5-2017

Stock Market Wealth impact on Consumption Expenditure

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Recommended Citation
Sosa Cueto, Ramberto Jr., "Stock Market Wealth impact on Consumption Expenditure" (2017). *Applied Economics Theses*. 23.
https://digitalcommons.buffalostate.edu/economics_theses/23

State University of New York College at Buffalo
Department of Economics and Finance

Stock Market Wealth impact on Consumption Expenditure

A Thesis in Economics and Finance

By

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Submitted in Partial Fulfillment
Of the Requirements
For the Degree of

Master of Arts in Applied Economics
Spring 2017

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Abstract of Thesis

Stock Market Wealth Impact on Consumption Expenditure

The purpose of this thesis is to explain the role of the stock market in determining aggregate consumer behavior. Theoretically, the life-cycle hypothesis is the main link between consumption and wealth. Additionally, a household's corporate equities holdings form part of that wealth (a small proportion). However, stock market fluctuations account for a significant part of the variation in household wealth, because of the stock prices' volatility.

In regression models, the estimated relationship between consumption and wealth is commonly positive and statistically significant. The empirical evidence in this paper suggests that the relationship between consumption and wealth is positive and statistically significant. Also, the empirical evidence indicates that the relationship between wealth and the S&P500 is positive and statistically. However, the evidence does not show any direct relationship between aggregate consumer behavior and the S&P500. In other words, the stock market impact on consumption is only reflected through the changes aggregate wealth.

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1. Introduction

This paper estimates an empirical model of the United States consumer spending that links the personal consumption expenditure to the stock market fluctuations. Theoretically, the life-cycle hypothesis is the main link between consumption and wealth. According to the theory, private consumption depends on income and wealth. Additionally, a household's corporate equities holdings form part of that wealth (a small proportion). However, it seems that the stock market is important for consumption, but it is difficult to say to which degree.[1] It has been extensively observed in the U.S. that changes in the consumption expenditure are related to fluctuations in national wealth. In regression models, the estimated relationship between consumption and wealth is commonly positive and statistically significant.[2]

For instance, in the latter half of the 1990s, household wealth increased as a result of the significant increase in stock prices. The economic phenomena provoked much interest among economists and policymakers. Specifically, it involved measuring the degree of the stock market wealth's effect on consumption. To illustrate, the wealth's effect may have added an average 1 to 2% per year to the growth rate of real GDP in the second half of the 1990s.[3] Further, other econometric estimations of private consumption as that covered in the Federal Reserve Board's FRB/US model (Brayton and Tinsley, 1996) widely estimate that each added extra dollar of stock market wealth raises the consumer spending by 3 to 5¢, with the effect rising steadily over several

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[1] R. & Fischer, S. & Startz, R. Dornbusch, *Macroeconomics (International Edition)*, 9th ed. (Bostom: McGraw-Hill, 2004), 375.

[2] Case, Karl E.; Quigley, John M.; Shiller, Robert J., "Comparing Wealth Effects: The Stock Market Versus the Housing Market," *Berkeley Electronic Press* 5, no. 1 (2005): 1, accessed January 12, 2017, http://www.nber.org/papers/w8606.pdf.

[3] Yash P. Mehra, "The Wealth Effect in Empirical Life-Cycle Aggregate Consumption Equations," *Federal Reserve Bank of Richmond Economic Quarterly* 87, no. 2 (2001): 46, 66, accessed September 10, 2016,https://www.richmondfed.org/ /media/richmondfedorg/publications/research/economic_quarterly/2001/spring/pdf/mehra.pdf.

years. The calculations suggest that the wealth-consumption relationship may explain most of the decline in the saving rate since the mid 1990s.[4]

Accordingly, the life-cycle model predicts that consumers spend more over their lifetimes in response to higher wealth. Understanding the response of consumer spending to changes in wealth is necessary for determining how stock market fluctuations affect the economy. Also, its relevance is directly related to the issue of retirement preparedness by today's labor force, and the theories of saving behavior.[5]

The main goal is to explore the causal relationship between private consumption and stock market fluctuations, starting with the theoretical framework of the life-cycle hypothesis. The main concern is the role of the stock market in determining aggregate consumer behavior. The second concern is to measure to which the stock market impacts household consumption. And thirdly, to test how the United States economy fits the hypothesis in question. The proposed model includes stock market-related variables and macroeconomic variables. Overall, the results will be summed up in a consumption expenditure model of the U.S. economy.

Incidentally, it is important to have in mind that an increase in consumer spending following a rise in share prices could be attributable to either of two reasons: first, stock prices may rise anticipating strong economic activity, including consumer spending. And second, the wealth effect; changes in share values changes consumptions by relaxing the resource constraints that household face. Our focus will be the second reason.[6]

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[4] Karen E. Dynan, Dean M. Maki and, "Does Stock Market Wealth Matter for Consumption?," Federal Reserve Board (2001): 1, accessed September 10, 2016, https://www.federalreserve.gov/pubs/feds/2001/200123/200123pap.pdf.

[5] Martha Starr-McCluer, "Stock Market Wealth and Consumer Spending," *Finance and Economics Discussion Series, Board of Governors of the Federal Reserve System (U.S.)* 20 (1998): 1, accessed January 16, 2017, https://www.federalreserve.gov/pubs/feds/1998/199820/199820pap.pdf.

[6] James M. Poterba, Andrew A. Samwick, Andrei Shleifer and Robert J. Shiller, "Stock Ownership Patterns, Stock Market Fluctuations, and Consumption," Brookings Papers on Economic Activity 1, no. 2 (1995): 295-372, accessed September 10, 2016, http://www.jstor.org/stable/2534614.

The stocks are an important household asset, but consumer wealth also includes money, government bonds, real estate and tangible assets. However, stock market fluctuations account for a significant part of the variation in household wealth, because stock prices are more volatile than aforementioned assets. Both the theory and the statistical evidence indicate that these fluctuations in wealth have a small but important effect on consumer spending.[7]

The structure of this paper goes as follows: section 2, a literature review of the works related to stock market wealth and consumption; section 3, a discussion of the theoretical model of the life-cycle hypothesis, and the consumption-wealth link; section 4, a specification of the econometric model; section 5, a discussion of the data; and last, section 6, estimated results and evaluation. Overall, we expect to find a significant relationship between consumer expenditure and the stock market, as implied in the life-cycle hypothesis.

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[7] C. Alan Garner, "Has the Stock Market Crash Reduced Consumer Spending?," *Economic Review* (1988): 3-16, accessed January 12, 2017, https://www.kansascityfed.org/PUBLICAT/ECONREV/EconRevArchive/1988/2q88garn.pdf.

2. Literature Review

In short, the model which explains the role of wealth in consumption, the life-cycle hypothesis, dates back to Albert Ando and Franco Modigliani (1963).[8] The theory emphasizes the fact that each person experiences an economic life-cycle. It focuses on the pattern of income, consumption and saving throughout an individual's life. [9]

Within the framework, household consumption is a function of income and wealth. Additionally, the model is based on utility maximization. The marginal propensity to consume from the income is different than wealth. The theory implies that the marginal propensity to consume from income is high, while it is low from wealth. As a result, that wealth (as temporary income increases) is distributed equally over the remaining years of lifespan.[10]

A major assumption in the model is that most households choose a stable lifestyle. In other words, they do not save in a period to spend everything in the next period. They try to spend evenly over their life-cycle by borrowing in early age, saving during their working life and dissaving in retirement. Thus, an increase in wealth encourages households to spread its wealth gain over the rest of their life cycle. "Being wealthier, the person does not have to save as much of current income (decreasing saving) to provide for the future". [11]Accordingly, maximizing current and future utility. [12]

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[8] Albert Ando and Franco Modigliani, "Permanent Income, Current Income, and Consumption: The 'Life Cycle' Hypothesis of Saving: Aggregate Implications and Tests," The American Economic Review 53, no. 1 (1963): 55-84, accessed September 10, 2016, http://www.jstor.org/stable/1817129.

[9] Andrew B. Abel; Ben S. Bernanke and Dean Croushore. Macroeconomics (New York: Pearson Addison-Wesley, 2013, 164.

[10] R. & Fischer, S. & Startz, R. Dornbusch, Macroeconomics (International Edition), 9th ed. (Bostom: McGraw-Hill, 2004), 364-365, 370. & Boone, L., C. Giorno and P. Richardson, "Stock Market Fluctuations and Consumption Behaviour: Some Recent Evidence,"OECD Economics Department Working Papers 28 (1998): 1, accessed September 10, 2016, http://www.oecd-ilibrary.org/docserver/download/5lgsjhvj84xp.pdf?expires=1473537963&id=id&accname=guest&checksum=3566D3EE7B7FE4AB76635C75AF1308FF.

[11] Andrew B. Abel; Ben S. Bernanke and Dean Croushore. Macroeconomics (New York: Pearson Addison-Wesley, 2013, 163.

[12] R. & Fischer, S. & Startz, R. Dornbusch, Macroeconomics (International Edition), 9th ed. (Bostom: McGraw-Hill, 2004), 364-365, 370. & Boone, L., C. Giorno and P. Richardson, "Stock Market Fluctuations and Consumption Behaviour: Some Recent Evidence,"*OECD Economics Department Working Papers* 28 (1998): 1, accessed September 10, 2016, http://www.oecd-

According to Ando and Modigliani (1963), the propensity to consume from wealth ranges from 4 to 8 percent in the US throughout the period of 1929-1959 excluding the years 1941-46 (World War II).[13] Subsequent to Ando-Modigliani's (1963) work, is the FRB-MIT-PENN econometric model (Ando-Modigliani, 1969 and deLeew-Gramlich) which directly addresses the effect of stock valuation on consumption. The estimated model examines the relationship between consumer spending; current and past real disposable income; and several quarters lag on real net worth. The study concludes that there are statistically significant short-run impacts as a result of changes in net worth, including changes in stock market prices. Specifically, the regression for consumption services suggests that a $1 billion decrease in net worth will result in an average decrease in consumption of $0.039 billion over the succeeding year. 84 percent of the $0.039 billion occurs in the first quarter.[14]

Robert Hall (1978) also agrees that wealth has a strong influence on consumption. Particularly, Hall's model explains consumption as a function of past consumption and past values of the Standard and Poor's comprehensive index of the prices of stocks. The results indicated that the stock prices significantly affect private spending. Particularly, his paper does not set up any structural relationships between consumption and the variable used to predict it.[15]

Similarly, Poterba, Samwick, Shleifeer and Shiller (1995), summarize the time series relationship between stock price changes and later consumption fluctuations, for the period 1947-95. But, they do not find any significant effects of stock price fluctuations in the mix of luxury and

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ilibrary.org/docserver/download/5lgsjhvj84xp.pdf?expires=1473537963&id=id&accname=guest&checksum=3566D3EE7B7FE4AB76635C75AF1308FF.

[13] Albert Ando and Franco Modigliani, "Permanent Income, Current Income, and Consumption: The 'Life Cycle' Hypothesis of Saving: Aggregate Implications and Tests," The American Economic Review 53, no. 1 (1963): 55-84, accessed September 10, 2016, http://www.jstor.org/stable/1817129.

[14] Robert H. Rasche, "Impact of the Stock Market On Private Demand," *The American Economic Review* 62, no. 1/2 (1972): 222, accessed January 16, 2017, http://www.jstor.org/stable/1821546.

[15] Robert. E Hall, "Stochastic Implications of the Life Cycle-Permanent Income Hypothesis," The Journal of Political Economy 86, no. 6 (1978): 971, 984-985, accessed September 10, 2016, http://web.stanford.edu/~rehall/Stochastic-JPE-Dec-1978.pdf.

non-luxury consumption. Their evidence casts doubt on the short-run importance of wealth effects associated with stock price movements. They argue that consumption may respond gradually to increases in stock market wealth. Hence, a focus on fluctuations in consumption within a year of stock price movements does not capture these effects. Further, they do not find any evidence that changing patterns of share ownership have altered the relationship between stock price and fluctuations and consumption, even though such effects might be expected in some behavioral model of saving and consumption.[16] Also, The analysis distinguishes between the wealth effect and a signaling effect where stock prices rise in expectation of output increases in the manner of leading indicator in economic activity or business cycle.

Likewise, Starr-McCluer (1998), asserts that in the 1990s the majority of stockholders reported no appreciable effect of stock prices on their spending or saving. Particularly, the paper is an analysis of the Michigan SRC Survey of Consumers, a national representative survey of U.S. households. Further, the study indicates that the distribution of spending is not as concentrated as the distribution of wealth. Specifically, in 1995, the households in the top 20 percent of the income distribution accounted for 37 percent of total spending.[17]

Granted that less than 30% of the households directly own corporate stocks, Poterba (2000), noted that given the highly skewed distribution of stock ownership, the wealth effects are likely limited for most households. Nonetheless, he argues that stock market fluctuation may provoke changes in consumer confidence, even among those who do not hold corporate equities.

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[16] James M. Poterba, Andrew A. Samwick, Andrei Shleifer and Robert J. Shiller, “Stock Ownership Patterns, Stock Market Fluctuations, and Consumption,” Brookings Papers on Economic Activity 1, no. 2 (1995): 297, 335, 356, accessed September 10, 2016, http://www.jstor.org/stable/2534614.

[17] Martha Starr-McCluer, “Stock Market Wealth and Consumer Spending,” *Finance and Economics Discussion Series, Board of Governors of the Federal Reserve System (U.S.)* 20 (1998): 6,12, accessed January 16, 2017, https://www.federalreserve.gov/pubs/feds/1998/199820/199820pap.pdf.

However, such effect is difficult to measure. For example, the evidence suggests that the rising stock market contributed to rising consumer spending in the 1990s. Additionally, Poterba portrays the following: if we assume a 1% marginal propensity to consume from wealth, the post-1995 wealth accumulation could account for $66 billion, or 1%, in consumer spending in 2000. Further, if 1$ of additional wealth generates 3 cents of additional spending, the 1995 to 1999 increase in house net worth could account for a consumption increase equal to roughly 2.8% of the disposable income in early 2000.[18]

Garner (1988), suggests that despite a skewed distribution of stock ownership, stock market fluctuations may affect consumer spending. It is possible that households with high net worth may reduce their spending in response to sharp drops in stock prices. For example, if a wealthy household holds most of its assets in corporate stocks, its net worth is significantly affected by the stock market volatility and thus the private spending. On the other hand, if a wealthy household holds most of their non-stock assets in real estate, unincorporated businesses, and collectibles, its wealth or net worth cannot be converted quickly into cash to pay for consumer purchases. Additionally, middle-income households may be affected indirectly by stock market fluctuations through pension plans and annuities. Garner argues that for all these reasons, it is possible that the wealth effect is important despite the high concentration of stock ownership.[19]

According to Dynan and Maki's (2001) estimation, for households with reported securities less than $100,000, a $1 capital gain increases consumption by between 5 and 15¢, with the effect occurring gradually over a couple of years. More importantly, all the point estimates of the

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[18] James M. Poterba, "Stock Market Wealth and Consumption," Journal of Economic Perspective 14, no. 2 (2000): 100, 108, 116. accessed September 10, 2016, http://www-personal.umich.edu/~kathrynd/JEP.StockMarketWealthandConsumption.pdf.

[19] Garner, C. Alan. "Has the Stock Market Crash Reduced Consumer Spending?" *Economic Review* (1988): 8-9. Accessed January 12, 2017. https://www.kansascityfed.org/PUBLICAT/ECONREV/EconRevArchive/1988/2q88garn.pdf.

marginal propensity to consume are statistically significant.[20] Similarly, Mehra (2001), indicates that the long-term marginal propensity to consume from equity wealth remained stable during the 1990s, with point estimates staying between 0.03 to 0.04. [21]

Additionally other papers, such as Apergis and Miller (2006), focus on a different aspect of the stock market-consumption relationship. Their empirical study examines whether this wealth effect exhibits an asymmetric effect on consumption. The data used covers the quarterly data from 1957 to 2002 on personal consumption, consumer price index, and stock market capitalization. The results show that the stock market fluctuations asymmetrically affect real per capita consumption during the short-run adjustment process. When compared to good news shocks, bad news shocks have a greater effect on consumption, as much as 50%. In other words, bad news shocks have a greater impact on private spending than good news shocks.[22]

In brief, the link between consumption and wealth has been extensively studied. A common issue is how to distinguish signaling from wealth effects. Also, the population shows a highly skewed distribution of stock ownership. This implies that the stock market affects the population asymmetrically. Although stock market movements may provoke changes in consumer confidence even among those who do not hold corporate equities. The analysis of the hypothesis has its limitations. Regardless, the present work tackles the problem with these issues in mind. To

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[20] Karen E. Dynan, Dean M. Maki and, "Does Stock Market Wealth Matter for Consumption?" Federal Reserve Board (2001): 26, accessed September 10, 2016, https://www.federalreserve.gov/pubs/feds/2001/200123/200123pap.pdf.

[21] Yash P. Mehra, "The Wealth Effect in Empirical Life-Cycle Aggregate Consumption Equations," *Federal Reserve Bank of Richmond Economic Quarterly* 87, no. 2 (2001): 47, accessed September 10, 2016,https://www.richmondfed.org/-/media/richmondfedorg/publications/research/economic_quarterly/2001/spring/pdf/mehra.pdf.

[22] Nicholas Apergis, and Stephen M. Miller, "Consumption asymmetry and the stock market: New evidence through a threshold adjustment model," Economics Letters 93, no. 3 (2006): 338,341, accessed January 12, 2017, http://dx.doi.org/10.1016/j.econlet.2006.06.002.

understand the analysis, this researcher has reviewed several papers on stock market wealth and consumption, but does not replicate any of the econometric models.

3. Development of theoretical model

3.1. Life-Cycle model

The life-cycle hypothesis stress on private consumption decisions as income evolves or changes during the life-cycle. For a start, the hypothesis considers that the individuals carefully plan the consumption and saving for a long period. Specifically, they attempt to distribute consumption evenly throughout their life time. Thus, to smooth consumption, individuals must save and dissave in their life-cycle.[23]

Further, as described in “figure I” below, the *income (Y)* trajectory in early stages of the life-cycle is increasing until it reaches a maximum, then it decreases moderately until retirement, and finally, the *income* falls to “0” after the individual retires. “In the figure, the typical consumer’s pattern of income and consumption are plotted against the consumer’s age, from 20 (the about age of independence) to 90 (the about age of death).”[24]

Initially, at the start of the life-cycle (area A), there is dissaving, since *income* is less than *Average Consumption* $(\bar{C})$. Later, the individual starts to earn higher incomes and start paying his debt (area B), and eventually, begins to accumulate net assets instead. Hence, at this point of the life-cycle, he accumulates wealth. This wealth is spent after retirement (area C). At the end, the

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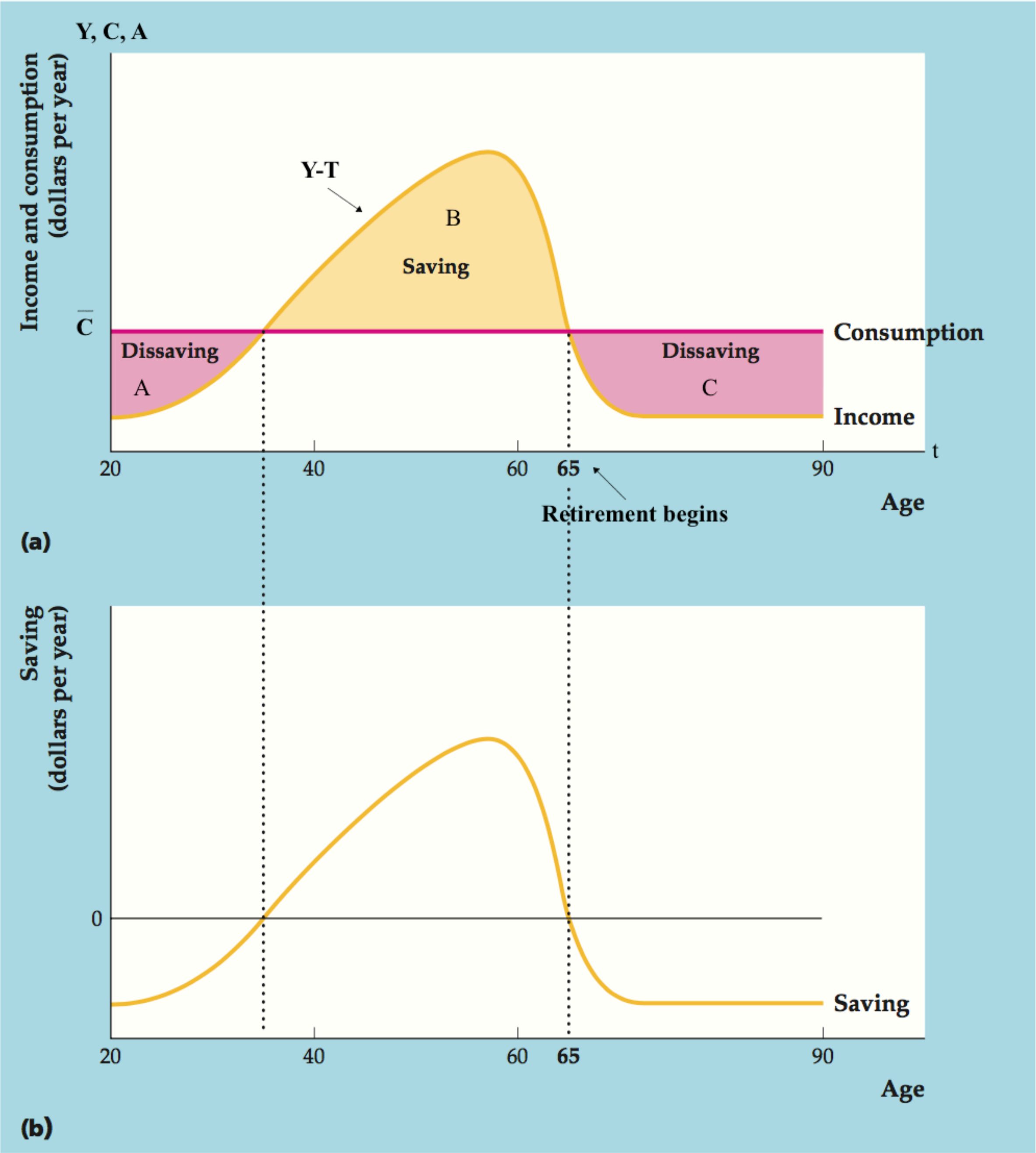
[23] R. & Fischer, S. & Startz, R. Dornbusch, Macroeconomics (International Edition), 9th ed. (Bostom: McGraw-Hill, 2004), 356.

[24] Andrew B. Abel, Ben S. Bernanke, and Dean Croushore. Macroeconomics: Student Value 9th Edition. Pearson College Div: P, 2013, 164-165, PDF.

individual consumes all his savings and ends with “0” assets. Accordingly, if the interest rate is “0” or greater, area B is equal to the sum of area A and area C. [25]

Figure I



Andrew B. Abel, Ben S. Bernanke, and Dean Croushore. Macroeconomics: Student Value 9th Edition. Pearson College Div: P, 2013, 165, PDF.

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[25] Andrew B. Abel, Ben S. Bernanke, and Dean Croushore. Macroeconomics: Student Value 9th Edition. Pearson College Div: P, 2013, 164-165, PDF.

3.2. Life-cycle Mathematical model

Mathematically, the life-cycle hypothesis consumption function has two variables: wealth, W, which grows as savings increases the assets stock or reduces the liabilities. And the lifelong expected income, Y, which is what a person expects to earn on average annually, over his life. The function will be:[26]

$$C = \alpha Y + \beta W$$

Further, the hypothesis argues that the marginal propensity to consume (MPC) is different from the income and wealth. For instance, the MPC from the income is high, while the MPC from the wealth is low. In particular, wealth distributes equally over the remaining years of life. Hence, an increase in the stock market values will increase present and future consumption and reduce savings. Also, a transitory increase in income has the same effect as wealth.[27]

To illustrate, let us assume the following numerical example: A person starts his life at the age of 20, he works until retirement at the age of 65, his age of death is 90 and his lifelong expected income, Y, is *$30.000*. The available resources through his life are the Y (annual income) times the years he spends working (*WL = 65 – 20 = 45*): thus, the available resources in his life-cycle equals, *$1,350.00* (*=$30.000 x 45)*. Distributing it throughout his life time (*NL = 90 – 20 = 70*), the resources that he earns in his life-cycle allow him an annual consumption of *C = $1.350.000 / 70 = $19,285.71*. As a result, the general formula is [28]

$$C = \frac{WL}{NL} * Y$$

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[26] Ernesto Screpanti and Stefano Zamagni, *An Outline of the History of Economic Thought*, 2nd ed. (Oxford: Oxford University Press, 2005), 329, accessed December 2, 2016, http://catdir.loc.gov/catdir/enhancements/fy0636/2005280602-d.html.

[27] R. & Fischer, S. & Startz, R. Dornbusch, *Macroeconomics (International Edition)*, 9th ed. (Bostom: McGraw-Hill, 2004), 365.

[28] R. & Fischer, S. & Startz, R. Dornbusch, *Macroeconomics (International Edition)*, 9th ed. (Bostom: McGraw-Hill, 2004), 365

Then, the MPC out of income is *WL/NL*. Alternatively, the marginal propensities to consume are calculated by examining the variations in the income. For example, assume that the annual income increases by *\$3,000* permanently. The *\$3,000* multiplied by the 45 years of labor and distributed throughout the 70 years of life, increases the annual consumption in *\$3,000 x (45/70) = \$1, 928.57*. This means that the MPC for the income is equal to *WL/NL = 45/70*. [29]

On the other hand, now assume a temporary increase in income. In particular, the income increases by *\$3,000*, but the increase only lasts for one year. The *\$3,000* scattered throughout the 70 years of the life span will increase the annual consumption by *\$3,000 x (1/70) = \$42.86.* That is, the MPC out of a transitory increase of income is *1/NL = 1/70.* The example indicates that the MPC out of income is high, while from the wealth is low, given that the MPC of the wealth is equal to the MPC of the transitory income.[30]

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[29] R. & Fischer, S. & Startz, R. Dornbusch, *Macroeconomics (International Edition)*, 9th ed. (Bostom: McGraw-Hill, 2004), 365

[30] R. & Fischer, S. & Startz, R. Dornbusch, *Macroeconomics (International Edition)*, 9th ed. (Bostom: McGraw-Hill, 2004), 365

3.3. Life-cycle hypothesis assumptions

Overall, the aggregate consumption function follows some assumptions in respect to the individual's utility function, the age structure of the population and life pattern of earnings. The basic assumptions are:[31]

I. The individual distributes every additional resource evenly through his life span, in the same way, he initially allocated his resources. In other words, "The utility function is homogeneous with respect to consumption at different points in time."

II. The individual does not receive or leave any bequest.

III. At any age, the consumer attempts to consume his total income and wealth evenly over the rest of his life-cycle.

IV. "Every age group within an earning span has the same average income in any given year. In a given year, any age group will have the same average expected income for any later period within their earning span. Every household has the same total life and earnings spans."

V. Lastly, the individual expects the rate of return on assets to stay constant.

Additionally, our concern is the effect of the stock market wealth on private consumption. But, the life-cycle hypothesis refers to the consumption of nondurable goods and services. The nondurable goods refer to items that report us pleasure at the time of purchase of short-lived items, such as food and cloth. While durable goods are long-lived items such as apartments, automobiles etc. The theory concerned with durable goods and services is the theory of investment applied to

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[31] Albert Ando and Franco Modigliani, "Permanent Income, Current Income, and Consumption: The 'Life Cycle' Hypothesis of Saving: Aggregate Implications and Tests," The American Economic Review 53, no. 1 (1963): 56, 59, accessed September 10, 2016, http://www.jstor.org/stable/1817129.

the household instead of firms. Further, one must distinguish between stock market wealth and non-stock market wealth for the purpose of the hypothesis in question.[32]

4. Specification of Econometric Model

4.1. Two-Stage Least Squares Estimation

In the life-cycle hypothesis theoretical framework, consumption is a function of income and wealth. But, to explain the changes in consumption with respect to the fluctuations in the stock market one may add an extra equation. Due to this, the single equation model becomes a simultaneous equation model. Overall, the least squares estimators are not used to estimate an equation in a simultaneous equations model.

Instead, the two-stage least squares (2SLS) is the method widely used for estimating the parameters of an identified structural equation. And it is useful because the least squares estimator of parameters in a structural simultaneous equation is biased and inconsistent. Due to the correlation between the random error and the endogenous variables on the right-hand side of the equation.[33]

The simultaneous equation model used to estimate the relationship between the consumption and the stock market fluctuations, is expressed in the following population regression functions:

$$C_t = \alpha_1(W_t) + u_t$$

$$W_t = \beta_1(Y_t) + \beta_2(SP500_t) + v_t$$

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[32] R. & Fischer, S. & Startz, R. Dornbusch, *Macroeconomics (International Edition)*, 9th ed. (Bostom: McGraw-Hill, 2004), 368.

[33] R Carter Hill, William E. Griffiths, and G C. Lim, *Principles of Econometrics*, 4th ed. (Hoboken, NJ: Wiley, ©2011), 450, 452.

Where:

C_t: *the consumption growth of non-durable goods and services in the period t.*

$SP500_t$: *The rate of return of the Standard & Poor's 500 in period t.*

Y_t: *The Gross Domestic Product growth in period t.*

W_t: *The percentage change of net worth in period t.*

α_1: *The elasticity of C with respect to W.*

β_1: *The elasticity of W respect to Y.*

β_2: *The elasticity of W respect to SP500.*

u_t: *Error term in first equation.*

v_t: *Error term in second equation.*

In the first equation, the model indicates that the *consumption growth* in period t (dependent variable) is a function of *the percentage change of wealth* in period t (independent variable). In the second equation, the model indicates that *the percentage change of wealth* (dependent variable) in period t, is explained by the *GDP growth*, and the *rate of return of the Standard & Poor's 500* (independent variables) in period t.

4.2. The Two-stage Least Squares Estimation Procedure

The two-stage least squares estimation procedure is used to estimate the parameters of any identified equation within a simultaneous equation system. In this case, the first structural equation within the system is[34]

$$C_t = \alpha_1(W_t) \ + u_t$$

If this equation is identified, then its parameters can be estimated in two steps:

1. Estimate the parameters of the reduced-form equation

$$W_t = \beta_1(Y_t) + \beta_2(SP500_t) + v_t$$

by least squares and obtain the predicted values

$$\widehat{W}_t = \widehat{\beta_1}(Y_t) + \ \widehat{\beta_2}(SP500_t)$$

2. Replace the variable, W_t, on the right-hand side of the first equation by the predicted values from the second equation

$$C_t = \alpha_1\left(\widehat{W}_t\right) + u_t$$

The last step is to estimate the parameters of the above equation by least squares.

In the simultaneous equation system, the variables Y and SP500 are instrumental variables (IVs). And the variable W is an endogenous variable. In general, an instrumental variable must satisfy two conditions:

(1) Relevance: $Cov\ (z,\ x) \neq 0,$ the instrumental variable is correlated with the endogenous variable
(2) Exogeneity: $Cov\ (z,\ \varepsilon) = 0$ the instrumental variable is uncorrelated with the disturbances.

On the other hand, an endogenous variable is one that is correlated with the error term, $Cov\ (x,\ e) \neq 0$.

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[34] R Carter Hill, William E. Griffiths, and G C. Lim, *Principles of Econometrics*, 4th ed. (Hoboken, NJ: Wiley, ©2011), 453-454.

4.3. The Properties of the Two-Stage Least Squares Estimator

The properties of the 2SLS estimator are summarized as follows:[35]

1. The estimator is consistent, but a biased estimator.
2. It is approximately normally distributed in large samples.
3. The variances and covariances of the estimator are unknown in small samples, but for large samples, there are expressions that are used as approximations. Overall, the standard error and the t-values are reported just like an ordinary least square (OLS) regression.
4. If 2SLS estimates are obtained by applying two least squares regressions using OLS regression software, the standard errors and t-values reported in the second regression are not correct for the 2SLS estimator. A specialized 2SLS or instrumental variable software is necessary for obtaining estimates of structural equations.

4.4. Expected Signs of the Coefficients

In our system of equations, we expect the following:

$$C_t = f[(+)W_t]$$

$$W_t = f[(+)Y_t, (+)SP500]$$

In the first equation, we expect a positive relationship. If the household wealth increases, the consumption increases. Accordingly, the life-cycle hypothesis states that the marginal propensity to consume from wealth is positive.

In the second equation, we expect a positive correlation between the GDP and the household wealth. In general, wealth is the excess of total assets over total liabilities. And the wealth is correlated with the income trajectory in the life-cycle hypothesis. On the other hand, the

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[35] R Carter Hill, William E. Griffiths, and G C. Lim, *Principles of Econometrics*, 4th ed. (Hoboken, NJ: Wiley, ©2011), 452-453.

wealth and the S&P500 are positively related. In fact, the household corporate equities holdings form part of the wealth. Being that, all the fluctuations in the stock market are reflected in the wealth.

Additionally, the 2SLS estimators are only consistent if the instrumental variables, GDP and S&P500, are highly correlated with the endogenous variable, wealth. Otherwise, the whole model forecast is inconsistent. In other words, the estimates do not converge in probability to the true value.

4.5. Hypothesis test

The hypothesis test for sample regression functions goes as follows:

$$C_t = \hat{\alpha}_1(\widehat{W}_t) + \hat{u}_t$$

H_0:$\widehat{\alpha_1}$≤0, case it is not statistically significant.

H_1:$\widehat{\alpha_1}$ >0, case it is statistically significant.

$$\widehat{W}_t = \widehat{\beta_1}(Y_t) + \widehat{\beta_2}(SP500_t)$$

H_0:$\widehat{\beta_1}$≤0, case it is not statistically significant.

H_1: $\widehat{\beta_1}$ >0, case it is statistically y significant.

H_0: $\widehat{\beta_2}$ ≤0, case it is not statistically significant.

H_1: $\widehat{\beta_2}$ >0, case it is statistically significant.

The $\hat{\alpha}_1$ is the estimated elasticity of C with respect to W. If $\hat{\alpha}_1$ is statistically significant, it means that there is evidence that wealth impacts the consumption of non-durable goods and services in the given sample. If it is not statistically significant, we cannot accept the alternative hypothesis, that wealth positively affects private consumption. Further, we expect $\hat{\alpha}_1$ to be statistically significant.

Similarly, $\widehat{\beta_1}$ is the estimated elasticity of W with respect to Y. And $\widehat{\beta_2}$ is the estimated elasticity of W with respect to SP500. If $\widehat{\beta_1}$ is statistically significant, it implies that GDP positively impacts Wealth for the given sample. And if $\widehat{\beta_2}$ is statistically significant it means that S&P500 positively affects Wealth for the period range.

One expects the structural model estimators to be statistically significant at a confidence level of 95%. Hence, the hypothesis test for the estimators will be based on a p-value of 5 %. Consequently, for the results to be statistically significant, the p-value must be less than 5%. Due to this, the chance of committing a Type-I error will be 5%.

5. Data

In particular, the data was compiled from several sources. The source of the data for GDP and consumption is from the Bureau of Economic Analysis; the data source of wealth is the Federal Reserve Statistical release on Financial Accounts; lastly, the data for the S&P500 was extracted from Yahoo! Finance. Also, the time period is 1985:01-2016:01, quarterly data.

For start, the data arrayed for the GDP growth have the following specifications: It is the percentage change in the GDP. The GDP values were initially expressed in billions of chained (2009) dollars, seasonally adjusted at annual rates.

Similarly, the data for the consumption growth have the following specifications: it is the percentage change in the consumption expenditure of non-durable goods and services. Initially, the values were billions of chained (2009) dollars, seasonally adjusted at annual rates.

Also, the data for wealth is in terms of percentage change. The data was deflated using the deflator for consumption expenditure and transformed into billions of chained (2009) dollars, seasonally adjusted at annual rates. And lastly, it was calculated in terms of growth rate.

Lastly, the data on the S&P500 returns went through two steps: the monthly returns were estimated using the monthly adjusted close price. And second, the average quarterly returns were calculated using the estimated monthly returns. (Variables plot, Appendix A)

6. Estimated Results, Documentation and Evaluation

6.1 Unit root Tests for Stationarity

The main reason we prefer stationary time series variables in the regression analysis is to avoid any significant results from unrelated data, in other words, a spurious regression. Formally, a time series is stationary if its mean and variance are constant over time, and if the covariance between two values from the series depends only on the length of time separating the two values.[36]

A test for determining whether a series is stationary is the Augmented-Dickey-Fuller test. With regard to an AR(1) model '$\Delta y_t = (\rho - 1)y_{t-1} + v_t$', one way to test stationarity is to test H_0: $\rho = 1$, nonstationary process, against the alternative H_1: $\rho < 1$, stationary process.[37] In particular, the variables in our consumption expenditure model are tested using the Phillips-Perron test. The test is automatically carried out assuming three possible scenarios: no constant and no trend (Zero Mean), constant and no trend (Single Mean), and both constant and trend (Trend). SAS computes two alternative test statistics, Rho and Tau, and their p-values. The Phillips-Perron test statistics have the same asymptotic distributions as the corresponding ADF tests.[38]

The overall results show that the test statistics are less than the critical values at 5% level significance. In other words, the time series in the simultaneous equation model are stationary. Therefore, a spurious regression is less likely. (Unit root tests, Appendix B)

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[36] R Carter Hill, William E. Griffiths, and G C. Lim, *Principles of Econometrics*, 4th ed. (Hoboken, NJ: Wiley, ©2011), 482, 477.

[37] R Carter Hill and Randall C. Campbell, Using Sas for Econometrics (New York: Wiley, ©2012), 378.

[38] R Carter Hill and Randall C. Campbell, Using Sas for Econometrics (New York: Wiley, ©2012), 381.

6.2 Estimated Consumption Expenditure Model with 2SLS

According to SAS, the estimated structural simultaneous model using the two-stage least squares estimation procedure is the following:

First-stage regression, reduced-form estimates:

$$\widehat{W}_t = 0.653190(Y_t) + 0.653965(SP500_t) \qquad \textbf{(1)}$$

$se(\widehat{\beta_\iota}) = (0.121231) \qquad (0.038549)$
$t = \qquad (5.39) \qquad (16.96)$
$Pr > |t| = (< .0001) \qquad (< .0001)$
$R - square = 0.78470 \quad n = 125 \quad F - value = 224.15 \quad adj\ R - square = 0.78120$

Second-stage regression, estimated Consumption Expenditure model:

$$\hat{C}_t = 0.188180\left(\widehat{W}_t\right) \qquad \textbf{(2)}$$

$se(\widehat{\beta_\iota}) = (0.028055)$
$t = \qquad (6.71)$
$Pr > |t| = (< .0001)$
$R - square = 0.26624 \quad n = 125 \quad F - value = 44.99 \quad adj\ R - square = 0.26032$

The results indicate that all the estimated slope coefficients are statistically significant under the alternative hypothesis. In other words, the p-values (Pr>|t|) are less than 5% significance level. The p-value is calculated using the t-statistic. The t-statistic is calculated using the standard errors. The standard error $se(\widehat{\beta_\iota})$ is a measure of precision. Thus, the smaller the values of $se(\widehat{\beta_\iota})$ the more accurate the estimation.

Further, the 2SLS parameter estimates predict the following:

First-stage regression (1):

1. *The elasticity of wealth, with respect to GDP is 0.6532; for each 1 percent growth in the US GDP, US Wealth increases by 0.6532%.*

2. *The elasticity of wealth, with respect to S&P500 is 0.6540; for each 1 percent increase in the S&P 500 rate of return, national wealth increases by 0.6540%.*

Second Stage regression (2):

1. *The elasticity of the consumption of non-durable goods and services with respect to wealth is 0.1882; for each 1 percent growth in national wealth, the US consumption of non-durable goods and services increases by 0.1882%.*

The estimated model suggests that the stock market fluctuations account for a significant part of the variation in household wealth. That wealth has a significant impact on aggregate consumer behavior. In other words, the 2SLS estimates suggest a link between the consumption expenditure and the stock market through the wealth effect. Also, the estimated model shows that the GDP have a greater impact on consumption than the wealth.

With regard to the theory, the estimated consumption expenditure model agrees that changes in share prices impact consumption by relaxing the resource constraints that households face. Because the stock prices are volatile, they have an important impact on national wealth. Further, the statistical evidence indicates that the fluctuations in the S&P500 affect consumer spending through wealth.

6.3 Estimated Model R-Square, Adjusted-R Square and F-Value

In the first stage regression, the adjusted coefficient of determination for the estimated wealth model is 0.78120. This means the estimated model explains most of the variation in the percentage change of wealth. Also, the estimated F-value, 224.15, is greater than the critical value of $F_{0.05(123,\ 125)}$, 1.34. Thus, the Adj. R-square is significant at a 5% significance level.[39] Both Adj. R-square and R-square give an idea of the goodness of fit of the estimated model. But, the R-square assumes that every single variable explains the variation in the dependent variable. While the Adj. R-square adjusts for the number of terms in a model, if a useless variable is added, the Adj. R-square will decrease. In contrast, if a more useful variable is added, the Adj. R-square will increase.

In particular, in the first stage regression of a 2SLS the F-test is important. For instance, it measures the strength of the instruments. The instruments are the independent variables used to estimate wealth: GDP growth rate and S&P500 rate of return. Overall, weak instruments tend to bias towards the ordinary least square estimates. Due to this, it is preferable for the Adj. R-square to be statistically significant. This implies that the instruments are valid.

In the second stage regression, the coefficient of determination for the estimated model is 0.26032. This means the estimated model explains about 26.032 percent of the variation in the consumption growth. In contrast to the first stage regression, the estimated model uses the R-square because it has a single explanatory variable.

(2SLS estimations, Appendix C)

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[39] Specifically with the F-value we tested the following hypothesis: H_0:$\beta_1 = \beta_2 = \beta_3 = \beta_4$=0, case it is not statistically significant. H_1: Otherwise, case it is statistically significant.

6.4 Test for Overidentifying Restrictions

In general, a model is over-identified when the number of instruments exceeds the number of endogenous variables. In our simultaneous equation system, we have two instrumental variables (IVs), Y and SP500, for W. Due to this, the simultaneous equation system has one overidentifying restriction. Specifically, the Test for Overidentifying Restrictions is used to test the validity of the IVs.

To test the Overidentifying restrictions, SAS applies the likelihood ratio test of the joint significance of these instrumental variables. The null hypothesis is that the predetermined variables that do not appear in any equation have zero coefficients. The alternative hypothesis is that at least one of the assumed zero coefficients is nonzero. Rejecting the alternative hypothesis raises doubts about the validity of the instruments, Y and SP500. *According to the results, the p-value is below the 5% critical value. This means that the instrumental variables are statistically significant; the overidentifying restrictions are valid.* (Test for Overidentifying Restrictions, Appendix D)

6.5 Cointegration tests

Nonstationary time series are cointegrated if they tend to move together through time. This implies that there is a long-run relationship between dependent and independent variables. Conversely, non-cointegrated time series are subject to a spurious regression. A linear combination to examine the cointegration is the least squares residuals ($\hat{e} = Y - X\hat{\beta}_i$). Testing cointegration involves regressing one I (1) variable on another using OLS. The null hypothesis is that the residuals are nonstationary. The test for stationarity is based on the equation $\Delta\hat{e}_t = \gamma\hat{e}_t + \upsilon_t$. [40]

In SAS, one may use the Phillips-Perron test on the residuals to check cointegration. The test is run assuming three possible scenarios: no constant and no trend (Zero Mean), constant and

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[40] R Carter Hill and Randall C. Campbell, Using Sas for Econometrics (New York: Wiley, ©2012), 385-386.

no trend (Single Mean), and both constant and trend (Trend). SAS computes two alternative test statistics, Rho and Tau, and their p-values.[41]

The results show that the test statistics are less than the critical values at 5% level significance. In other words, it suggests that the model's residuals for both regressions are stationary. Consequently, the regressions are not spurious. (Cointegration tests, Appendix E)

6.6 Normality Tests

In the regression analysis, the normality in the residual enables us to derive reliable probability distributions of the estimated parameters and the estimated standard error. This simplifies the task of establishing confidence intervals and testing hypotheses. In other words, if the residuals are not normally distributed, the hypothesis test is unreliable.[42] Specifically, the tests run in this paper are the Shapiro-Wilk, Kolmogorov-Smirnov, Cramer-von Mises, and Anderson-Darling.

The tests for normality in our analysis show all the p-values are above 0.05. Hence, we accept the null hypothesis of normality. The normality test suggests that the 2SLS estimators are consistent. Since the variances and covariances of the estimators are known in the sample, the standard errors and the t-values are reported like an ordinary least square (OLS). (Normality tests, Appendix F)

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[41] R Carter Hill and Randall C. Campbell, Using Sas for Econometrics (New York: Wiley, ©2012), 381.

[42] Damodar N. Gujarati and Dawn C. Porter, Basic Econometrics, 4th ed., The Mcgraw-Hill Series, Economics (Boston: McGraw-Hill Irwin, ©2004), 112.

6.7 Serial Correlation Tests

Serial correlation refers to the Gauss-Markov theorem assumption, $cov(e_t, e_s) = 0$ (for t different that s). For instance, when the assumption is not satisfied, the OLS parameter estimates of the partial regression coefficients are not biased, but the OLS no longer is minimum variance, and the hypothesis test is unreliable. Similarly, in the 2SLS, serial correlation implies that the hypothesis test is unreliable.

To test serial correlation the Durbin-Watson test (DW test). The DW test for serial correlation is based on the following: *The null hypothesis is "no positive autocorrelation", and we reject if "*$0 < d < d_L$*". For instance, the results show d=1.32035 and d=0.822187 for the first-stage and the second-stage regressions, while the Durbin-Watson critical value-95% is about 1.64. Hence, there is evidence of positive serial correlation.* As a result, the hypothesis test is unreliable. (Serial Correlation tests, Appendix G)

6.8 Multicollinearity Tests

Another important assumption in the classical regression model is no perfect multicollinearity. In other words, there are no perfect linear relationships among explanatory variables.[43] The result for multicollinearity is as follows: there are no biased OLS estimators, but the separate effects of the estimates are not reliable; even more, there are high standard errors and low t-scores. A possible solution is to drop redundant variables, but to drop others might introduce bias. Thus, doing nothing is often the best. The multicollinearity test is only applicable to multiple regression models. Consequently, the test is used in the first-stage regression alone.

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[43] Damodar N. Gujarati and Dawn C. Porter, Basic Econometrics, 4th ed., The Mcgraw-Hill Series, Economics (Boston: McGraw-Hill Irwin, ©2004), 75.

In the calculated pairwise multicollinearity correlation matrix, none of the calculated correlation coefficients (or estimates) exceed 0.8, suggesting that multicollinearity is unlikely. [44] *Additionally, between the parameter estimates, the calculated tolerance is greater than 0.2 and the variance inflation less than 5. This means that interactive multicollinearity is also unlikely.* (Multicollinearity test, Appendix H)

6.10 Alternative Procedure: Seemingly Unrelated Regressions (SUR)

Given the estimated model exhibits correlation, the 2SLS standard errors are not consistent. However, in a multivariate regression model, when the residuals are serially correlated the efficiency of the estimation can improve by taking these cross-equation correlations into account. Hence, one can use the SUR.

The SUR is a generalization of OLS for multi-equation systems. Unlike the 2SLS, the SUR procedure assumes that all the regressors are exogenous variables. Further, it uses the correlations among the errors in different equations to improve the estimates. The method produces the same results as OLS unless the model has at least one regressor not used in the other equations.

According to SAS, the estimated structural simultaneous model using the seemingly unrelated regressions procedure is the following:

The estimated wealth model:

$$\widehat{W}_t = 0.805408(Y_t) + 0.6625043(SP500_t)$$

$$se(\widehat{\beta_i}) = (0.119991) \qquad (0.038343)$$
$$t = \qquad (6.71) \qquad (16.30)$$
$$Pr > |t| = (< .0001) \qquad (< .0001)$$
$$System\ Weighted\ R - square = 0.6944 \quad n = 125$$

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[44] According to the rule of thumb: if the correlation coefficient between any two independent variables is above 0.8, multicollinearity is likely present.

The estimated consumption model:

$$\hat{C}_t = 0.180124(W_t)$$

$se(\widehat{\beta_i}) = (0.024686)$
$t = \quad (7.30)$
$Pr > |t| = (< .0001)$
$System\ Weighted\ R - square = 0.6944 \quad n = 125$

According to the SUR procedure run in SAS, the estimators for the structural simultaneous equation are statistically significant. The system weighted R-Square in 69.44%. This means the estimated model explains most of the joint variation in wealth and consumption. Overall, the purpose of the SUR procedure is to improve the efficiency of the estimation when the residuals are serially correlated. In other words, it does not solve the serial correlation. Accordingly, both regressions still have serial correlation. The DW test *estimates a d=1.357759 and d=0.599537, for the first and second model, while the Durbin-Watson critical value-95% is about 1.64. Hence, there is evidence of positive serial correlation.*

Further, the SUR estimated standard errors are smaller when compared to the earlier 2SLS estimates. This suggests that the estimated slopes are more precise. Further, *the normality tests show all p-values are above 0.05. Hence, we accept the null hypothesis of normality, being that SUR estimators are consistent*. Additionally, *the correlations of parameter estimates do not exceed 0.8, suggesting that multicollinearity is unlikely.*

Additionally, the forecast of the parameters is different. For instance, the SUR parameter estimates predict the following:

The estimated wealth model:

1. *The elasticity of wealth, with respect to GDP is 0.8054; for each 1 percent growth in the US GDP, US Wealth increases by 0.8052%.*
2. *The elasticity of wealth, with respect to S&P500 is 0.6250; for each 1 percent increase in the S&P 500 rate of return, national wealth increases by 0.6250%.*

The estimated consumption model:

2. *The elasticity of the consumption of non-durable goods and services with respect to wealth is 0.1801; for each 1 percent growth in the national wealth, US consumption of non-durable goods and services increases by 0.1801%.*

Similarly, to the 2SLS estimators, the SUR estimators suggest a link between the consumption expenditure and the stock market through the wealth effect. However, the estimated *elasticity of the consumption of non-durable goods and services with respect to wealth* is less when compared to the 2SLS estimate. Likewise, the estimated *elasticity of wealth with respect to S&P500* is less than the 2SLS estimate.

However, both the 2SLS and SUR procedures are serially correlated. Due to this neither of the estimated models are good for policy purposes or to precisely forecast the consumption phenomenon of the wealth effect. But, by estimating the multi-equation systems with both methods, one checks whether the estimated parameters are statistically significant. Further, it is a way to see if the properties of the model remain the same. For instance, both estimates suggest a link between the stock market and consumption. (SUR Estimates, Appendix I)

6.11 Autoregressive Error Model Corrects for Serial Correlation

The autoregressive error model is used to correct for serial correlation. Given there is serial correlation one may use the AUTOREG procedure in SAS to further study the causal relationship between consumption expenditure and wealth, and even more the direct impact of the S&P500 in the consumer spending. However, the autoregressive error model is not applicable to structural simultaneous equations. Regardless, it is possible to use the Yule-Walker estimates to directly measure the effect of wealth in consumption, and the impact of GDP growth and S&P500 in consumption. *In this way, it is possible to see if the S&P 500 have a direct impact on consumption growth. Also, the elasticity of consumption vs GDP and Consumption vs Wealth can be separately estimated and compared.*

According to SAS, the estimated models using Yule-Walker estimates are the following:

The estimated consumption model, with wealth as regressor:

$$\hat{C}_t = 0.0284(W_t)$$

$se(\widehat{\beta_i}) = (0.0134)$
$t = \quad (2.11)$
$Pr > |t| = (< .0367)$
$R - square = 0.8248 \quad n = 125$

The estimated consumption model, with GDP and S&P500 as regressors:

$$\hat{C}_t = 0.5400(Y_t) + \ 0.000639(SP500_t)$$

$se(\widehat{\beta_i}) = (0.0500) \quad (0.0121)$
$t = \quad (10.80) \quad (0.05)$
$Pr > |t| = (< .0001) \quad (< 0.9581)$
$R - square = 0.7807 \quad n = 125$

The first model, consumption regressed on wealth, indicates that *for each 1 percent of growth in national wealth, US consumption of non-durable goods and services increases by 0.0284%.* Additionally, the estimate parameter is statistically significant, and the model explains about 80% of the variation in consumption. In contrast to the earlier estimates, the impact of wealth is much less.

The second model, consumption regressed on GDP and S&P500, indicates that *for each 1 percent of growth in US GDP, the US consumption of non-durable goods and services increases by 0.5400%.* Also, it indicates that the S&P500 does not affect the consumption. Further, the elasticity of consumption with respect to GDP is statistically significant. On the other hand, the elasticity of consumption with respect to S&P500 is not statistically significant. Overall, the results imply that for the given sample there is not evidence that the S&P500 has any impact on consumption. However, there is evidence that wealth and GDP impacts consumption, as the theory suggests. It is possible that the stock market impact on consumption is only reflected through the wealth, since most of the U.S. population does not own stocks there is not a direct impact.

In brief, Yule-Walker estimates suggest the following: The S&P500 do not affect consumption, and that the elasticity of consumption respect to GDP is greater than the elasticity of consumption respect to wealth. The results agree with the theory that the marginal propensity to consume from income is high, while it is low from wealth. (Yule-Walker Estimates, Appendix J and Appendix K)

6.12 Additional Estimations and Models

Additionally, using annual sample data for the period 1953-2015, we ran on SAS models which included median age, and lags in GDP and S&P500 for the purpose of observing the impact of age on wealth, and improving the estimated model. According to the life-cycle hypothesis wealth and age are closely related. However, such impact is difficult to observe at an aggregate level. Overall, median age was not statistically significant when estimating wealth, neither the lag values of GDP and S&P500. (Estimated models, Appendix L and Appendix M)

7. Conclusion

In summary, the life-cycle hypothesis is the main link between consumption and wealth. Within the framework, the household consumption is a function of income and wealth. Additionally, the corporate equities are part of that wealth. Due to this, one may use the life-cycle hypothesis to analyze the effects of stock market wealth in consumption expenditure. However, there are limitations in the analysis. For instance, an issue is how do we distinguish signaling from wealth effects? Also, there is a highly skewed distribution of stock ownership. This implies that the stock market affects asymmetrically the population.

In regard to the estimated structural simultaneous model, all the point estimates are statistically significant. Even more, it estimates that for each *1 percent of growth in the US GDP, the US Wealth increases by 0.6532%;* further, it forecasts that for *each 1 percent increase in the S&P500 rate of return, the national wealth increases by 0.6540%.;* and that *for each 1 percent of growth in the national wealth, the US consumption of non-durable goods and services increases by 0.1882%.*

Accordingly, the 2SLS estimated model suggests a link between the consumption expenditure and the stock market through the wealth effect. The estimated consumption expenditure model agrees that changes in share prices impact consumptions by relaxing the resource constraints that the economy faces. Because the stock prices are volatile they have an important impact on the national wealth.

However, the estimated model has serial correlation. Which means that the standard errors are not correct. Consequently, the hypothesis test is unreliable, being that the estimated model cannot be used for policy purposes or to predict the consumption phenomenon of the wealth effect. Nonetheless, the autoregressive error model is used to correct for serial correlation. However, the autoregressive error model is not applicable to structural simultaneous equations. Due to this, the results are not interpreted as in the case of 2SLS. Overall, the Yule-Walker estimates suggest that The S&P500 do not affect consumption and that the elasticity of consumption respect to GDP is greater than the elasticity of consumption respect to wealth.

In general, all the methods and models used in this paper indicates that the stock market impact on consumption is only reflected through the wealth. Further, they agree with the theory that the marginal propensity to consume from income is high, while it is low from wealth. Lastly, in future papers, one may consider using other estimation methods that directly correct the serial correlation. And so, improve the efficiency of the estimation.

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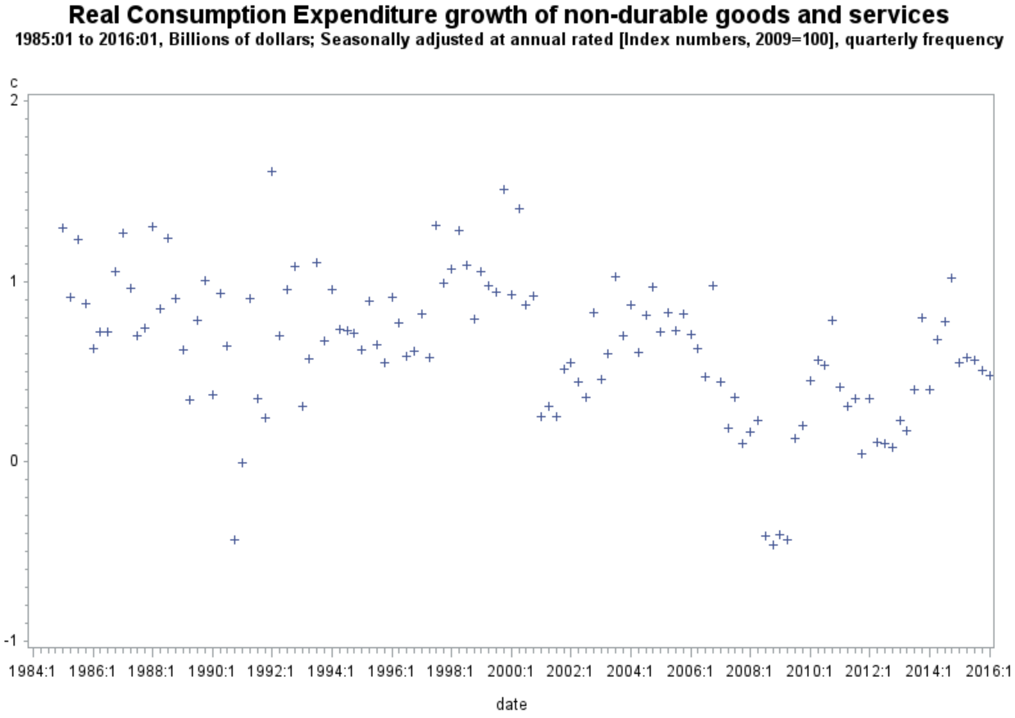
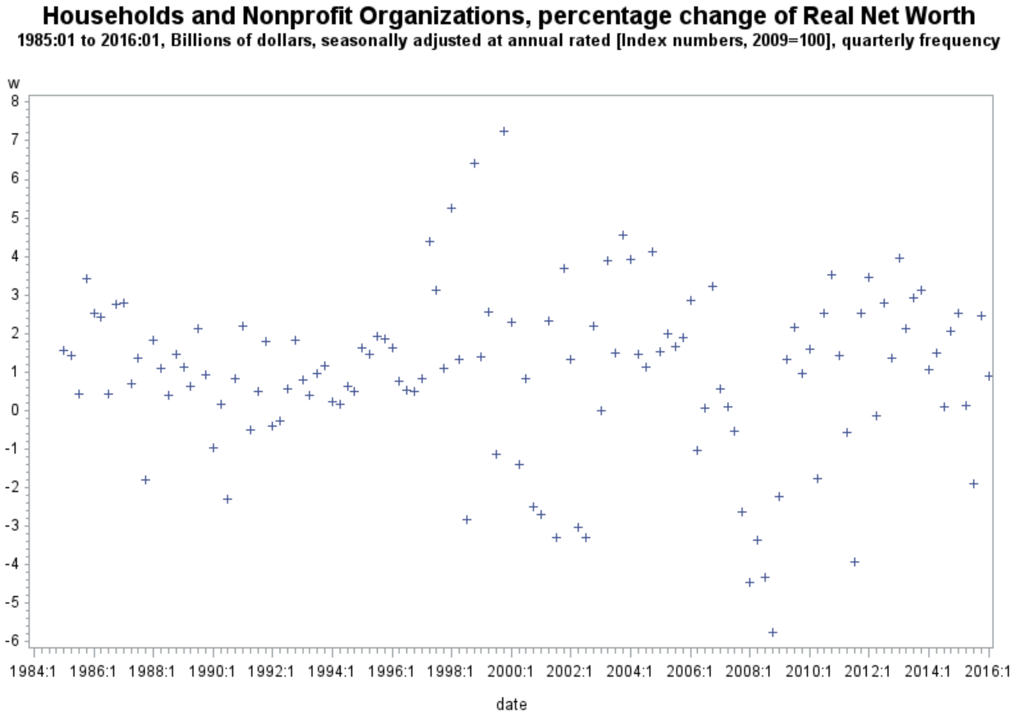
Appendix A- Data Plots



Real Consumption Expenditure growth of non-durable goods and services

1985:01 to 2016:01, Billions of dollars; Seasonally adjusted at annual rated [Index numbers, 2009=100], quarterly frequency

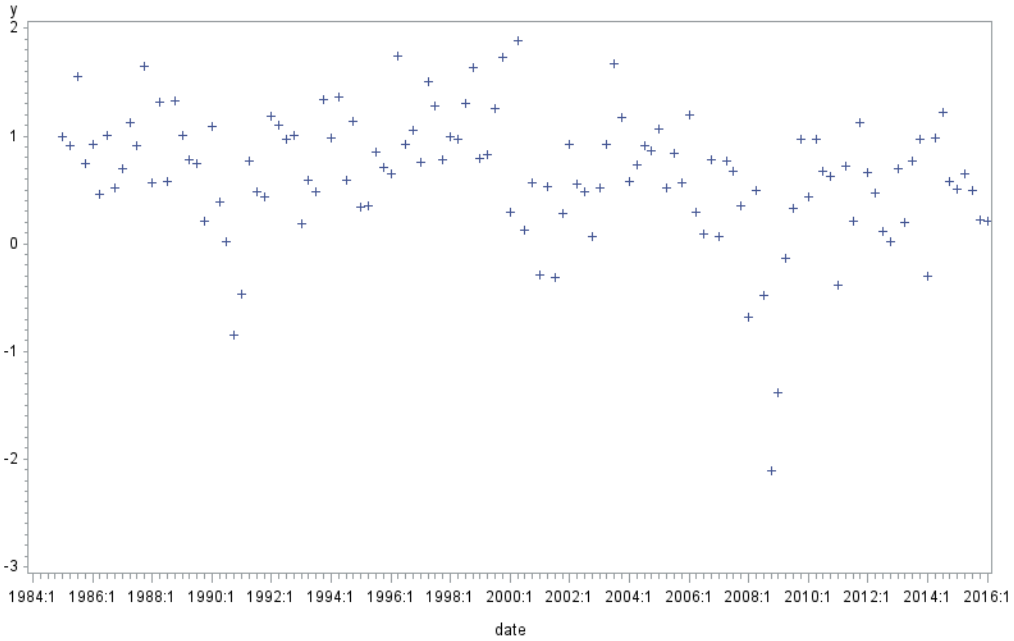
Source: Compiled by author with data from Bureau of Economic Analysis



Households and Nonprofit Organizations, percentage change of Real Net Worth

1985:01 to 2016:01, Billions of dollars, seasonally adjusted at annual rated [Index numbers, 2009=100], quarterly frequency

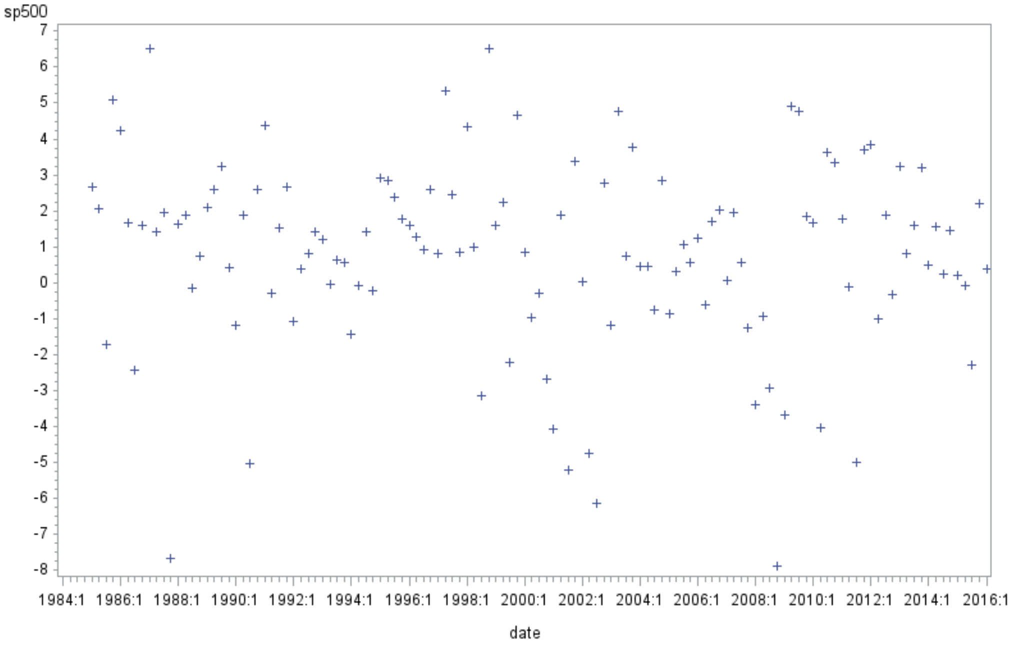
Source: Compiled by author with data from Z1 Federal Reserve, US Financial accounts



Real GDP Growth

1985:01 to 2016:01, Billions of dollars; Seasonally adjusted at annual rated [Index numbers, 2009=100], quarterly frequency

Source: Compiled by author with data from Bureau of Economic Analysis



S&P500, rate of return

1985:01 to 2016:01, quarterly frequency

Source: Compiled by author with data from Yahoo! Finance

Appendix B – Unit root tests

Phillips-Perron test for Consumption Expenditure Growth

The AUTOREG Procedure

Ordinary Least Squares Estimates

SSE	19.6804396	**DFE**	124
MSE	0.15871	**Root MSE**	0.39839
SBC	128.476884	**AIC**	125.64857
MAE	0.30733347	**AICC**	125.68109
MAPE	174.939478	**HQC**	126.797565
Durbin-Watson	0.8173	**Regress R-Square**	0.0000
		Total R-Square	0.0000

Phillips-Perron Unit Root Test

Type	Lags	Rho	Pr < Rho	Tau	Pr < Tau
Zero Mean	2	-9.1136	0.0346	-2.4391	0.0148
Single Mean	2	-45.1391	0.0011	-5.5083	<.0001
Trend	2	-58.4740	0.0004	-6.2939	<.0001

Parameter Estimates

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	0.6399	0.0356	17.96	<.0001

Phillips-Perron test for Wealth Percentage Change

The AUTOREG Procedure

Ordinary Least Squares Estimates			
SSE	579.405443	**DFE**	124
MSE	4.67262	**Root MSE**	2.16163
SBC	551.27404	**AIC**	548.445726
MAE	1.57923841	**AICC**	548.478246
MAPE	295.777973	**HQC**	549.594721
Durbin-Watson	1.5213	**Regress R-Square**	0.0000
		Total R-Square	0.0000

Phillips-Perron Unit Root Test

Type	Lags	Rho	Pr < Rho	Tau	Pr < Tau
Zero Mean	2	-77.0805	<.0001	-7.5400	<.0001
Single Mean	2	-95.0190	0.0011	-8.6711	<.0001
Trend	2	-95.2597	0.0004	-8.6508	<.0001

Parameter Estimates

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	0.9599	0.1933	4.96	<.0001

Phillips-Perron test for GPD growth

The AUTOREG Procedure

Ordinary Least Squares Estimates			
SSE	43.9202302	**DFE**	124
MSE	0.35420	**Root MSE**	0.59514
SBC	228.82061	**AIC**	225.992296
MAE	0.42634606	**AICC**	226.024816
MAPE	132.453001	**HQC**	227.14129
Durbin-Watson	1.1999	**Regress R-Square**	0.0000
		Total R-Square	0.0000

Phillips-Perron Unit Root Test

Type	Lags	Rho	Pr < Rho	Tau	Pr < Tau
Zero Mean	2	-27.7916	<.0001	-4.1347	<.0001
Single Mean	2	-75.5997	0.0011	-7.2668	<.0001
Trend	2	-83.1100	0.0004	-7.7015	<.0001

Parameter Estimates

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	0.6470	0.0532	12.15	<.0001

Phillips-Perron test for S&P500 Rate of Return

The AUTOREG Procedure

Ordinary Least Squares Estimates			
SSE	877.953686	**DFE**	124
MSE	7.08027	**Root MSE**	2.66088
SBC	603.22296	**AIC**	600.394646
MAE	1.95881569	**AICC**	600.427167
MAPE	181.160937	**HQC**	601.543641
Durbin-Watson	1.9091	**Regress R-Square**	0.0000
		Total R-Square	0.0000

Phillips-Perron Unit Root Test

Type	Lags	Rho	Pr < Rho	Tau	Pr < Tau
Zero Mean	2	-110.6259	<.0001	-9.9189	<.0001
Single Mean	2	-117.9594	0.0011	-10.5950	<.0001
Trend	2	-118.7881	0.0004	-10.6372	<.0001

Parameter Estimates

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	0.7688	0.2380	3.23	0.0016

Appendix C – Two-Stages Least Squares Estimation

Estimated Consumption Model

The SYSLIN Procedure
Two-Stage Least Squares Estimation

Model	CONSUMPTION
Dependent Variable	c

Analysis of Variance

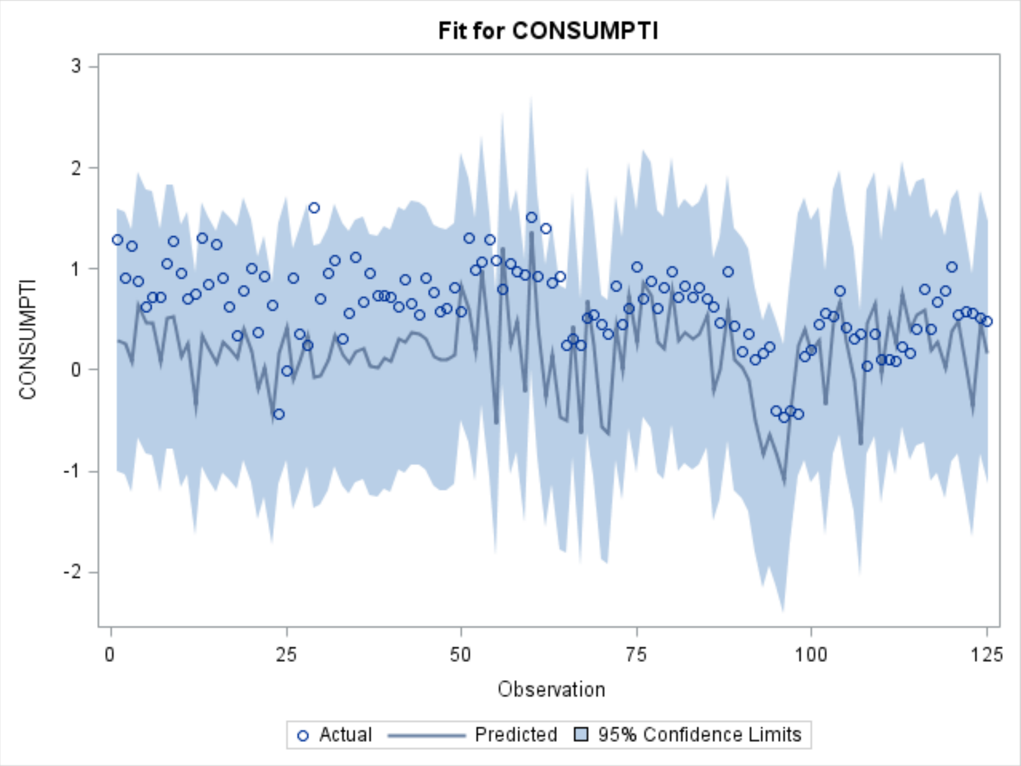
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	19.31242	19.31242	44.99	<.0001
Error	124	53.22652	0.429246		
Uncorrected Total	125	70.86703			

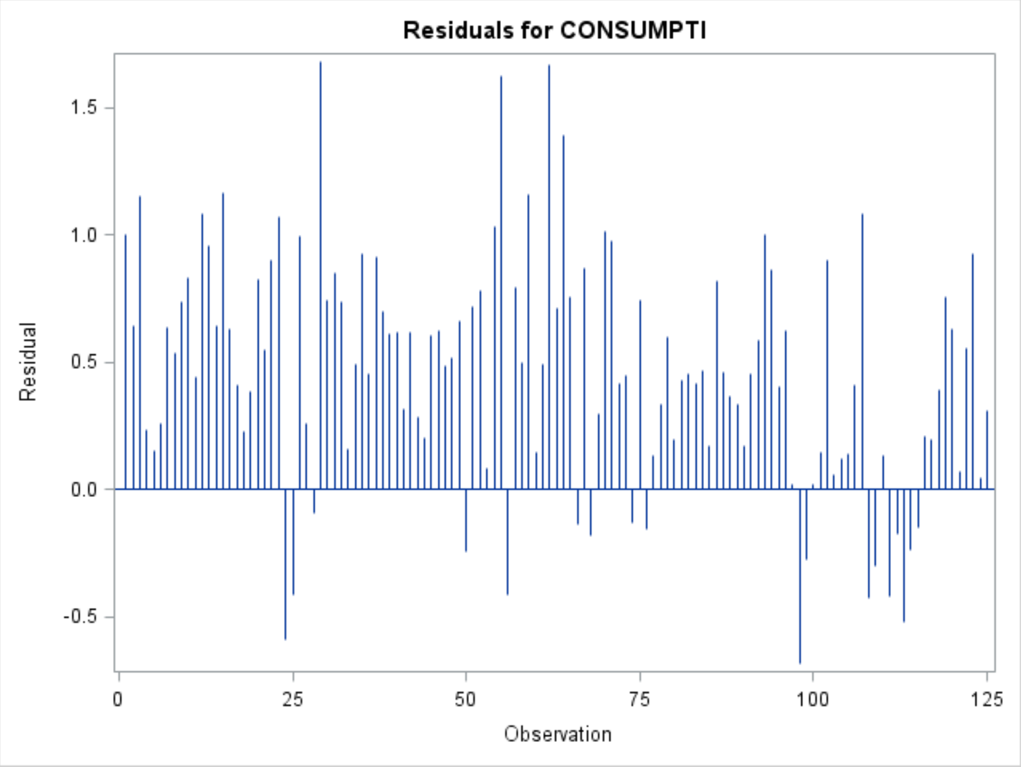
Root MSE	0.65517	**R-Square**	0.26624
Dependent Mean	0.63992	**Adj R-Sq**	0.26032
Coeff Var	102.38353		

Note: The NOINT option changes the definition of the R-Square statistic to:
1 - (Residual Sum of Squares/Uncorrected Total Sum of Squares).

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardized Estimate
w	1	0.188180	0.028055	6.71	<.0001	1.02104846


Fit for CONSUMPTI
CONSUMPTI
3
2
1
0
-1
-2
0
25
50
75
100
125
Observation
Actual
Predicted
95% Confidence Limits


Residuals for CONSUMPTI
Residual
1.5
1.0
0.5
0.0
-0.5
0
25
50
75
100
125
Observation

Estimated Wealth, reduced-form equation

The SYSLIN Procedure
Two-Stage Least Squares Estimation

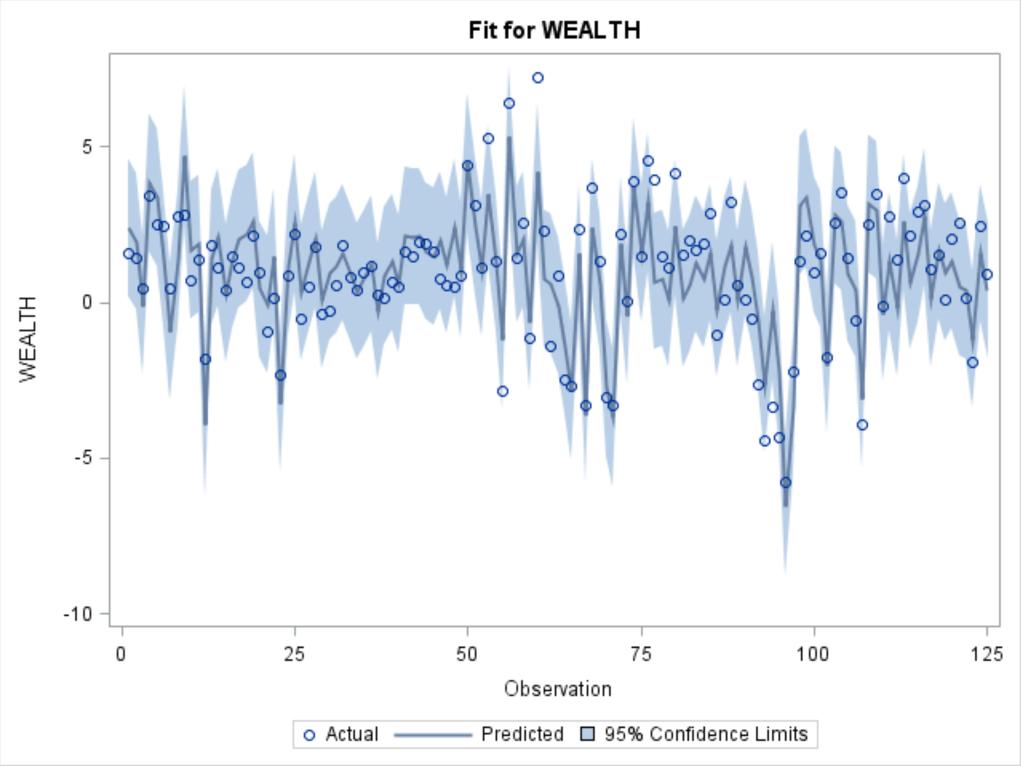
Model	WEALTH
Dependent Variable	w

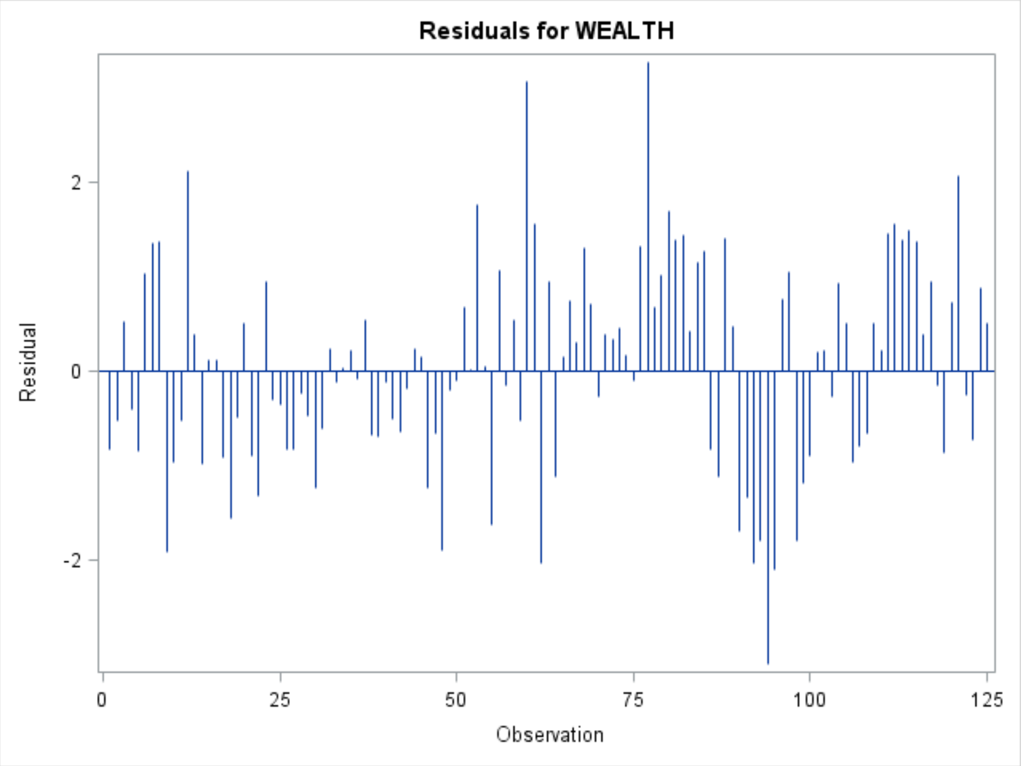
Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	2	545.0438	272.5219	224.15	<.0001
Error	123	149.5431	1.215798		
Uncorrected Total	125	694.5869			

Root MSE	1.10263	**R-Square**	0.78470
Dependent Mean	0.95992	**Adj R-Sq**	0.78120
Coeff Var	114.86675		

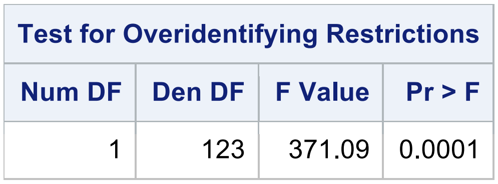
Note: The NOINT option changes the definition of the R-Square statistic to:
1 - (Residual Sum of Squares/Uncorrected Total Sum of Squares).

Parameter Estimates						
Variable	**DF**	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**	**Standardized Estimate**
y	1	0.653190	0.121231	5.39	<.0001	0.17983764
sp500	1	0.653965	0.038549	16.96	<.0001	0.80500530


Fit for WEALTH
WEALTH
5
0
-5
-10
0
25
50
75
100
125
Observation
○ Actual
Predicted
95% Confidence Limits


Residuals for WEALTH
Residual
2
0
-2
0
25
50
75
100
125
Observation

Appendix D – Test for Overidentifying Restrictions



Test for Overidentifying Restrictions			
Num DF	Den DF	F Value	Pr > F
1	123	371.09	0.0001

Appendix E – Cointegration Tests

Phillips-Perron test for Estimated Consumption Model Residuals

The AUTOREG Procedure

Dependent Variable	Resid
	Residual Values

Phillips-Perron test for Residuals

The AUTOREG Procedure

Ordinary Least Squares Estimates			
SSE	26.8594534	**DFE**	124
MSE	0.21661	**Root MSE**	0.46541
SBC	167.35096	**AIC**	164.522646
MAE	0.36403238	**AICC**	164.555167
MAPE	149.258928	**HQC**	165.671641
Durbin-Watson	1.6293	**Regress R-Square**	0.0000
		Total R-Square	0.0000

Phillips-Perron Unit Root Test

Type	Lags	Rho	Pr < Rho	Tau	Pr < Tau
Zero Mean	2	-43.0275	<.0001	-5.4369	<.0001
Single Mean	2	-101.0911	0.0011	-9.2516	<.0001
Trend	2	-112.5103	0.0004	-10.1089	<.0001

Parameter Estimates

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	0.4593	0.0416	11.03	<.0001

Phillips-Perron test for Estimated Wealth Model Residuals

The AUTOREG Procedure

Dependent Variable	Resid
	Residual

Phillips-Perron test for Residuals

The AUTOREG Procedure

Ordinary Least Squares Estimates			
SSE	149.393947	**DFE**	124
MSE	1.20479	**Root MSE**	1.09763
SBC	381.847075	**AIC**	379.018761
MAE	0.87578367	**AICC**	379.051281
MAPE	100.345078	**HQC**	380.167756
Durbin-Watson	1.3217	**Regress R-Square**	0.0000
		Total R-Square	0.0000

Phillips-Perron Unit Root Test

Type	Lags	Rho	Pr < Rho	Tau	Pr < Tau
Zero Mean	2	-79.2940	<.0001	-7.7520	<.0001
Single Mean	2	-79.3746	0.0011	-7.7290	<.0001
Trend	2	-81.4718	0.0004	-7.8341	<.0001

Parameter Estimates

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	0.0345	0.0982	0.35	0.7255

Appendix F – Normality Tests

Normality Test - Estimated Consumption Model Residuals

The UNIVARIATE Procedure
Variable: c_ (Residual Values)

Moments			
N	125	**Sum Weights**	125
Mean	0.45927828	**Sum Observations**	57.4097852
Std Deviation	0.46354679	**Variance**	0.21487563
Skewness	-0.0235306	**Kurtosis**	0.08649792
Uncorrected SS	53.2265209	**Corrected SS**	26.8594534
Coeff Variation	100.929395	**Std Error Mean**	.

Basic Statistical Measures			
Location		**Variability**	
Mean	0.459278	**Std Deviation**	0.46355
Median	0.460029	**Variance**	0.21488
Mode	.	**Range**	2.36940
		Interquartile Range	0.59494

Tests for Location: Mu0=0				
Test	**Statistic**		**p Value**	
Sign	**M**	44.5	**Pr >= |M|**	<.0001
Signed Rank	**S**	3269.5	**Pr >= |S|**	<.0001

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.990168	**Pr < W**	0.5186
Kolmogorov-Smirnov	**D**	0.045509	**Pr > D**	>0.1500
Cramer-von Mises	**W-Sq**	0.03783	**Pr > W-Sq**	>0.2500
Anderson-Darling	**A-Sq**	0.305291	**Pr > A-Sq**	>0.2500

Normality Test - Estimated Wealth Model Residuals

The UNIVARIATE Procedure
Variable: ehat1 (Residual)

Moments			
N	125	**Sum Weights**	125
Mean	0.03454813	**Sum Observations**	4.31851675
Std Deviation	1.09322988	**Variance**	1.19515158
Skewness	0.06804484	**Kurtosis**	0.17329255
Uncorrected SS	149.543144	**Corrected SS**	149.393947
Coeff Variation	3164.36738	**Std Error Mean**	.

Basic Statistical Measures			
Location		Variability	
Mean	0.034548	**Std Deviation**	1.09323
Median	0.045295	**Variance**	1.19515
Mode	.	**Range**	6.37642
		Interquartile Range	1.46852

Tests for Location: Mu0=0				
Test	Statistic		p Value	
Sign	**M**	2.5	**Pr >= |M|**	0.7207
Signed Rank	**S**	141.5	**Pr >= |S|**	0.7289

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	**W**	0.992869	**Pr < W**	0.7788
Kolmogorov-Smirnov	**D**	0.035021	**Pr > D**	>0.1500
Cramer-von Mises	**W-Sq**	0.023502	**Pr > W-Sq**	>0.2500
Anderson-Darling	**A-Sq**	0.216839	**Pr > A-Sq**	>0.2500

Appendix G –Serial Correlation Tests

Parameter Estimates for Second-Stage Regression

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardized Estimate
w	1	0.188180	0.028055	6.71	<.0001	1.02104846

Durbin-Watson	0.822187
Number of Observations	125
First-Order Autocorrelation	0.578573

Parameter Estimates for reduced-form equation

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardized Estimate
y	1	0.653190	0.121231	5.39	<.0001	0.17983764
sp500	1	0.653965	0.038549	16.96	<.0001	0.80500530

Durbin-Watson	1.320352
Number of Observations	125
First-Order Autocorrelation	0.336628

Appendix H – Multicollinearity Test

The REG Procedure
Model: MODEL1
Dependent Variable: w

Number of Observations Read	125
Number of Observations Used	125

Note: No intercept in model. R-Square is redefined.

Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	2	545.04380	272.52190	224.15	<.0001
Error	123	149.54314	1.21580		
Uncorrected Total	125	694.58695			

Root MSE	1.10263	**R-Square**	0.7847
Dependent Mean	0.95992	**Adj R-Sq**	0.7812
Coeff Var	114.86675		

Parameter Estimates							
Variable	**DF**	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**	**Tolerance**	**Variance Inflation**
y	1	0.65319	0.12123	5.39	<.0001	0.85954	1.16341
sp500	1	0.65396	0.03855	16.96	<.0001	0.85954	1.16341

Correlation of Estimates		
Variable	**y**	**sp500**
y	1.0000	-0.3748
sp500	-0.3748	1.0000

Appendix I – Alternative procedure: Seemingly unrelated regressions

Estimated Wealth Consumption

The SYSLIN Procedure
Seemingly Unrelated Regression Estimation

Crossproducts for the System X'X, X'Y, Y'Y

	w	y	sp500	All Y
w	1669.02	28.514	144.926	414.179
y	28.51	80.894	95.343	129.882
sp500	144.93	95.343	800.039	602.953
All Y	414.18	129.882	602.953	800.799

X'X Generalized Inverse, Parameter Estimates, and SSE

	w	y	sp500	All Y
w	0.000609	-.000099	-.000099	0.180
y	-.000099	0.014398	-.001698	0.805
sp500	-.000099	-.001698	0.001470	0.625
All Y	0.180124	0.805408	0.625043	244.716

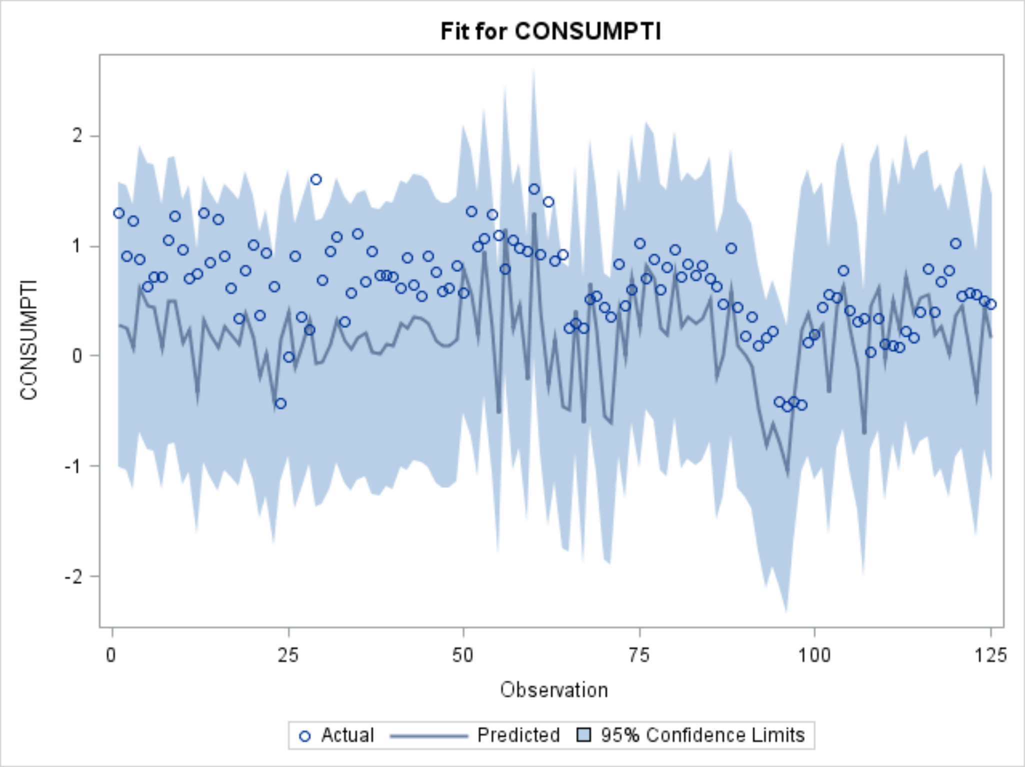
System Weighted MSE	0.9908
Degrees of freedom	247
System Weighted R-Square	0.6944

Model	CONSUMPTI
Dependent Variable	c

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardized Estimate
w	1	0.180124	0.024686	7.30	<.0001	0.97733756

Durbin-Watson	0.779597
Number of Observations	125
First-Order Autocorrelation	0.599537


Fit for CONSUMPTI
CONSUMPTI
2
1
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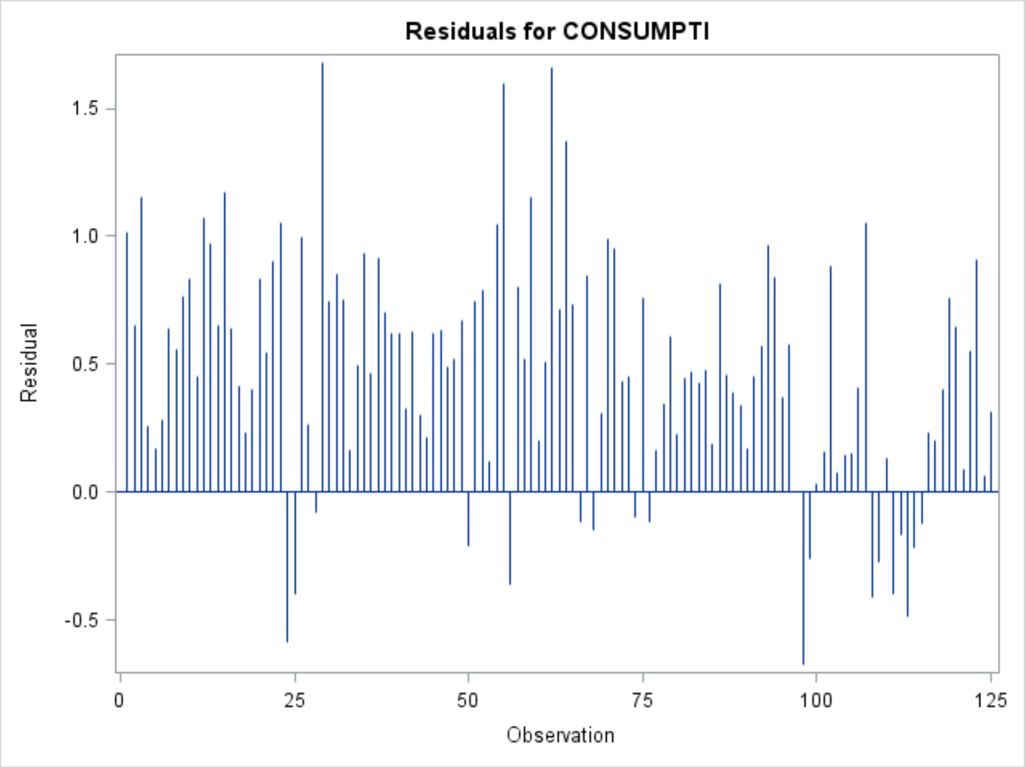
-1
-2
0
25
50
75
100
125
Observation
○ Actual
Predicted
▨ 95% Confidence Limits


Residuals for CONSUMPTI
Residual
1.5
1.0
0.5
0.0
-0.5
0
25
50
75
100
125
Observation

Normality Test - Estimated Consumption Model Residuals

The UNIVARIATE Procedure
Variable: c_ (Residual Values)

Moments			
N	125	**Sum Weights**	125
Mean	0.46701136	**Sum Observations**	58.3764196
Std Deviation	0.45353162	**Variance**	0.20569093
Skewness	-0.0324993	**Kurtosis**	0.13672166
Uncorrected SS	52.9738176	**Corrected SS**	25.7113667
Coeff Variation	97.1136176	**Std Error Mean**	.

Basic Statistical Measures			
Location		**Variability**	
Mean	0.467011	**Std Deviation**	0.45353
Median	0.468302	**Variance**	0.20569
Mode	.	**Range**	2.35557
		Interquartile Range	0.58712

Tests for Location: Mu0=0				
Test	**Statistic**		**p Value**	
Sign	**M**	43.5	**Pr >= |M|**	<.0001
Signed Rank	**S**	3340.5	**Pr >= |S|**	<.0001

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.990622	**Pr < W**	0.5608
Kolmogorov-Smirnov	**D**	0.043185	**Pr > D**	>0.1500
Cramer-von Mises	**W-Sq**	0.03612	**Pr > W-Sq**	>0.2500
Anderson-Darling	**A-Sq**	0.297721	**Pr > A-Sq**	>0.2500

Estimated Wealth Model

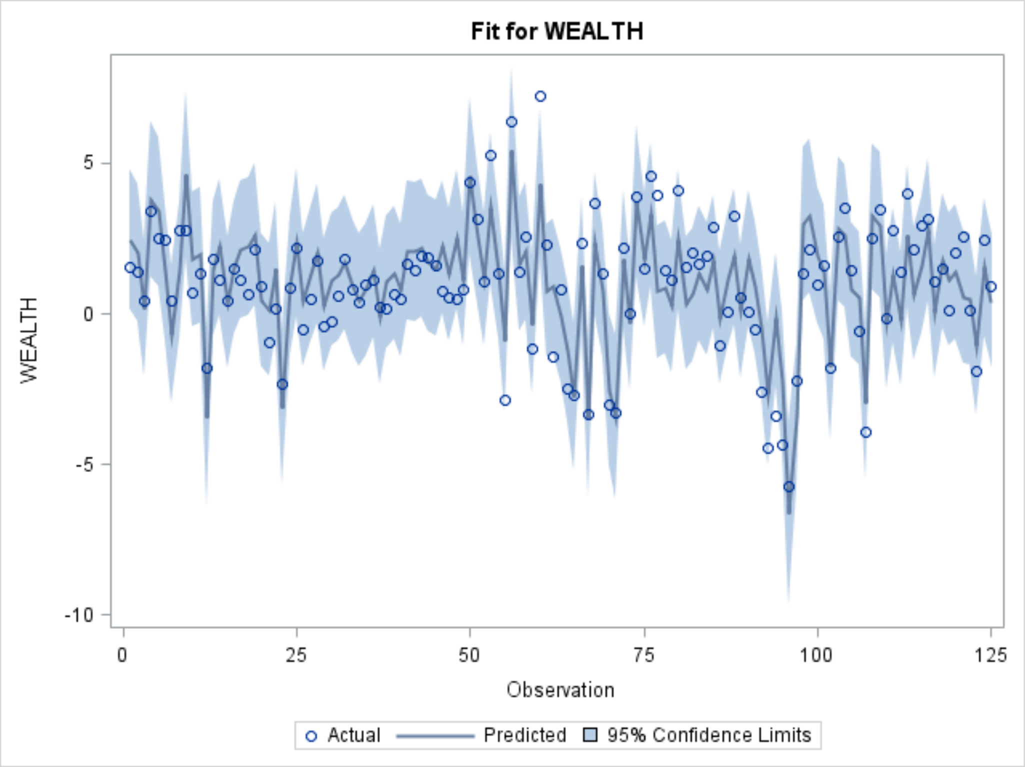
The SYSLIN Procedure
Seemingly Unrelated Regression Estimation

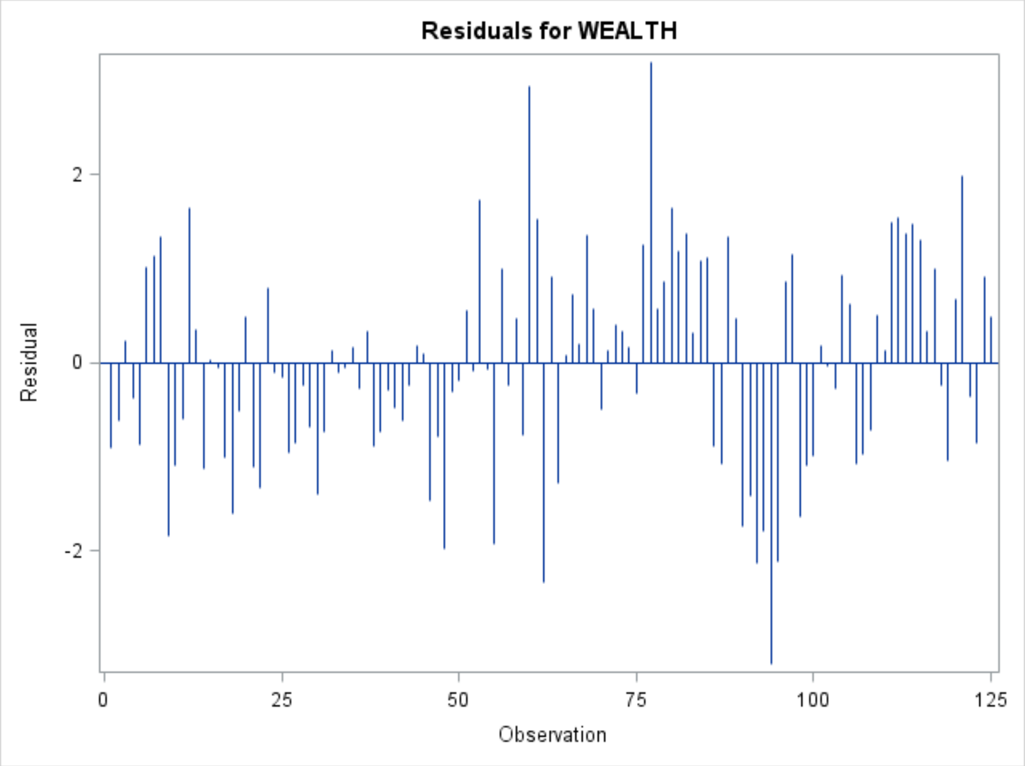
Model	WEALTH
Dependent Variable	w

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardized Estimate
y	1	0.805408	0.119991	6.71	<.0001	0.22174660
sp500	1	0.625043	0.038343	16.30	<.0001	0.76940383

Durbin-Watson	1.357759
Number of Observations	125
First-Order Autocorrelation	0.317609


Fit for WEALTH
WEALTH
5
0
-5
-10
0
25
50
75
100
125
Observation
○ Actual
Predicted
▨ 95% Confidence Limits


Residuals for WEALTH
Residual
2
0
-2
0
25
50
75
100
125
Observation

Normality Test - Estimated Wealth Model Residuals

The UNIVARIATE Procedure
Variable: w_ (Residual Values)

Moments			
N	125	**Sum Weights**	125
Mean	-0.0416976	**Sum Observations**	-5.2122052
Std Deviation	1.10037517	**Variance**	1.21082552
Skewness	0.04475536	**Kurtosis**	0.09213163
Uncorrected SS	151.570527	**Corrected SS**	151.35319
Coeff Variation	-2638.9386	**Std Error Mean**	.

Basic Statistical Measures			
Location		**Variability**	
Mean	-0.04170	**Std Deviation**	1.10038
Median	-0.05455	**Variance**	1.21083
Mode	.	**Range**	6.40401
		Interquartile Range	1.58443

Tests for Location: Mu0=0				
Test	**Statistic**		**p Value**	
Sign	**M**	-2.5	**Pr >= |M|**	0.7207
Signed Rank	**S**	-158.5	**Pr >= |S|**	0.6978

Tests for Normality				
Test	**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.99376	**Pr < W**	0.8571
Kolmogorov-Smirnov	**D**	0.034913	**Pr > D**	>0.1500
Cramer-von Mises	**W-Sq**	0.023763	**Pr > W-Sq**	>0.2500
Anderson-Darling	**A-Sq**	0.206969	**Pr > A-Sq**	>0.2500

Covariances and Correlation Estimates

The SYSLIN Procedure Seemingly Unrelated Regression Estimation

Covariances of Parameter Estimates			
	w	**y**	**sp500**
w	0.000609	-.000099	-.000099
y	-.000099	0.014398	-.001698
sp500	-.000099	-.001698	0.001470

Correlations of Parameter Estimates			
	w	**y**	**sp500**
w	1.0000	-0.0333	-0.1042
y	-0.0333	1.0000	-0.3691
sp500	-0.1042	-0.3691	1.0000

Cross Model Covariance		
	CONSUMPTI	**WEALTH**
CONSUMPTI	0.425280	-0.10527
WEALTH	-.105272	1.21580

Cross Model Correlation		
	CONSUMPTI	**WEALTH**
CONSUMPTI	1.00000	-0.14640
WEALTH	-0.14640	1.00000

Cross Model Inverse Correlation		
	CONSUMPTI	**WEALTH**
CONSUMPTI	1.02190	0.14961
WEALTH	0.14961	1.02190

Cross Model Inverse Covariance

	CONSUMPTI	WEALTH
CONSUMPTI	2.40289	0.208058
WEALTH	0.20806	0.840520

Appendix J– Autoregressive Error Model, Corrects for Serial Correlation

Estimated Consumption Model

The AUTOREG Procedure

Dependent Variable	c

c = α(w)

The AUTOREG Procedure

Ordinary Least Squares Estimates			
SSE	52.7347369	**DFE**	124
MSE	0.42528	**Root MSE**	0.65214
SBC	251.683028	**AIC**	248.854714
MAE	0.55216269	**AICC**	248.887234
MAPE	151.594644	**HQC**	250.003708
Durbin-Watson	0.6838	**Regress R-Square**	0.2559
		Total R-Square	0.2559
NOTE: No intercept term is used. R-squares are redefined.			

Parameter Estimates

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
w	1	0.1616	0.0247	6.53	<.0001

<table>
<tr><th colspan="4">Estimates of Autocorrelations</th></tr>
<tr><th>Lag</th><th>Covariance</th><th>Correlation</th><th>-1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1</th></tr>
<tr><td>0</td><td>0.4219</td><td>1.000000</td><td>| |********************|</td></tr>
<tr><td>1</td><td>0.2728</td><td>0.646731</td><td>| |************* |</td></tr>
<tr><td>2</td><td>0.2570</td><td>0.609102</td><td>| |************ |</td></tr>
<tr><td>3</td><td>0.2791</td><td>0.661606</td><td>| |************* |</td></tr>
<tr><td>4</td><td>0.2226</td><td>0.527576</td><td>| |*********** |</td></tr>
</table>

Preliminary MSE	0.1910

Estimates of Autoregressive Parameters			
Lag	Coefficient	Standard Error	t Value
1	-0.332323	0.091211	-3.64
2	-0.180465	0.090035	-2.00
3	-0.368824	0.090035	-4.10
4	0.040743	0.091211	0.45

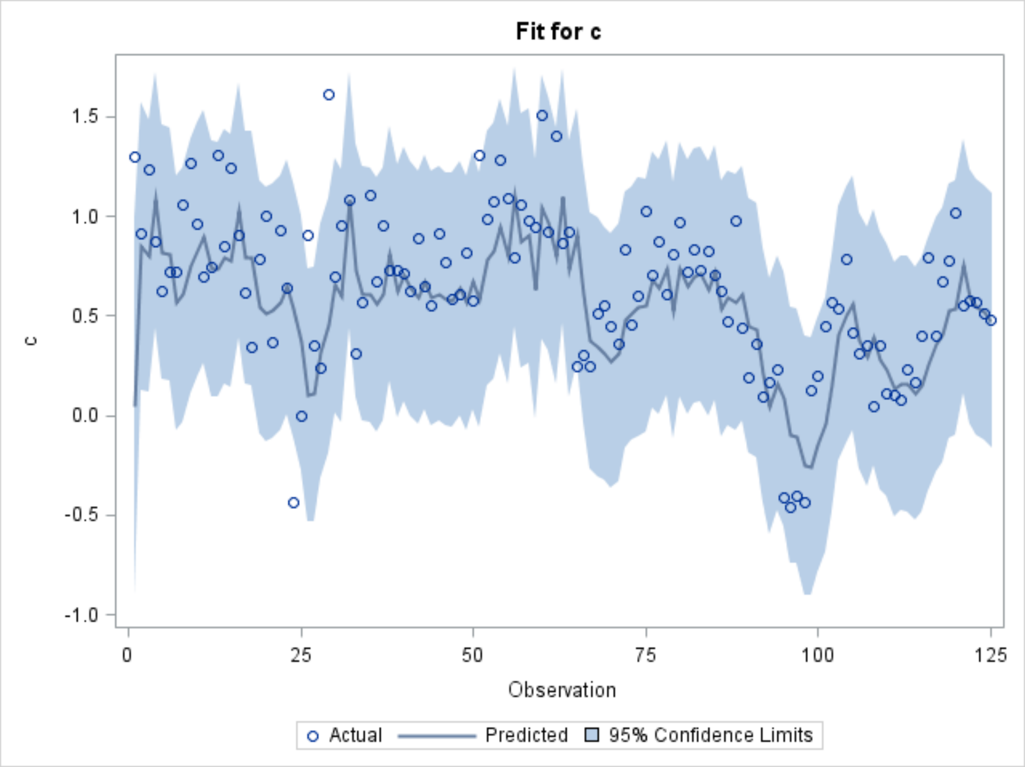
Autoregressive Error Model Correct for serial Correlation

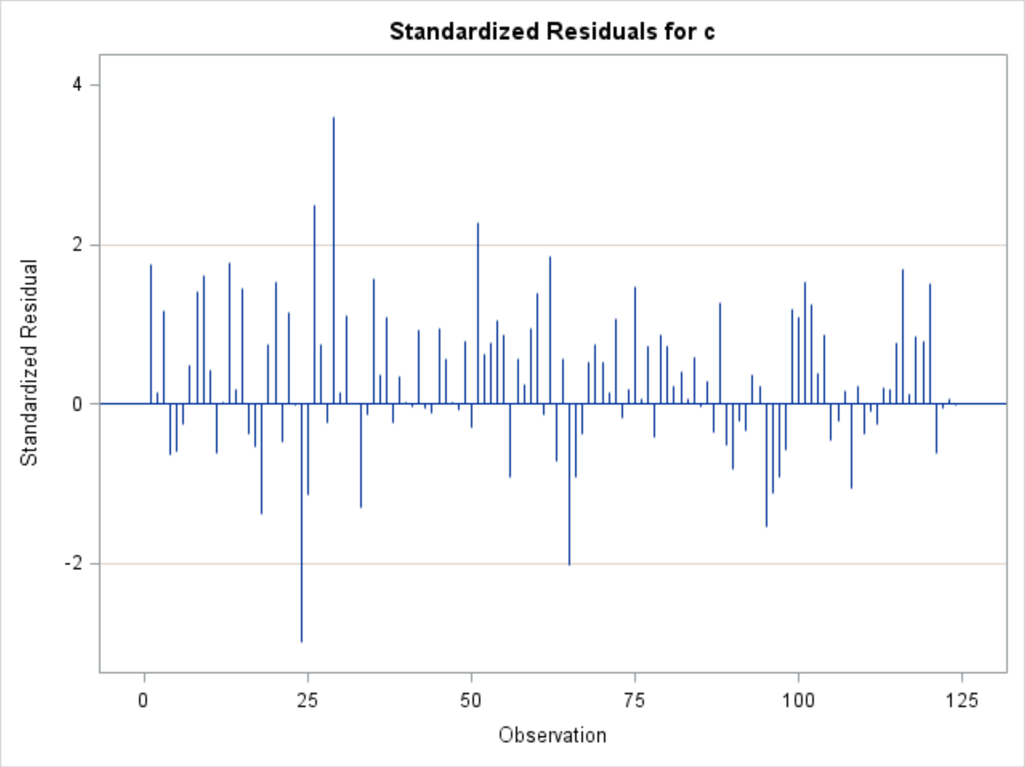
The AUTOREG Procedure

Yule-Walker Estimates			
SSE	12.4133287	**DFE**	120
MSE	0.10344	**Root MSE**	0.32163
SBC	91.3656829	**AIC**	77.2241142
MAE	0.23450308	**AICC**	77.7283158
MAPE	98.7118404	**HQC**	82.969087
Durbin-Watson	1.4981	**Regress R-Square**	0.0359
		Total R-Square	0.8248
NOTE: No intercept term is used. R-squares are redefined.			

Parameter Estimates

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
w	1	0.0284	0.0134	2.11	0.0367


Fit for c
c
1.5
1.0
0.5
0.0
-0.5
-1.0
0
25
50
75
100
125
Observation
Actual
Predicted
95% Confidence Limits


Standardized Residuals for c
Standardized Residual
4
2
0
-2
0
25
50
75
100
125
Observation

Appendix K– Autoregressive Error Model 2, Corrects for Serial Correlation

Estimated Consumption Model

The AUTOREG Procedure

Dependent Variable	c

$c = \alpha(y) + \beta(sp500)$

The AUTOREG Procedure

Ordinary Least Squares Estimates			
SSE	19.0553184	**DFE**	123
MSE	0.15492	**Root MSE**	0.39360
SBC	129.270324	**AIC**	123.613697
MAE	0.30937623	**AICC**	123.712057
MAPE	115.946692	**HQC**	125.911686
Durbin-Watson	1.7871	**Regress R-Square**	0.7311
		Total R-Square	0.7311
NOTE: No intercept term is used. R-squares are redefined.			

Parameter Estimates					
Variable	**DF**	**Estimate**	**Standard Error**	**t Value**	**Approx Pr > |t|**
y	1	0.7326	0.0433	16.93	<.0001
sp500	1	0.000956	0.0138	0.07	0.9447

Correlation of Parameter Estimates		
	y	**sp500**
y	1	-0.37478
sp500	-0.37478	1

<table>
<tr><th colspan="4">Estimates of Autocorrelations</th></tr>
<tr><th>Lag</th><th>Covariance</th><th>Correlation</th><th>-1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1</th></tr>
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<tr><td>2</td><td>0.0315</td><td>0.206476</td><td>| |**** |</td></tr>
<tr><td>3</td><td>0.0208</td><td>0.136669</td><td>| |*** |</td></tr>
<tr><td>4</td><td>0.0252</td><td>0.165260</td><td>| |*** |</td></tr>
</table>

Preliminary MSE	0.1415

Estimates of Autoregressive Parameters			
Lag	**Coefficient**	**Standard Error**	**t Value**
1	-0.042738	0.091063	-0.47
2	-0.169066	0.090678	-1.86
3	-0.100762	0.090678	-1.11
4	-0.114901	0.091063	-1.26

Autoregressive Error Model Correct for serial Correlation

The AUTOREG Procedure

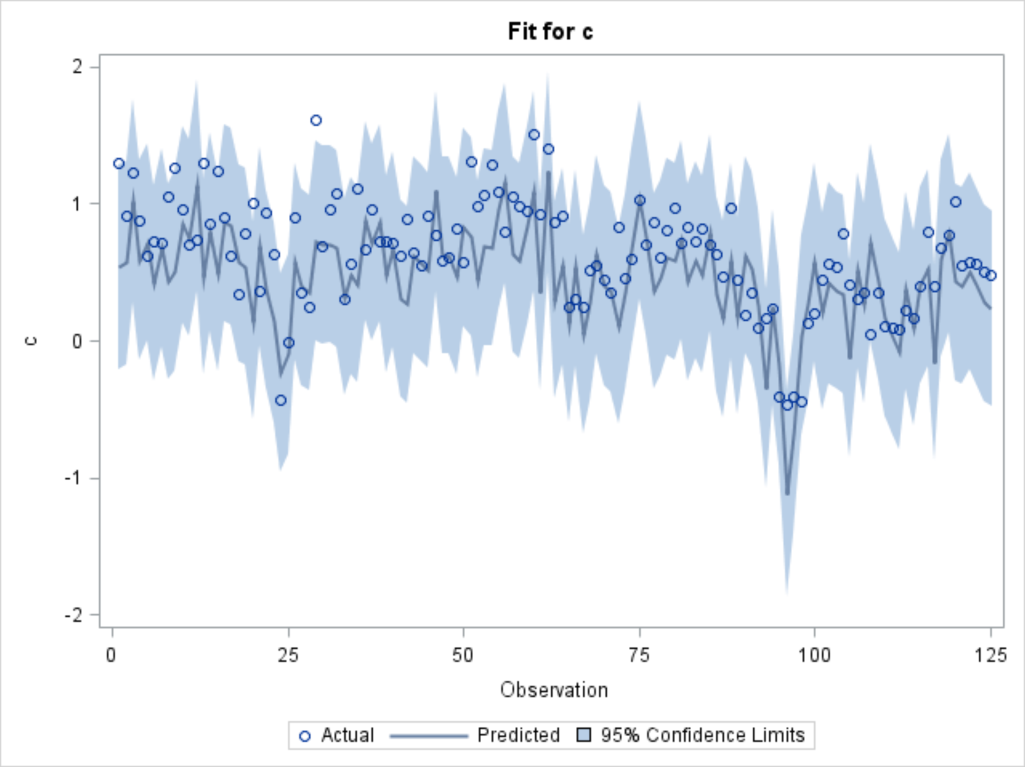
Yule-Walker Estimates			
SSE	15.5403872	**DFE**	119
MSE	0.13059	**Root MSE**	0.36137
SBC	123.273453	**AIC**	106.30357
MAE	0.27695315	**AICC**	107.015435
MAPE	72.3000451	**HQC**	113.197538
Durbin-Watson	1.5895	**Regress R-Square**	0.5122
		Total R-Square	0.7807
NOTE: No intercept term is used. R-squares are redefined.			

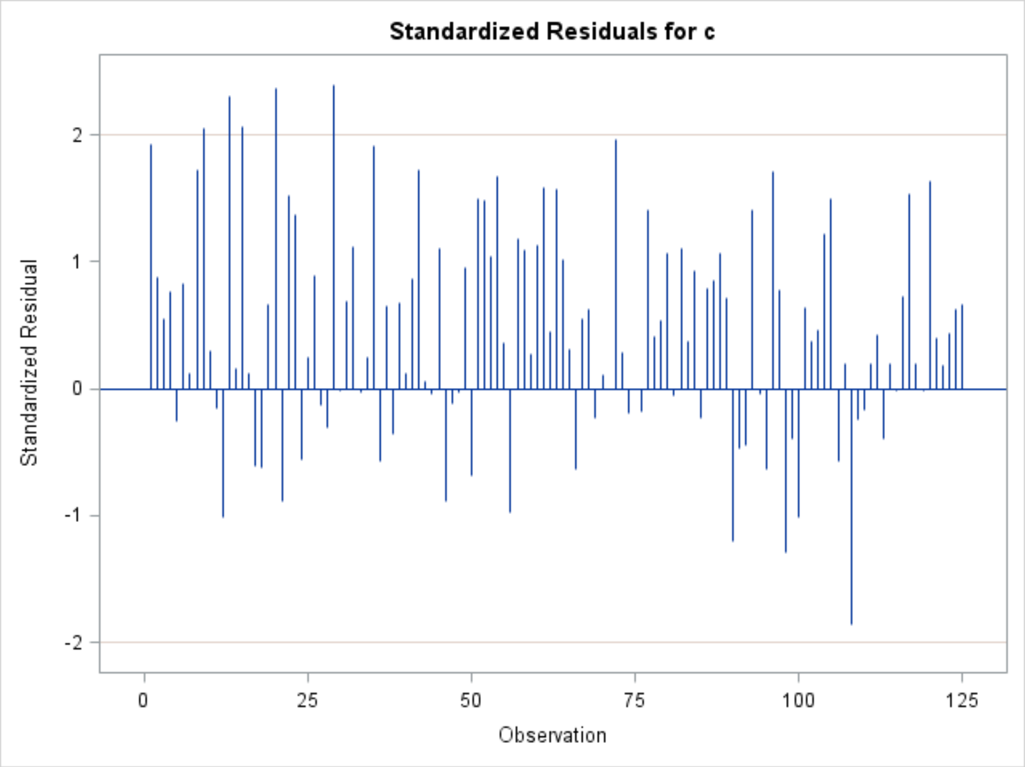
Parameter Estimates

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
y	1	0.5400	0.0500	10.80	<.0001
sp500	1	0.000639	0.0121	0.05	0.9581

Correlation of Parameter Estimates

	y	sp500
y	1	-0.25327
sp500	-0.25327	1


Fit for c
2
1
0
-1
-2
c
0
25
50
75
100
125
Observation
Actual
Predicted
95% Confidence Limits


Standardized Residuals for c
2
1
0
-1
-2
Standardized Residual
0
25
50
75
100
125
Observation

Appendix L – Estimated Model with Lags in GDP and S&P500

Estimated Consumption Model

The SYSLIN Procedure
Two-Stage Least Squares Estimation

Model	CONSUMPTION
Dependent Variable	c

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	414.8889	414.8889	60.67	<.0001
Error	61	417.1262	6.838134		
Uncorrected Total	62	718.2431			

Root MSE	2.61498	**R-Square**	0.49866
Dependent Mean	3.11993	**Adj R-Sq**	0.49044
Coeff Var	83.81548		

Note: The NOINT option changes the definition of the R-Square statistic to:
1 - (Residual Sum of Squares/Uncorrected Total Sum of Squares).

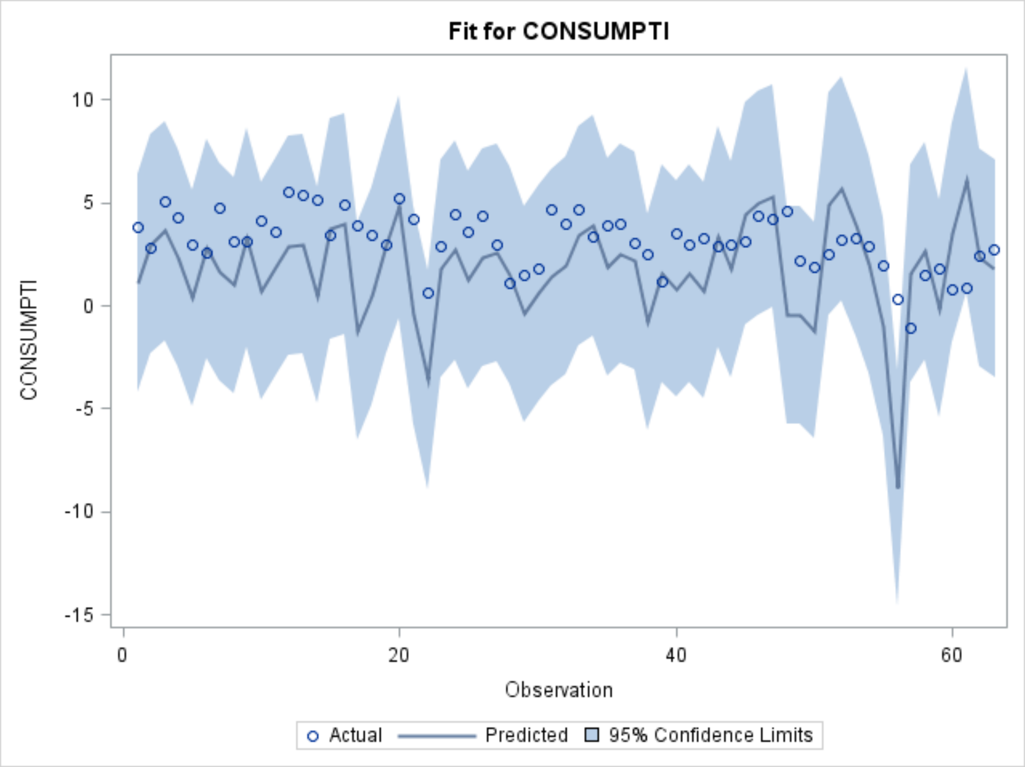
Parameter Estimates

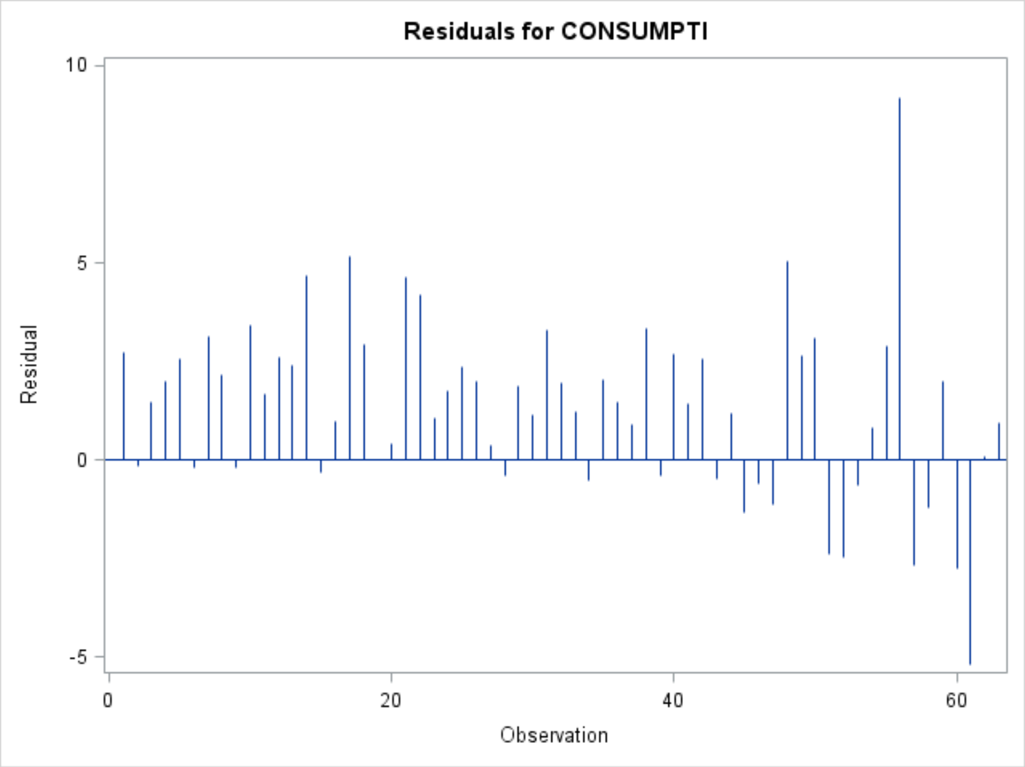
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardized Estimate
w	1	0.478856	0.061476	7.79	<.0001	1.67340111

Durbin-Watson	1.269886
Number of Observations	62
First-Order Autocorrelation	0.363905

Test for Overidentifying Restrictions

Num DF	Den DF	F Value	Pr > F
3	58	35.69	0.0001


Fit for CONSUMPTI
CONSUMPTI
10
5
0
-5
-10
-15
0
20
40
60
Observation
Actual
Predicted
95% Confidence Limits


Residuals for CONSUMPTI
Residual
10
5
0
-5
0
20
40
60
Observation

Estimated Wealth Model with Lags

The SYSLIN Procedure
Two-Stage Least Squares Estimation

Model Crossproducts for each Equation Given By X'X, X'y, y'y					
	y	**l_y**	**sp500**	**l_sp500**	**w**
y	883.55	632.41	2133.3	3742.4	911.72
l_y	632.41	898.85	2045.9	2240.9	734.06
sp500	2133.30	2045.87	27971.2	9443.8	6559.05
l_sp500	3742.42	2240.93	9443.8	28530.1	3749.03
w	911.72	734.06	6559.0	3749.0	2262.92

X'X Generalized Inverse, Parameter Estimates, and SSE					
	y	**l_y**	**sp500**	**l_sp500**	**w**
y	0.004337	-.001932	-.000055	-.000399	0.681
l_y	-.001932	0.002389	-.000056	0.000084	-0.058
sp500	-.000055	-.000056	0.000045	-.000003	0.193
l_sp500	-.000399	0.000084	-.000003	0.000082	-0.017
w	0.680872	-.058109	0.192585	-.017090	485.720

Model	WEALTH
Dependent Variable	w

Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	4	1777.204	444.3011	53.05	<.0001
Error	58	485.7201	8.374485		
Uncorrected Total	62	2262.925			

Root MSE	2.89387	**R-Square**	0.78536
Dependent Mean	3.72812	**Adj R-Sq**	0.77055
Coeff Var	77.62272		

Note: The NOINT option changes the definition of the R-Square statistic to:
1 - (Residual Sum of Squares/Uncorrected Total Sum of Squares).

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Standardized Estimate
y	1	0.680872	0.190578	3.57	0.0007	0.31718023
l_y	1	-0.05811	0.141439	-0.41	0.6827	-0.02717641
sp500	1	0.192585	0.019445	9.90	<.0001	0.70352697
l_sp500	1	-0.01709	0.026188	-0.65	0.5166	-0.06244039

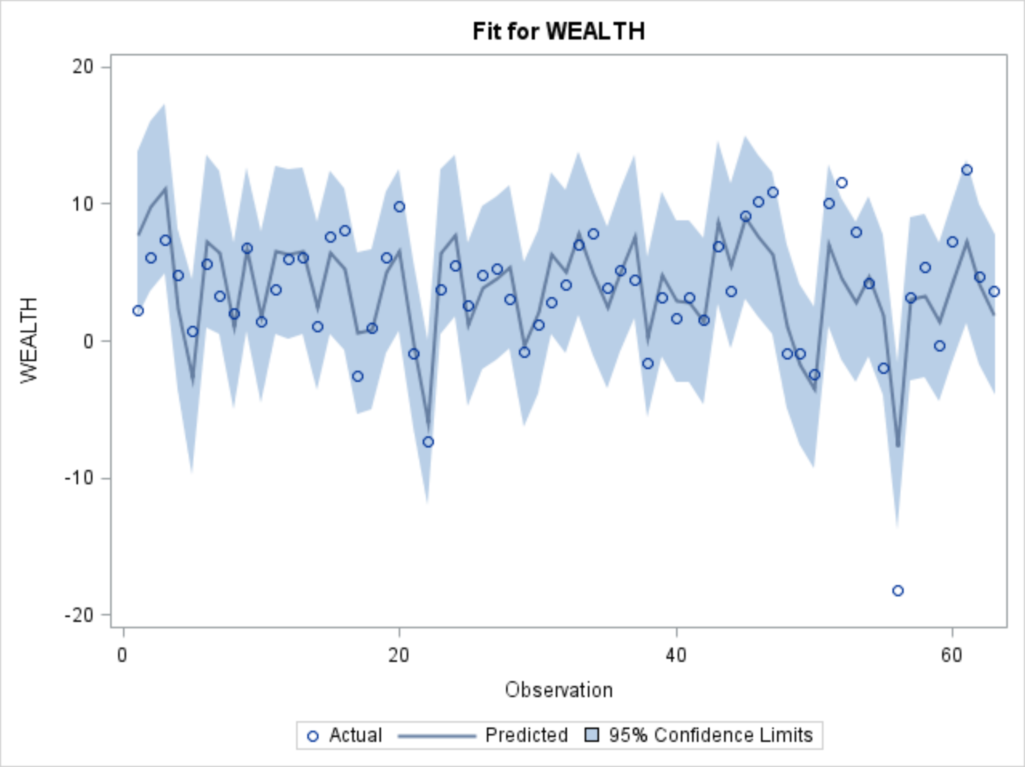
Covariances of Parameter Estimates

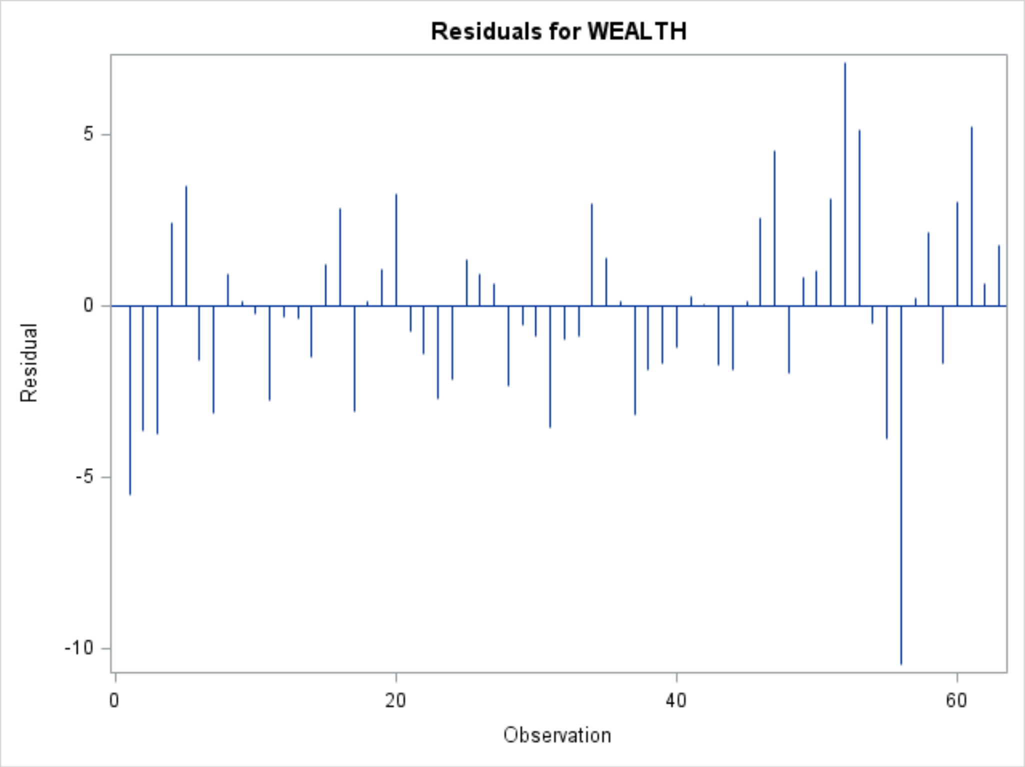
	y	l_y	sp500	l_sp500
y	0.036320	-.016179	-.000458	-.003342
l_y	-.016179	0.020005	-.000468	0.000706
sp500	-.000458	-.000468	0.000378	-.000028
l_sp500	-.003342	0.000706	-.000028	0.000686

Correlations of Parameter Estimates

	y	l_y	sp500	l_sp500
y	1.0000	-0.6002	-0.1237	-0.6696
l_y	-0.6002	1.0000	-0.1700	0.1905
sp500	-0.1237	-0.1700	1.0000	-0.0556
l_sp500	-0.6696	0.1905	-0.0556	1.0000

Durbin-Watson	1.207134
Number of Observations	62
First-Order Autocorrelation	0.383406


Fit for WEALTH
WEALTH
20
10
0
-10
-20
0
20
40
60
Observation
Actual
Predicted
95% Confidence Limits


Residuals for WEALTH
Residual
5
0
-5
-10
0
20
40
60
Observation

Appendix M – Estimated Model with Median Age

The SYSLIN Procedure
Two-Stage Least Squares Estimation

Model	CONSUMPTION
Dependent Variable	c

Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	1	423.9525	423.9525	61.26	<.0001
Error	62	429.0794	6.920635		
Uncorrected Total	63	732.7927			

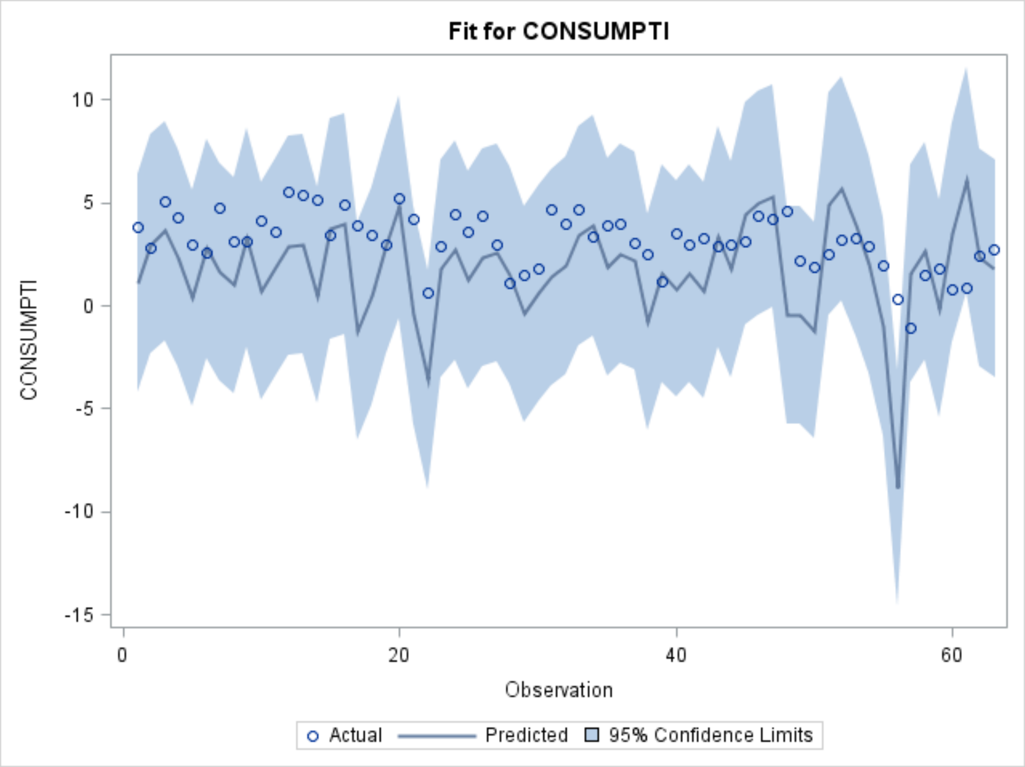
Root MSE	2.63071	**R-Square**	0.49699
Dependent Mean	3.13095	**Adj R-Sq**	0.48888
Coeff Var	84.02271		

Note: The NOINT option changes the definition of the R-Square statistic to:
1 - (Residual Sum of Squares/Uncorrected Total Sum of Squares).

Parameter Estimates						
Variable	**DF**	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**	**Standardized Estimate**
w	1	0.488187	0.062374	7.83	<.0001	1.70388823

Durbin-Watson	1.295914
Number of Observations	63
First-Order Autocorrelation	0.342258

Test for Overidentifying Restrictions			
Num DF	**Den DF**	**F Value**	**Pr > F**
3	59	33.87	0.0001


Fit for CONSUMPTI
CONSUMPTI
10
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-5
-10
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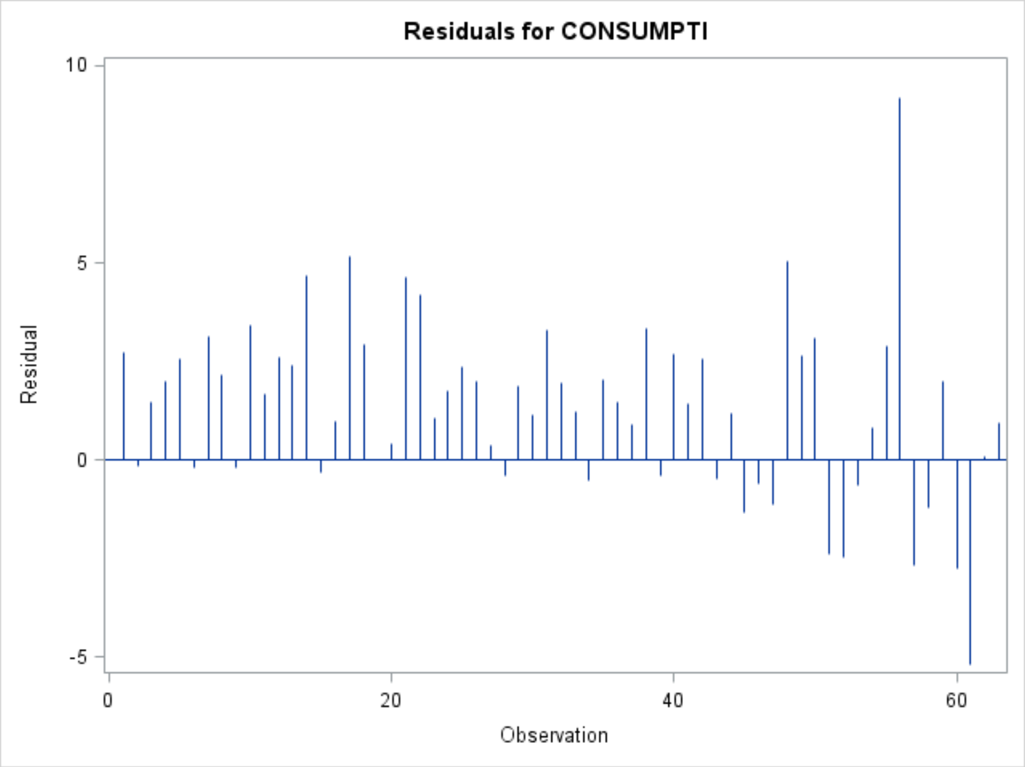
0
20
40
60
Observation
Actual
Predicted
95% Confidence Limits


Residuals for CONSUMPTI
Residual
10
5
0
-5
0
20
40
60
Observation

The SYSLIN Procedure
Two-Stage Least Squares Estimation

Model Crossproducts for each Equation Given By X'X, X'y, y'y					
	y	sp500	age	age2	w
y	905.59	2244.5	70.194	141.611	922.04
sp500	2244.46	28532.0	292.159	588.449	6611.12
age	70.19	292.2	35.987	72.099	84.90
age2	141.61	588.4	72.099	144.451	171.08
w	922.04	6611.1	84.900	171.081	2267.76

X'X Generalized Inverse, Parameter Estimates, and SSE					
	y	sp500	age	age2	w
y	0.00229	-.000068	1.32	-0.66	0.679
sp500	-0.00007	0.000045	0.05	-0.02	0.194
age	1.31723	0.048559	2235.05	-1117.06	182.930
age2	-0.65943	-.024356	-1117.06	558.30	-91.576
w	0.67865	0.193846	182.93	-91.58	496.636

Model	WEALTH
Dependent Variable	w

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	1771.124	442.7811	52.60	<.0001
Error	59	496.6356	8.417553		
Uncorrected Total	63	2267.760			

Root MSE	2.90130	**R-Square**	0.78100
Dependent Mean	3.70385	**Adj R-Sq**	0.76615
Coeff Var	78.33206		

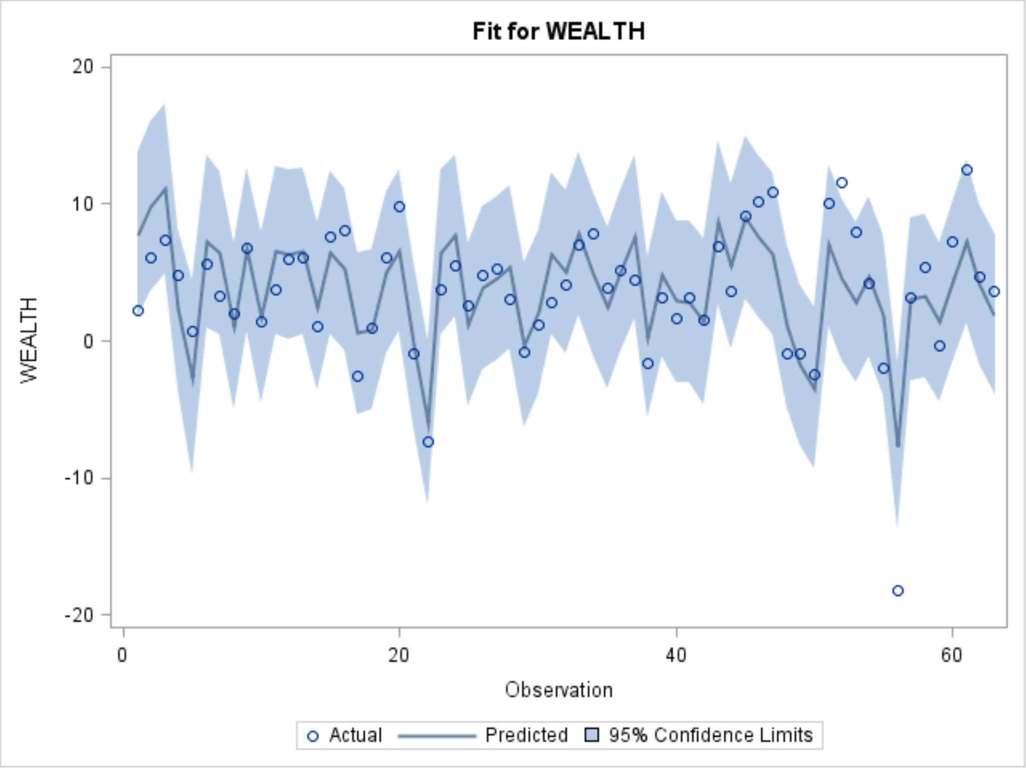
Note: The NOINT option changes the definition of the R-Square statistic to:
1 - (Residual Sum of Squares/Uncorrected Total Sum of Squares).

Parameter Estimates						
Variable	**DF**	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**	**Standardized Estimate**
y	1	0.678646	0.138859	4.89	<.0001	0.31725127
sp500	1	0.193846	0.019567	9.91	<.0001	0.70999340
age	1	182.9303	137.1628	1.33	0.1874	25.88269985
age2	1	-91.5757	68.55326	-1.34	0.1867	-25.91289710

Covariances of Parameter Estimates				
	y	**sp500**	**age**	**age2**
y	0.0193	-.000572	11.1	-5.55
sp500	-0.0006	0.000383	0.4	-0.21
age	11.0879	0.408752	18813.6	-9402.88
age2	-5.5508	-.205017	-9402.9	4699.55

Correlations of Parameter Estimates				
	y	**sp500**	**age**	**age2**
y	1.0000	-0.2107	0.5822	-0.5831
sp500	-0.2107	1.0000	0.1523	-0.1528
age	0.5822	0.1523	1.0000	-1.0000
age2	-0.5831	-0.1528	-1.0000	1.0000

Durbin-Watson	1.238367
Number of Observations	63
First-Order Autocorrelation	0.346668


Fit for WEALTH
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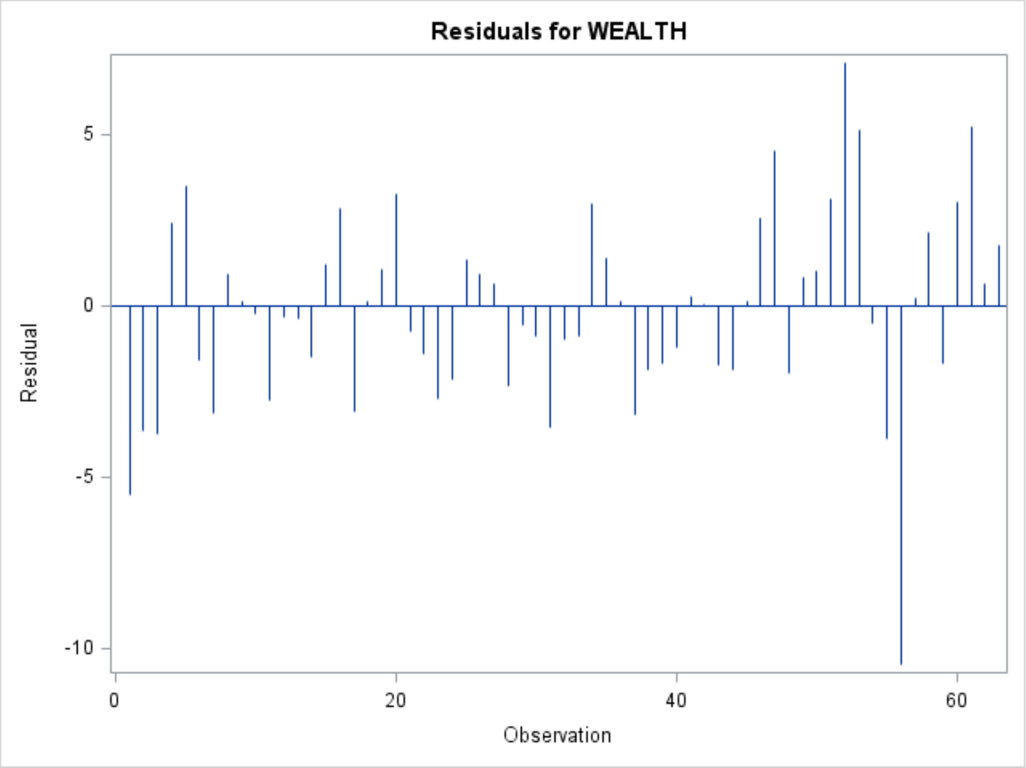
40
60
Observation
Actual
Predicted
95% Confidence Limits


Residuals for WEALTH
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-10
0
20
40
60
Observation