of the households is quite slow.

Columns (2) to (4) show the regression results for three subperiods. It seems that the wealth effects of the stock market are very sensitive to the estimation period. This instability can be explained by the changes in economic regulation, policy and technology. It can be seen that before 1985 the wealth effects of the stock market is significantly lower than those in the 1990s and 2000s. A plausible reason for this is that before the 1980s, computers and the internet were not as popular as they are today and therefore financial markets are also less popular among households. They are not able to keep track of the fluctuations of the stock market every second as we can today. Only a small portion of households hold stock equity and consequently the wealth effects of stock market are also less significant. The marginal propensity to consume out of stock wealth rises to 0.094 during the 1990s. This can be explained by the stock market boom during that period. As we know, the US economy experienced an economic expansion as well as a stock market boom during 1990s. The stock market was surging and households were willing to invest in stock. According to Hong et al. (2004), 48.9 percent of American households owned stock, either directly or indirectly through mutual funds in the 1990s. However, the participation rate in the stock market was merely 31.6 percent in the 1980s. Therefore, the higher the stock market participation rate, the stronger the wealth effects of the stock market because the wealth effects of the stock market estimated here include the wealth effects for both stock holders and non-stock holders. If the portion of households who hold stock increases, the estimated wealth effects of the stock market will also be higher.

Though dividing the full periods into three subperiods reveals some instability of the wealth effects of the stock market, it is more precise to use a formal technique to test the stability of the wealth effects. The stability test to be used is a Quandt likelihood ratio test (QLR). It is essentially a modified version of the Chow test, which tests a structural break in the population regression function at a given data. The simplest form of the Chow test is as follows:

$$y_t = \alpha + \beta x_t + \delta D_t + \gamma D_t x_t + u_t$$

where D_t is a binary variable that equals 0 before a certain date and 1 after that date, so $D_t(\tau) = 0\, if\ t \le \tau\ and\ D_t(\tau) = 1\, if\ t > \tau$. The Chow test is just to test if the coefficients δ and γ are significantly different from zero or not. If these two coefficients are statistically significant, then we have reasons to believe that the population regression function is different before and after the given period. The QLR test is just a modified Chow test by testing structural breaks at all possible periods.

The results of the QLR test are presented in Figure 1. The horizontal dash line represents the 1 percent critical value of the QLR test. As can be seen from this graph, the estimated break date is the fourth quarter in 1982, indicating that the wealth effects of the stock market might have changed before and after 1983. This finding is consistent with our explanation that the innovations of the internet and changes in the regulation might have changed the wealth effects of the stock market. However, there is a surprising finding in the results of the QLR test: nearly half of the estimated periods seem to be unstable. About 50 percent of the QLR statistics are above a 1 percent critical value, indicating either there are many different structural breaks in the population regression function or the coefficients of the population regression function are smoothly varying over time. Holinski and Vermeulen (2009) performed a similar stability test using international panel data from 29 countries. Their test results rejected the stability null hypothesis in over 30 percent of periods. It seems that this kind of high rejection rate for stability is very common for variables whose variance will change over time, like stock index. After taking the heteroskedasticity of the stock index into account, they found that the rejection rate dropped to 10 percent.

Table 1: OLS Regression Results of the Koyck Model

		Estimation period			
Independent variable		1 1952Q1-2014Q4	2 1952Q1-1984Q4	3 1985Q1-2000Q4	4 2001Q1-2014Q4
Income (PI)	coefficient	0.137*** (0.036)	0.196*** (0.063)	0.153*** (0.055)	0.136** (0.068)
	Long-run multiplier	0.85	0.74	0.77	0.51
Stock wealth (SW)	coefficient	0.0092*** (0.002)	0.0042 (0.004)	0.0189*** (0.0036)	0.0161** (0.0066)
	Long-run multiplier	0.057	0.016	0.094	0.060
Non-stock wealth (NSW)	coefficient	0.0034* (0.002)	0.0078 (0.011)	-0.0012 (0.004)	0.0062* (0.003)
	Long-run multiplier	0.021	0.029	-0.006	0.023
Lagged consumption (C_{t-1})	coefficient	0.829*** (0.048)	0.736*** (0.078)	0.801*** (0.056)	0.733*** (0.097)

Notes: the heteroskedasticity and autocorrelation consistent standard errors (HAC) are shown in parentheses. *,** and *** indicate significance at 10 percent, 5 percent and 1 percent level, respectively.

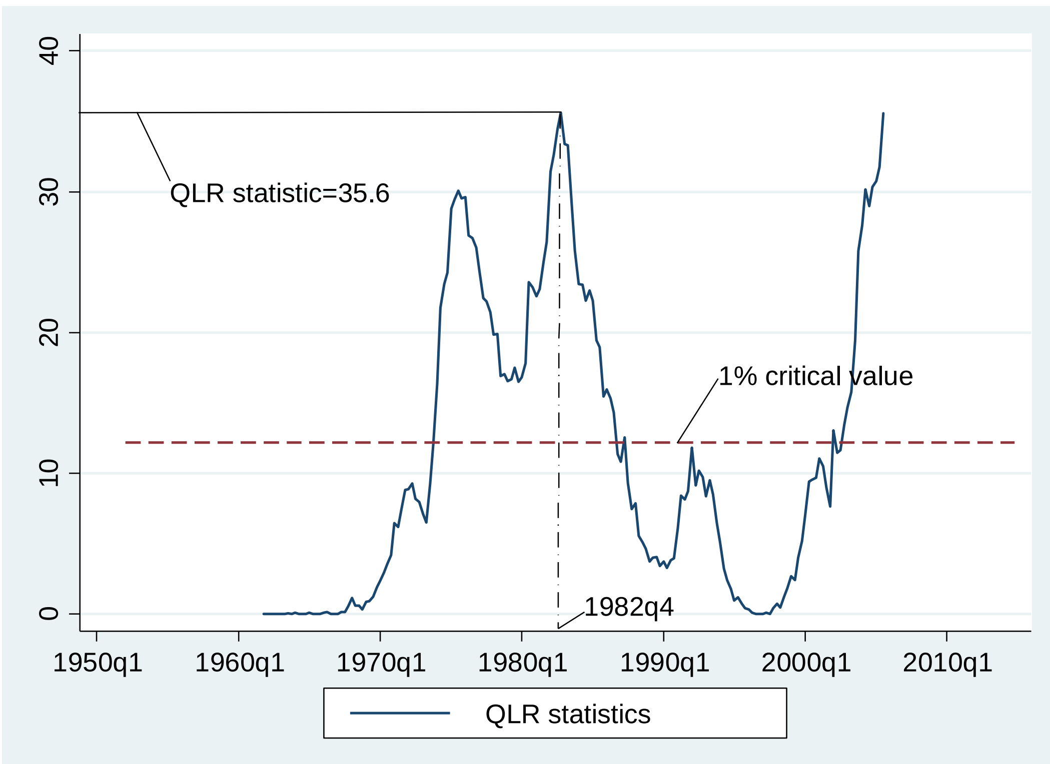
Unit Root Test and Cointegration

The unit root test seeks to investigate if a time series is stationary or not. Since aggregate economic variables usually follow exponential growth, I firstly take the natural logarithm of these variables to linearize their trends. Therefore, we then need to investigate if these variables are stationary around a linear trend. The presence of unit roots is examined using augmented Dickey-Fuller (ADF) test, which takes the following form:

$$\Delta X_t = \beta_0 + \delta X_{t-1} + \gamma_1 \Delta X_{t-1} + \cdots \gamma_p \Delta X_{t-p} + u_t \tag{9}$$

X stands for the variables we use in our regression. Under the null hypothesis, X contains a stochastic trend; under the alternative hypothesis, X is stationary. Therefore, a high significance of δ less than zero means that X is stationary and vice versa. The lag length p in (9) is estimated using Bayes information criterion (BIC), which seeks to minimize the following equation:

Figure 1: The Results of QLR Test for Stability



$$\text{BIC}(\text{p}) = \ln\left(\frac{SSR(p)}{T}\right) + (p+1)\frac{\ln(T)}{T} \tag{10}$$

Because the sum of residuals undoubtedly decreases when more lags are added into the regression function, a decrease in SSR does not necessarily mean that more lags in regression is helpful. Therefore, by including the second term on the right side of equation (10), we give penalty for using too many lags and can estimate the best lag length to be used in the regression.

The results for the augmented unit root tests are presented in Table 2. Column (1) gives the optimal lag length judged by the Bayes information criterion. Column (2) shows the test results for each variable. Variables in lower case mean that they have been taken the natural logarithm at first. As can be seen from column (2), all these statistics are not statistically significant, indicating that each variable contains a unit root. However, after we take the first difference of these variables, the statistics all become statistically significant at 1 percent significance level, which means that the first difference of each variable is a stationary process. The results show that all these variables (consumption, income and wealth) follow a first order integrated process (I(1)). This is consistent with our expectation.

Table 2: Augmented Unit Root Tests

Variables x	(1) lag	(2) t-statistics	(3) 1% critical value	(4) 5% critical value
c	3	-1.80	-3.99	-3.43
pi	1	-0.86	-3.99	-3.43
sw	1	-2.25	-3.99	-3.43
nsw	2	-3.07	-3.99	-3.43
Δc	2	-6.50	-3.46	-2.88
Δpi	1	-9.96	-3.46	-2.88
Δsw	2	-8.49	-3.46	-2.88
Δnsw	2	-4.91	-3.46	-2.88

Note: the optimal lag lengths in the augmented unit root tests are chosen using the Bayes information criterion (BIC).

Since we have found that all these variables are nonstationary and are integrated of the same order, we can then proceed to investigate if these variables are cointegrated. The procedure to test the cointegration between these variables that I choose is Engle-Granger Augmented Dickey-Fuller test (EG-ADF test). The first step is estimating equation (1) and then acquiring the residual μ. The second step is to justify a unit root test to investigate whether the residual is stationary or not. Here I applied two different unit root tests. The first one is the augmented Dicky-Fuller test and the second one is the Phillips-Perron test. The difference between the Dicky-Fuller test and Phillips-Perron test is that the Phillips-Perron test uses the nonparametric statistical method. The Phillips-Perron test corrects for potential serial correlation and heteroscedasticity in the error term. However, they have the same asymptotical distribution in the large sample so I will not go into detail about them. The results for these two tests are shown in Table 3. As we can see, the ADF test rejects the null hypothesis that there is a unit root in the residual term at a 10 percent significance level while Phillips-Perron test rejects it at a 5 percent level. Therefore, the residual is stationary and we can conclude that consumption is cointegrated with income and wealth.

Table 3: Residual Based Cointegration Test

Test	lag	t-statistics	5 % critical value	10 % critical value
Dickey-Fuller test	1	-3.94	-4.16	-3.84
Phillips-Perron test	1	-4.77	-4.49	-4.08

Long-run Consumption Function

The cointegration test in the previous section implies that there is a long-run relationship between consumption, income and wealth, just as the economic theory predicts. The consumption function can then be estimated superconsistently using the ordinary least squares approach. The number of lags and leads in dynamic ordinary least square are chosen using the Bayes criterion (BIC). In this regression, the consumption function includes one lag and lead of the first difference of the natural logarithm of these variables. The results of the DOLS are presented in Table 4. The full period is divided into two subperiods: 1952Q1 to 1984Q4 and 1985Q1 to 2014Q4. The reason for dividing the full period into two subperiods and not three is that from the results of the Koyck model and QLR test we can see that the wealth effects of the stock market before the 1980s are very different from the effects after the 1980s. What's more, dividing the full sample into too many subperiods will give each period too few observations and in this DOLS regression 12 coefficients have to be estimated which might make the results less precise. All these variables are in natural logarithm so the value of the regression coefficients is the elasticity of consumption with respect to these variables. To acquire the implied level coefficients, I multiply the mean value of wealth and income and then divide the consumption to show how a one-dollar increase in income and wealth will affect the level of consumption.[1]

Column (1) shows the point estimates for the full sample. As we can see from Table 4, all variables have the expected sign and are statistically significant. The level of coefficients of income and non-stock wealth are roughly the same with the estimates of the Koyck model. For a one-dollar increase in income and non-stock wealth, the level of consumption will increase by 70 and 4.3 cents respectively. However, the level coefficient of stock wealth is much smaller compared with the results of the Koyck model. The instability of the coefficients of the stock wealth is the same with that in the Koyck model. From column (2), we can see that the coefficient of stock wealth is negative and not significant, which suggests that stock wealth plays a less important role before the 1980s. After the 1980s, the wealth effects of the stock market seem to be more significant. For every one-dollar increase in stock wealth, the consumption will increase by 3.1 cents. Though not high, this result is consistent with most previous literature. One reason for the instability of the wealth effects of the stock market is the stock market participation rate. Due to the development of communication technology and the Internet, the stock market is playing a more important role in ordinary citizens' daily lives and therefore the wealth effects of it are also more significant.

[1] A simple way to calculate the implied level coefficients is to multiple the elasticity with the relevant consumption-income ratio or consumption-wealth ratio.

From Table 4, we can see that the wealth effects of the stock market are smaller than the wealth effects of the non-stock market. For a one-dollar increase, non-stock wealth will increase the consumption by 4.3 cents while stock wealth will only increase the consumption by 1.6 cents. This result is consistent with the finding of Pichette (2004) and Case et al. (2005). Since the increase or decrease of real estate or other non-stock assets is more persistent than that of stock, the changes in non-stock assets are more likely to cause changes in households' permanent income. Therefore, according to permanent income hypothesis and the lifetime-cycle model, non-stock wealth has stronger wealth effects on the consumption of households.

Table 4: Dynamic OLS Estimates of the Consumption Function[1]

	Estimation period					
	1 1952Q1-2014Q4		2 1952Q1-1984Q4		3 1985Q1-2014Q4	
variable	log	level	log	level	log	level
in	0.786*** (0.016)	0.700	0.749*** (0.045)	0.667	0.883*** (0.020)	0.787
sw	0.013*** (0.002)	0.016	-0.001 (0.004)	-0.002	0.0256*** (0.003)	0.031
nsw	0.224*** (0.015)	0.043	0.238*** (0.048)	0.046	0.107*** (0.014)	0.021

Notes: the heteroskedasticity and autocorrelation consistent standard errors (HAC) are shown in parentheses. *,** and *** indicate significance at 10 percent, 5 percent and 1 percent level, respectively.

Figure 2 depicts the actual consumption level and the estimated equilibrium consumption level using the long-run cointegration relationship between consumption, income and wealth. The dash line represents the actual consumption and the solid line represents the equilibrium consumption. As we can see from it, the actual consumption curve fluctuates closely around the equilibrium consumption level curve, indicating that households never deviate too far away from the level of consumption that "they should have". Figure 3, shows the gap between the actual and the estimated equilibrium level of consumption, which is just the residual of the regression function. As we can see from Figure 3, there seems no trend or obvious pattern in the residual. This finding is consistent with our conclusion in the previous part that the residual is a stationary process. If we take a closer look at the gap between actual and equilibrium consumption, we can find that a high

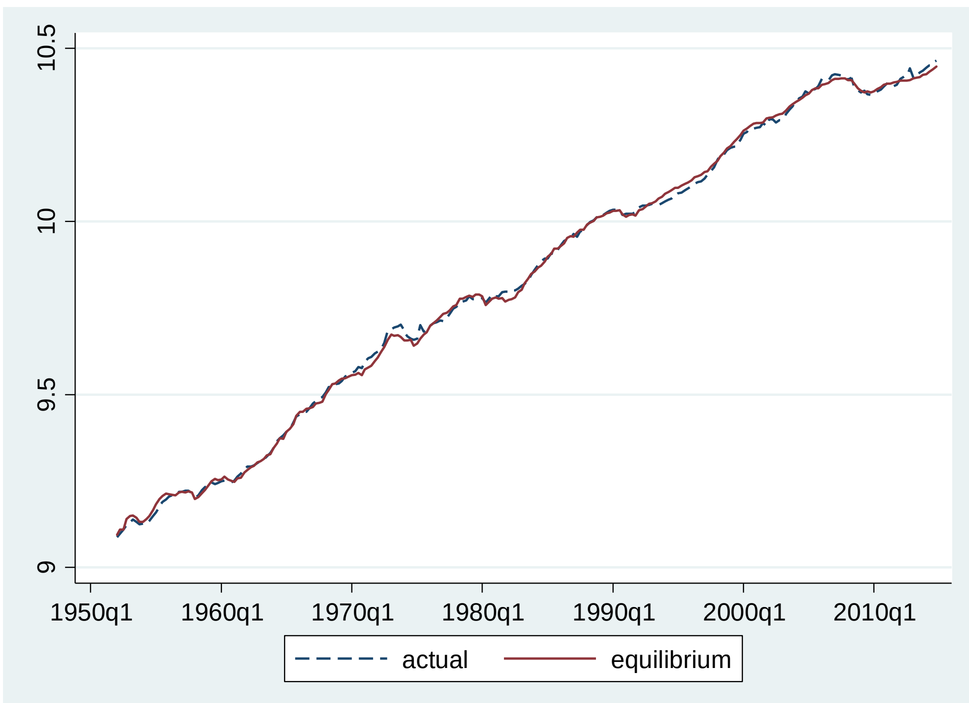
[1] The R-squared is not provided in the table because in most time series regression results, the R-squared is extremely high so it has been a custom not to show it in the regression results. The R-squared of the DOLS regressions are above 99 percent.

residual in the previous period will usually be accompanied by a lower residual in the latter period. This surprising finding gives us a preliminary evidence that households do have an "error correction" process when deciding how much to consume. If households consume too much in the last period, they are more likely to consume less in the current period. More details about this process will be provided in the next section.

Short-run Dynamics in Consumption Function

The results of the short-run error correction model for the consumption function are reported in Table 5. Again, the full period is divided into two subperiods, just the same as the long-run results. All these variables are expressed in log first difference so the coefficients mean the elasticity of the change in log consumption with respect to the

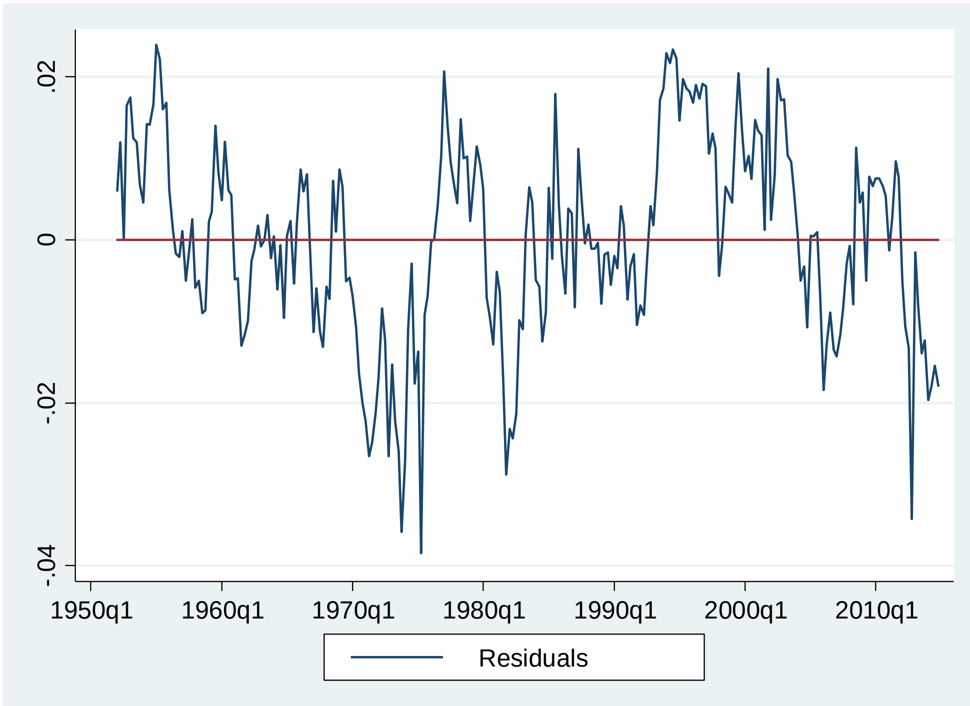
Figure 2: Actual Consumption and Equilibrium Consumption



change in log change in income and wealth. To acquire the corresponding level coefficients, I use the same approach as I did in the previous section.

As can be seen from Table 5, the coefficients of z_{t-1}, which is the error correction term in this model, are all significant at the 1 percent significance level in all three periods and have the theoretically expected negative sign. The coefficient of the error correction term for the full period is -0.122, which means that 12.2 percent of the disequilibrium in the previous period will be adjusted in the current period. This adjustment speed is quite slow because it takes about two years for the disequilibrium in the consumption to be adjusted. If we look at the two subperiods, we will see that the adjustment speed is slightly higher after the 1980s.

Figure 3: The Gap Between Actual and Equilibrium Consumption (Residual)



An unexpected finding of this short-run error correction model is that the coefficients of the stock wealth are not statistically significant even at the 10 percent level. This surprising finding is consistent with the results of Case et al. (2005) and Ludvigson and Steindel (1999). According to this result, households will not change their level of consumption in response of the fluctuation in the stock market. However, changes in non-stock wealth like real estate will change the current level of consumption of households. Though the wealth effects of non-stock assets are not very strong – just around a 4 cent increase in the consumption for every one-dollar increase in non-stock wealth – these effects are significant at a 1 percent level. The difference of the wealth effects of stock market in the short run and long run can be explained by the permanent income hypothesis and lifetime-cycle model. Since most of the fluctuations in the total wealth of households are caused by the stock market, households tend to think the fluctuations in their portfolio are transitory and will not change their patterns of consumption significantly in the short run. However, in the long run the accumulated appreciations of their portfolios are stable and households will consider these appreciations as increases in their permanent income. They will correspondingly increase their level of consumption as a result of the increases in their permanent income. Therefore, the stock market wealth does not affect the level of consumption in the short run but have an equilibrium relationship with consumption in the long run.

Conclusion and Discussion

This paper reiterates and provides more evidence about the wealth effects of the stock market on the level of consumption. The Koyck model gives a rough estimation about the wealth effects of the stock market. The augmented Dicky-Fuller test indicates that all these variables (consumption, income and wealth) are non-stationary around the trend and are I(1) process. However, the following residual-based cointegration test shows that there is a long-run relationship between consumption, income and wealth. The following dynamic OLS estimates of the consumption function indicate that though stock wealth has significant effects on consumption, the level of marginal propensity to consume out of stock wealth is quite small. For a one-dollar increase in the stock wealth, the level of consumption will only increase by 2 to 3 cents. After dividing the full period into several subperiods, the wealth effects of the stock market vary over time, with a low MPC before the 1980s but a relatively high MPC after the 1980s. These changes in the

Table 5: OLS Estimates of the Short-run Error Correction Model

	Estimation period					
	1		2		3	
	1952Q1-2014Q4		1952Q1-1984Q4		1985Q1-2014Q4	
variable	log	level	log	level	log	level
z_{t-1}	-0.122*** (0.039)	-0.122	-0.176*** (0.056)	-0.176	-0.203*** (0.069)	-0.203
Δin	0.343*** (0.067)	0.385	0.557*** (0.102)	0.624	0.163*** (0.059)	0.183
Δsw_t	-0.001 (0.005)	-0.001	-0.0003 (0.007)	-0.0004	-0.014 (0.007)	-0.017
Δnsw_t	0.199*** (0.043)	0.039	0.156* (0.082)	0.030	0.244*** (0.047)	0.047

Notes: the heteroskedasticity and autocorrelation consistent standard errors (HAC) are shown in parentheses. *,** and *** indicate significance at 10 percent, 5 percent and 1 percent level, respectively.

wealth effects of the stock market can be explained by the participation rate of household in the stock market. Although the wealth effects of the stock market are very significant in the long run, fluctuation in the stock price will not alter the level of consumption much in the short run. Households might think of fluctuations of stock price in the short run as temporary and will not adjust to them. The coefficients of the error correction terms are also statistically significant and have the theoretically expected sign, which indicates the existence of an adjustment process for the households to recover from the disequilibrium in consumption. However, the value of the coefficients is approximately -0.15 and the adjustment speed is slow. It takes about one and a half years for households to fully adjust from disequilibrium in consumption on average.

Though most of the results in this paper are consistent with previous studies, there are still some potential issues in this paper. The first one regards the underlying assumption- “representative agent”. During the analysis of the wealth effects of the stock market in this paper, I assume that a representative agent will hold some amount of equity either directly investing in the stock market or indirectly through mutual funds. In that case, the coefficient in the regression measures the wealth effects of the stock market to everyone in the economy. However, studies have found that actually only part of households in the US hold some wealth in equity form. The participation rate varies dramatically over time and across the wealth level. It has been shown in many studies that the stock market participation rate for the most wealthy people are much higher than that of ordinary people, probably because wealthy people have more assets than ordinary people. For those households who do not hold any stock wealth, the fluctuation in the stock market surely will not affect their level of consumption. Therefore, our estimation of the wealth effects of the stock market actually measures the “average wealth effects” of the stock market. The actual wealth effects of the stock market for those who hold stock wealth should be larger than the average level. However, in order to acquire the wealth effects for the stockholders, we need to divide the population into different parts but the relevant data might be very difficult to find. I believe that further studies, using data for stockholders, can reveal more precise wealth effects for only stockholders, not the whole economy.

The second potential issue is about the model specification. By using the error correction model (ECM), we assume that only consumption will change when there is any disequilibrium between consumption, income and wealth. However, we have reasons to believe that income and wealth might also adjust in response to any disequilibrium between them. For example, if one bought a car in the last period, which causes him to overdraft his credit, he might work harder in the current period so that he can earn more and repay the debt in time. In this case, the adjustment will work not only on consumption, but also on income. To incorporate this adjustment, using the vector error correction model (VEC) would be a better choice, which accounts for the adjustment of both income and wealth.

The third problem in estimation is about the potential structural changes in the wealth effects. The QLR test indicates that the level of the wealth effects of the stock market are instable over the estimation period. Though this test just shows some preliminary evidences about the instability in the population regression function, we have reasons to believe that the level of the wealth effects are likely to vary over time. Changes in technology, policy and market participation rate will all affect the relationship between the stock market and households’ daily lives and therefore affect how strong the wealth effects are. If these changes happen continuously in the economy, the coefficients of the population regression function will vary smoothly over the estimation period. In this case, our regression estimation of the wealth effects merely tells us what the “average” wealth effects are over that period. To take into account the smooth changes in the parameters, we can use time varying parameter models like rolling regression. We can plot the estimated wealth effects of the stock market against time. If we find that the values of the estimated coefficients vary dramatically over time, we can conclude that the wealth effects are not stable.

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