U.S. Consumption Dynamics in the 2007 – 2009 Financial Crisis

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I. Introduction

Consumption equations play a key role in most macroeconomic models of the United States economy,[1] as personal consumption expenditure has accounted for 65 to 70 percent of US aggregate demand since the mid-1990s. However, the well-established behavior of aggregate consumption has deviated from the standard models in the aftermath of the 2007 – 2009 financial crisis. This atypical behavior has renewed academic interest in understanding consumption behaviour, particularly the role played by wealth, as well as less frequently considered factors such as the credit channel and uncertainty.

This study explores the drivers of US consumption during the crisis using an equation based on the standard permanent income/life-cycle hypothesis, augmented to incorporate credit, uncertainty, and different types of wealth. The main findings detailed in the text are as follows:

- Co-integration is found between consumption, income, wealth stocks, credit conditions, and income uncertainty, and the relationship between these variables is modelled well by an error correction process.

- Long-term wealth effects on consumption are estimated at 1.0 and 1.6 percent for financial and housing wealth respectively. Significantly higher effects are found for *housing* wealth, regardless of model specification.

- Changes in wealth and the unemployment rate have significant effects on consumption in the short run.

- The destruction of housing and financial wealth accounts for over half of the observed decline in consumption following the financial crisis, while a combination of credit restrictions and rising uncertainty explains most of the remaining decrease.

- Counterfactual analysis demonstrates the sensitivity of consumption to housing and financial wealth, credit conditions and the unemployment rate, and emphasizes the need to account for these variables in consumption forecasting exercises.

[1] See, for example, the OECD global model (Hervé et al., 2010) and the FRB/US model (Brayton, 1996).

The remainder of the paper is organized as follows: Section II provides an overview of consumption behaviour during the crisis; section III discusses the updated life-cycle model of consumption used throughout the study; section IV describes the dataset; section V explains the empirical framework; section VI presents the econometric results; section VII examines the sensitivity of consumption to wealth, uncertainty, and credit; and section VIII concludes and considers possibilities for future research.

II. Consumption Behaviour during the Crisis

Figures 1 and **2** provide an overview of the unusual behaviour of aggregate consumption during the recent financial crisis, and the motivation behind the present study. First, personal consumption expenditure fell from nearly 94% of disposable income to 89% from 2005 to 2009, marking the departure from the trend of steady increase in the series since the early 1980s (**Figure 1**). As well, the fall was sharper than after any other postwar recession, and the consumption rate was still well below its peak value four years later, whereas historically it had on average recovered by the three-year mark (**Figure 2**).

Although the backdrop for this study is aggregate demand and thus total personal consumption expenditure, it is interesting to briefly note the heterogeneous behaviour of the individual components of consumption: durables, non-durables[2] and services. Typically, expenditure on durables declines during a recession while non-durables and service spending remains fairly steady. However, the most recent recession is notable for an observed decline in all three components of consumption, although the fall in durable spending was still the greatest. Petev et al. (2011) provide a detailed analysis of the

[2] Durables and non-durables are defined as goods expected to last greater/fewer than three years, respectively (Guide to the National Income and Product Accounts of the United States, p. 8).

behaviour of durable, nondurable and service spending during the recession, which is summarized below.

The bulk of the decline in spending within durables is attributable to cars (a 25% decline by the end of 2008), and partly to furniture (10% decline).[3] Within nondurables, gasoline consumption was the main driver, and after 15 quarters was still 12% below pre-recession levels.[4] There was also an unusual decline in food spending, which has raised concerns about the impact of the recession on the average household's living standard.[5] Finally, within services, spending on health services *increased*, but was stable for housing and utilities and declined substantially for transportation services (related to swings in gasoline consumption and prices) and recreation.[6] In sum, the recession led households to reduce spending on all non-necessary items, and perhaps forced some to cut back on fundamental subsistence items as well.

[3] Petev et al. (2011), p. 10.
[4] Gasoline consumption closely follows the oscillation of oil prices, which increased sharply at the start of the recession.
[5] *Ibid.*, p. 11.
[6] *Ibid.*, p. 12.

Figure 1: Historical Consumption Rate

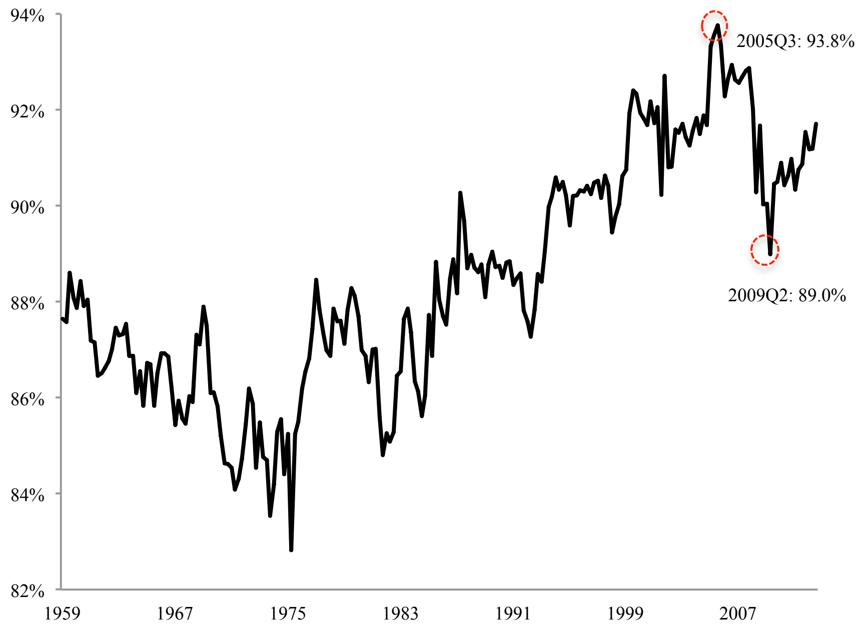
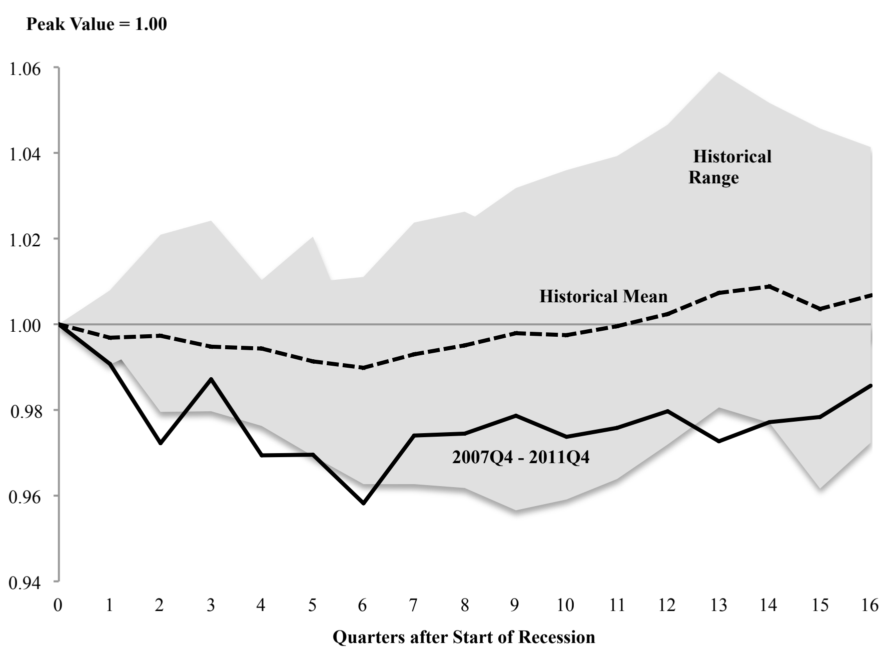


Figure 2: Consumption Rate Compared to Previous Recessions



Note: Historical range/mean includes all recessions after 1960.

III. An Updated Aggregate Consumption Model

In the "textbook" permanent-income/life-cycle consumption model developed through the work of Friedman (1957) and Ando and Modigliani (1963), an individual agent's consumption decision is determined by human wealth (the sum of current and expected future income[7]), non-human wealth, and the real interest rate on savings. Agents have consumption-smoothing preferences and, since available resources decline with age, the propensity to consume out of total resources must increase over time. In the aggregate version of the life-cycle model, the age-specific propensity to consume is replaced with a fixed aggregate propensity to consume, on the grounds that the proportion of the economy's total wealth held by the different age-cohorts of the population is relatively stable over time.[8]

I make three changes to the basic aggregate life-cycle model in order to study the behaviour of consumption during the financial crisis. The variation in housing wealth data has considerably increased since the crisis, making it important to more fully understand the relationship between housing wealth and consumption. Thus, I split total non-human wealth into a housing and a financial component, and test the hypothesis of equivalent "wealth effects."[9] I also include a "credit conditions index" (CCI) and the unemployment rate to capture capital market imperfections and precautionary effects that are largely ignored in the textbook model.

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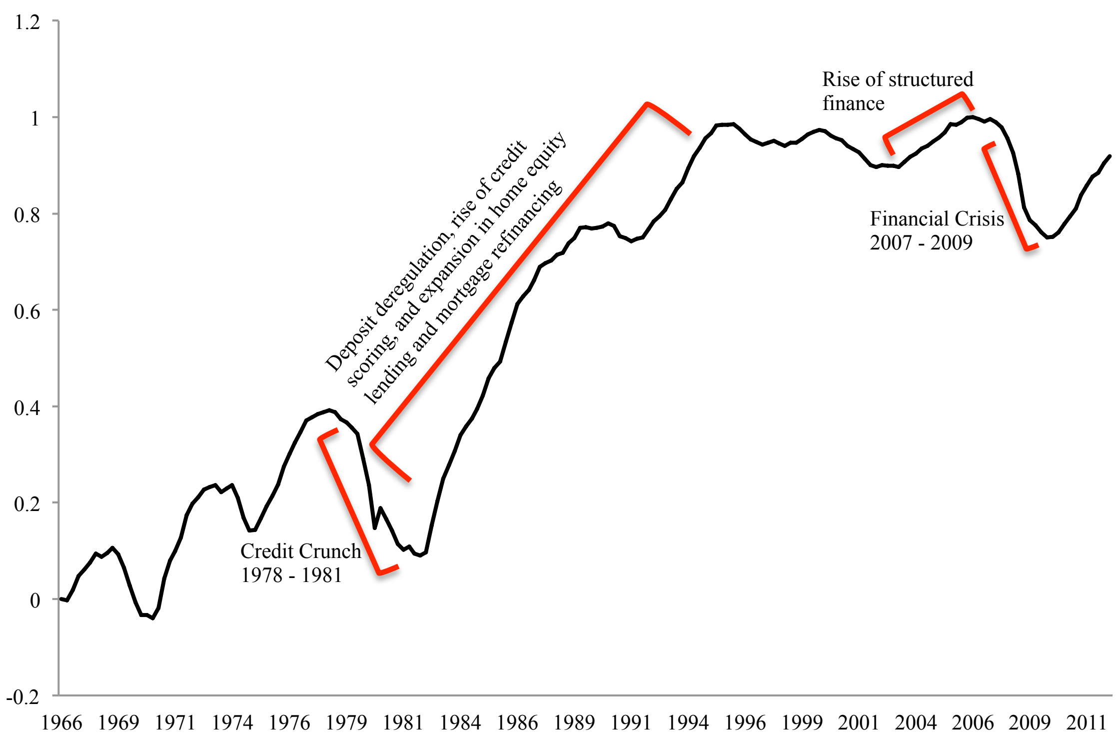
[7] Since current income should generally be expected to remain a constant share of expected future income, as noted by Davis and Palumbo (2001), current income is often used to proxy human wealth in empirical models, including the one presented in this study.
[8] Davis and Palumbo (2001), p. 15.
[9] Wealth effects refer to the effect of exogenous changes in each type of wealth on consumption behaviour (Case (2006), p. 1).

A 2005 European Central Bank study by Altissimo et al. (2005) presents several arguments for why changes in housing wealth may induce a stronger consumption response than changes in financial (in their case, specifically equity) wealth, three of which are summarized here. First, the authors argue that since equity prices are more volatile than house prices, households may find it more difficult to assess whether a change in their equity wealth is permanent or temporary. Therefore, they are likely to be more cautious in adapting consumption plans to changes in equity wealth than in housing wealth. Second, housing wealth is more evenly distributed than equity holdings, which are concentrated among richer households. Since the marginal propensity to consume is known to be lower for these households, the wealth effect observed from equity wealth should be smaller than that of housing wealth. Lastly, differential tax treatment of equity holdings and residential property may raise the perceived liquidity of housing wealth and thus its effect on consumption. For example, in the United States an individual can exclude from his or her reported income up to $250,000 of capital gains on the sale of a primary residence, whereas no similar exception exists for stock holdings. However, as noted in Catte et al. (2004), the effect of higher house prices on wealth is partially or fully offset by the higher cost of present and future housing services consumed, unlike for financial assets. Further empirical work will be necessary before we are able to accurately assess the net effect of these factors.

The addition of the credit conditions index (CCI) is based on the work of Muellbauer (2007) and is meant to control for households' ability to finance consumption through borrowing or refinancing into lower-rate mortgages. Constructed using data on consumer instalment loans, which are typically used to purchase cars, furniture, and large appliances (i.e., durable goods), the CCI ostensibly measures the supply of unsecured (non-mortgage) credit, but also captures movements in the mortgage credit market quite well.[10] The CCI is plotted in **Figure 3**. The index rises quite strongly between 1983 and 1995, matching the phase-out of interest rate controls, rise of credit scoring, and expansion in home equity lending and mortgage refinancing that occurred in the mid-1980s. The index is then relatively flat from 1995 to the mid-2000s, where it again rises notably, coinciding with the peak in structured finance that funded much subprime lending leading up to the financial crisis. During the crisis, the index falls to a similar extent to that seen in the credit crunch of the early 1980s.

Figure 3: Credit Conditions Index



[10] The correlation between the raw series used to construct the CCI, "net percentage of domestic banks reporting increased willingness to make consumer instalment loans," and the corresponding mortgage market indicator, "net percentage of banks tightening standards for mortgage loans," is -0.76.

Finally, the textbook consumption model fails to control for precautionary saving by households in the face of uncertainty regarding future income. To remedy this, I include the current unemployment rate in my model as a proxy for income uncertainty.

IV. Data

This section provides an overview of the quarterly time series data used in the study. All variables are in nominal terms unless indicated otherwise.

Consumption refers to total personal consumption expenditures and is taken from the National Income and Product Accounts (NIPA). Income is measured as personal disposable income and is also from NIPA. Wealth variables refer to the personal sector, which is made up of households and non-profit institutions serving households. Wealth variables are taken from the Federal Reserve Board (FRB) Flow of Funds accounts, Table B.100. Net housing wealth is measured as real estate assets net of mortgages, and net financial wealth is measured as total assets net of real estate and total liabilities excluding mortgages, as in Carroll et al. (2011). The real interest rate used is the 3-month Treasury bill rate, deflated by a two-year moving average of the four-quarter change in the consumer price index (CPI) excluding food and energy, and is also taken from the FRB. The unemployment rate is from the Bureau of Labor Statistics. The CPI series is taken from the Federal Reserve Economic Data (FRED) website.

As in Muellbauer (2007), the credit conditions index (CCI) is built using answers to the Senior Loan Officer Opinion Survey on Bank Lending Practices conducted by the Federal Reserve. It is based on the cumulative value of the net percentage of domestic banks reporting increased willingness to make consumer instalment loans over the past three months,[11] and normalised so that its highest value is 1 (in 2006Q3).

V. Empirical Framework

First, the order of integration of the data is assessed using the Augmented Dickey-Fuller unit root test (Dickey and Fuller, 1979). Each test is run with an intercept and a time trend where noted, and the lag structure is chosen by the Schwarz BIC criterion (Schwarz, 1978). Variable definitions and ADF test statistics are reported in **Table 1** below. The wealth variables are lagged one period as wealth stock valuations reported by the Flow of Funds are only revealed to households at the end of each quarter. Using lagged wealth also avoids some of the potential simultaneity problems involved in studying the relationship between changes in consumption and changes in wealth.[12]

Since most of the variables of interest appear to be I(1), an error correction model (ECM) is used to fit consumption behaviour. The ECM approach is also useful since it captures both the long and short run dynamics of consumption in one model.

[11] More precisely, noting n_t the net percentage of banks indicating more willingness than before, the CCI is built according to the recursive equation: $CCI_0 = n_0$ and $\Delta CCI_t = n_t - 6$, where time 0 refers to the quarter 1966Q3 when the survey was first conducted. The adjustment by -6 is equivalent to a trend adjustment for the cumulative series (Muellbauer (2007), p. 32).

[12] Carroll et al. (2011), p. 8.

Table 1: Augmented Dickey-Fuller Unit Root Tests

Series name	Variable in levels	Test statistic[a]	Variable in first differences	Test statistic[b]	Selected order of integration
Consumption/Income	C	-3.655	ΔC	-10.273	I(1)[13]
Wealth_{-1}/ Income	W	-2.438	ΔW	-11.532	I(1)
Financial wealth_{-1}/ Income	FW	-2.358	ΔFW	-12.65	I(1)
Housing wealth_{-1}/ Income	HW	-3.281	ΔHW	-3.641	I(1)
Credit Conditions Index	CCI	-2.378	ΔCCI	-4.704	I(1)
Unemployment Rate	u	-3.234	Δu	-5.691	I(1)
Real Interest Rate	r	-4.164	-	-	I(0)

Notes:

a. Test run with intercept and time trend.

b. Test run with intercept only.

MacKinnon (1996) critical values are (H_0: series contains a unit root)

For specification with trend and intercept: -4.013 (1%), -3.439 (5%), -3.139 (10%).

For specification with intercept only: -3.483 (1%), -2.885 (5%), -2.575 (10%).

The functional form used for the long run relationship is the log-linearization proposed by Muellbauer and Lattimore (1995), which links the log-ratio of consumption to income to the unlogged ratios of wealth to income, as this is the preferred approach when wealth stocks are disaggregated as in this study.[14] The error correction model is specified as follows:

$$\Delta \ln C_t = -\beta\left(\ln C_{t-1} - \left(\alpha_1 FW_{t-1} + \alpha_2 HW_{t-1} + \alpha_3 CCI_{t-1} + \alpha_4 u_{t-1} + \alpha_0\right)\right) + \delta_1 \Delta \ln W_t + \delta_2 \Delta u_t + \delta_3 r_t + \varepsilon_t \qquad (1)$$

Equation 1 is a variation on the error correction model formulated in Kerdrain (2011). The wealth to income ratios, credit conditions index, and unemployment rate define the long run equilibrium or “co-integrating vector” for the consumption rate, and β

[13] Although the test statistic for the consumption rate lies between the 1 and 5 percent critical values, the autocorrelation function reveals that the sample autocorrelations are very strong and positive and decay slowly, indicating that the process is non-stationary. The autocorrelation function is plotted in **Appendix A**.

[14] See Muellbauer and Lattimore (1995), section 11 for a derivation of the log-linear model of consumption and comparison with the full-log model.

represents the speed of adjustment to long run equilibrium. In the short run, the growth rate of consumption may also be affected by the growth rate of net wealth, the change in the unemployment rate, and the real interest rate. Note that the real interest rate appears outside the co-integrating vector since it is stationary. ε_t is an error term.

Finally, the model as written restricts the elasticity of income with respect to consumption to unity, so to test the validity of this constraint I add the log of real income[15] to the right-hand side of the equation, even though it is already implicitly controlled for in the consumption and wealth ratios. Applying this change yields:

$$\Delta \ln C_t = -\beta\left(\ln C_{t-1} - \left(\alpha_1 FW_{t-1} + \alpha_2 HW_{t-1} + \alpha_3 CCI_{t-1} + \alpha_4 u_{t-1} + \alpha_5 \ln Y_{t-1} + \alpha_0\right)\right) + \delta_1 \Delta \ln W_t + \delta_2 \Delta u_t + \delta_3 r_t + \varepsilon_t \quad (2)$$

Equation 2 is estimated both directly, using the single-equation procedure and the Bewley transformation,[16] and by the Engle-Granger two-step method, which involves estimating the co-integrating vector first and inserting the residuals into the short run equation. Both procedures are estimated using Ordinary Least Squares.

VI. Results

i. Baseline Estimates and Robustness Checks

The first section of **Table 2** reports coefficient estimates and t-statistics[17] for Equation 2, estimated using the single-equation procedure. The speed of adjustment is estimated as -0.39 and is highly significant, suggesting that consumption does follow an error correction process and adjusts to close gaps between target and actual consumption

[15] Deflated by the private consumption deflator, as in Kerdrain (2011).
[16] When the single-equation procedure is used, the estimated coefficient on each long run variable is actually a ratio of the true coefficient over the adjustment parameter, and standard errors and t-statistics are inaccurate. The Bewley transformation re-parameterizes the equation so that correct standard errors can be calculated. See **Appendix B** for details.
[17] Computed using Huber-White robust standard errors.

Table 2: Coefficient Estimates for Equation 2

$$\text{Model}: \Delta \ln C_t = -\beta\left(\ln C_{t-1} - \left(\alpha_1 FW_{t-1} + \alpha_2 HW_{t-1} + \alpha_3 CCI_{t-1} + \alpha_4 u_{t-1} + \alpha_5 \ln Y_{t-1} + \alpha_0\right)\right) + \delta_1 \Delta \ln W_t + \delta_2 \Delta u_t + \delta_3 r_t + \varepsilon_t$$

	1. Baseline		**2. Two-step method**		**3. Alternate Financial Wealth**		**4. Unadjusted CCI**	
Regressor	*Coef.*	*t-stat*	*Coef.*	*t-stat*	*Coef.*	*t-stat*	*Coef.*	*t-stat*
Speed of adjustment	-0.392***	-6.63	-0.387***	-6.94	-0.391***	-6.59	-0.396***	-6.68
FW_{t-1}	0.0104***	3.79	0.0154***	4.39	0.0104***	3.85	0.00827***	3.26
HW_{t-1}	0.0164***	4.75	0.0203***	4.80	0.0168***	4.78	0.0175***	4.78
CCI_{t-1}	0.0311***	5.36	0.0381***	5.42	0.0320***	5.37	0.0565***	5.03
u_{t-1}	-0.160*	-1.71	-0.0526	-0.52	-0.153	-1.62	-0.218**	-2.47
$\ln Y_{t-1}$	0.0287***	8.49	0.0192**	2.21	0.0279***	3.68	0.0127	1.16
Constant	-0.438***	-9.78	-0.392***	-7.53	-0.427***	-9.11	-0.299***	-4.03
$\Delta \ln W_t$	0.136***	4.23	0.141***	4.62	0.136***	4.24	0.134***	4.18
Δu_t	-0.469*	-1.93	-0.406**	-2.21	-0.461*	-1.88	-0.500**	-2.11
r_t	-0.0647**	-2.01	-0.0584**	-2.23	-0.0647**	-2.02	-0.0666**	-2.05
p-value for H_0: $\alpha_1 = \alpha_2$	0.036		0.155		0.025		0.007	
p-value for Chow F test 2007q4	0.264		-		0.266		0.248	
Diagnostics:								
Sample	1966Q4-2012Q3 (for all)							
R^2	0.321		For long-run equation:					
DW	2.26		0.697					
Durbin-h	-0.324							
ADF	-		-6.267[c]					

Notes:

a. *, **, and *** indicate significance at the 1, 5, and 10% levels.
b. All t-statistics based on Huber-White robust standard errors.
c. Computed using the residuals from the long-run equation.

quite rapidly.[18] In the long run, the financial and housing wealth, credit conditions, and unemployment rate coefficients each have the expected signs, and all but the unemployment rate are significant at the 5 percent level. The coefficient on log real income is also significant (and positive), supporting its inclusion on the right hand side of the equation.

The long-term wealth effects for financial and housing wealth are estimated as 1.0 and 1.6 percent, respectively, and the null hypothesis that the two effects are equal is rejected at the 5 percent level.[19] These values are low compared to much of the literature, which typically estimates wealth effects of about 3 to 7 percent without controlling for credit conditions. However, a specification regressing the log consumption rate on just housing and financial wealth (not reported here), increases the estimated wealth effects of housing and financial wealth to 5.1 and 4.5 percent respectively. These results imply that some of what has been interpreted as pure wealth effects in the literature may actually have reflected shifts in uncertainty and credit conditions that are correlated with wealth.

In the short run, the large and highly significant coefficients on the growth rate of wealth and the change in the unemployment rate suggest that household expectations are key drivers of the short-term dynamics of consumption. Uncertainty or the precautionary saving motive appears to have a greater effect on consumption in the short term than in the long term. Lastly, the real interest rate has the correct (negative) sign, and is significant at the 5 percent level.

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[18] $1-(1-.39)^4 = 86\%$ gives the proportion of the gap between actual and target consumption closed within a year.

[19] The finding of larger housing wealth effects than financial is consistent with Catte et al. (2004), Case et al. (2006), Muellbauer (2007), Carroll et al. (2011) and Kerdrain (2011).

The Durbin-Watson (DW) and Durbin-h statistics, which determine the decision rule for first-order serial correlation in the error terms, are included in the regression diagnostics at the bottom of the table. Durbin's h statistic is preferred when the model includes a lagged dependent term, since the DW statistic can give biased results. The reported Durbin-h statistic is -0.32, which is below the 5 percent critical value for the test and suggests that first-order serial correlation is not present in the residuals of Equation 2.

ii. Robustness Checks

Next, several robustness checks are performed on the baseline regression. First, the Chow F test is used to test for a structural break at the start of the financial crisis in 2007Q4, and no break is found (as indicated by the p-value in **Table 2**). Further, Brown's cumulative sum (CUSUM) and CUSUM-squared tests suggest that the estimated coefficients are stable over the entire sample period.[20]

The baseline estimates also prove robust to alternate specifications and methods of estimation. In the second section of **Table 2**, the baseline equation is estimated using the Engle-Granger two-step method rather than the single equation procedure. Although the unemployment rate becomes insignificant in this specification, the remaining coefficients are broadly unchanged. Since the long run relationship is estimated separately here, co-integration tests based on the ADF and DW statistics can be applied. For the DW statistic, the 1% critical value for no co-integration is equal to 0.51,[21] while for the ADF statistic on

[20] The CUSUM test results, shown in **Appendix C**, graph the cumulative sums (cusums) of the recursive residuals and their squares. Since both cusums lie within the 95% confidence bands, indicated in green, the results are consistent with the hypothesis of stability over time (Brown et al., 1975).
[21] Engle and Granger (1987), Table II.

the residuals the 1% critical value is equal to -5.1.[22] The actual statistics reported in the table are 0.7 and -6.3 respectively, so there is strong evidence of a co-integration relationship between the long-run variables included in the baseline equation.

The third section of the table explores the impact of using an alternate definition of wealth. In this model, financial wealth is defined as financial assets net of non-mortgage liabilities, rather than total assets net of non-mortgage liabilities and real estate. Similarly, in the fourth section the raw CCI is used rather than the trend-adjusted version used in Muellbauer (2007). Neither of these changes substantially affects the results obtained under the baseline specification.

Finally, there are several other candidate regressors that were tried but did not turn out to be significant predictors of consumption, including the University of Michigan's Index of Consumer Sentiment and expected income growth series; the Baker, Bloom, and Davis Economic Policy Uncertainty Index; and demographic variables such as the old-age dependency ratio. These results are consistent with Kerdrain (2011) and Carroll et al. (2013).

iii. Model Fit and Crisis Decomposition

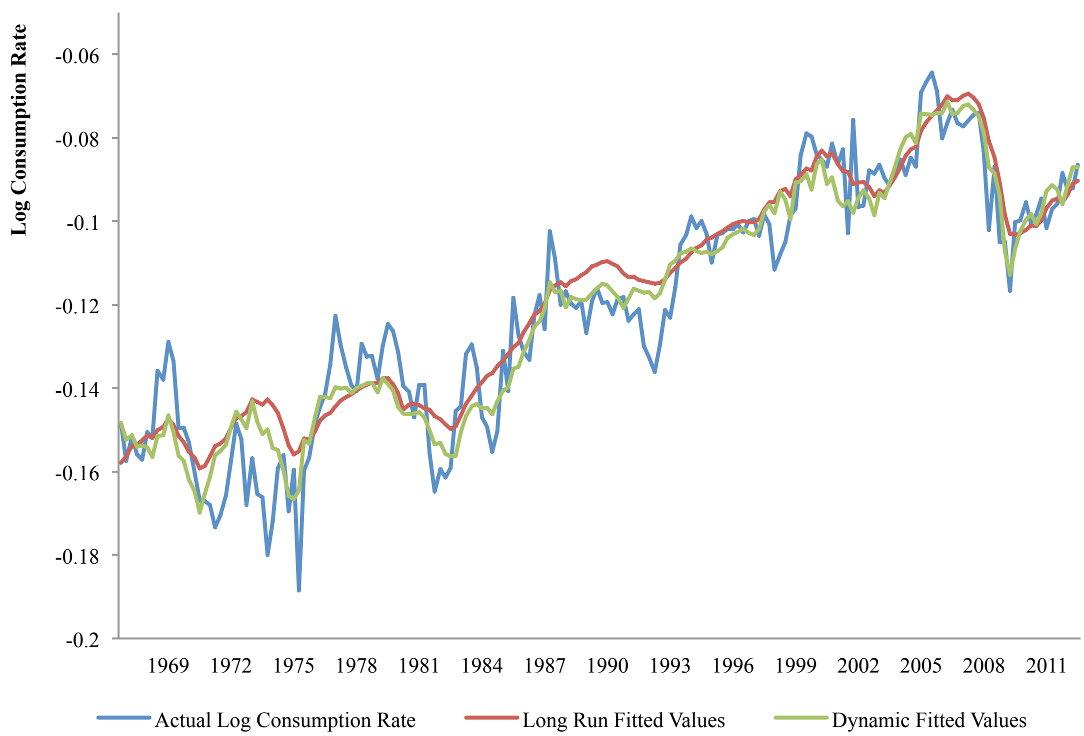
The fit of the baseline model is shown in **Figure 4**. The red line takes into account only the long run relationship, while the green line is a dynamic simulation calculated as follows:

$$C_t^D = -\hat{\beta}(C_{t-1}^D - C_{t-1}^*) + \widehat{\delta_1}\Delta \ln W_{t-1} + \widehat{\delta_2}\Delta u_t + \widehat{\delta_3} r$$

[22] Phillips and Ouliaris (1990), Table IIb.

where C_t^D is the value of the dynamic simulation in period t and C_t^* is the target value of the log consumption rate defined by the long run relationship estimated by Equation 2. Interestingly, both the long run and dynamic models track consumption behaviour more closely in the most recent recession than in previous recessions, for example in 1981 or 1990.

Figure 4: Baseline Model Fit 1966 – 2012



The long run portion of the baseline equation is then used to decompose the explained decrease in the consumption rate during the crisis period. As shown in **Table 3**, the baseline model tracks the fall in consumption during the crisis quite well, capturing around eighty percent of the observed change. Assuming the model is specified correctly, the shocks to net wealth, particularly related to the dramatic fall in house prices, explain just over half of the total decrease in the consumption rate, while the increase in uncertainty related to high unemployment rates and the decline in credit availability account for roughly a quarter each.

Table 3: Actual and Explained Change in Consumption Rate, 2007Q2 – 2009Q2[23]

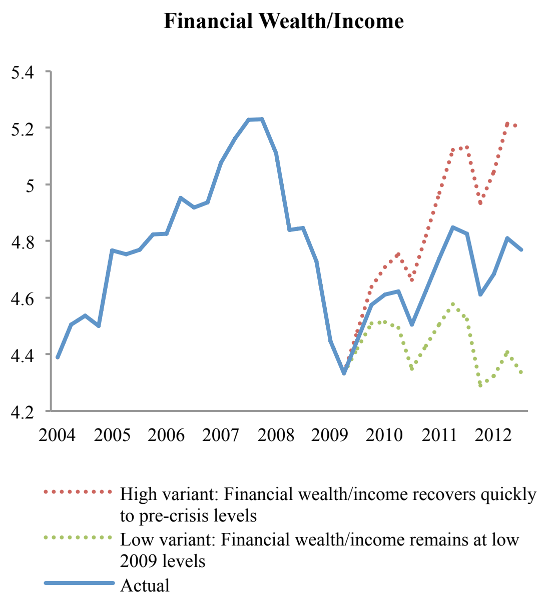
Variable	**Contribution to ΔC**	**Percent of Total**
Financial wealth: $\alpha_1 \times \Delta FW$	0.01 × -83 = -0.86	25.6
Housing wealth: $\alpha_2 \times \Delta HW$	0.016 × -65 = -1.06	31.4
Credit: $\alpha_3 \times \Delta CCI$	0.031 × -22 = -0.69	20.2
Uncertainty: $\alpha_4 \times \Delta u$	-0.16 × 4.8 = -0.77	22.8
Explained ΔC	-3.38	83.0
Actual ΔC	-4.08	

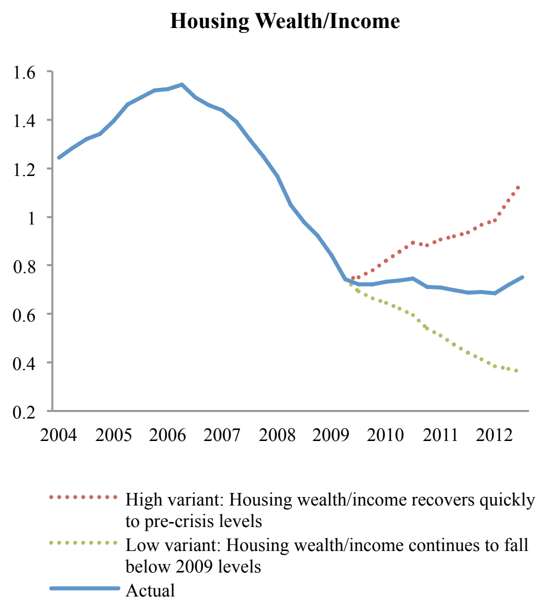
VII. Sensitivity of Consumption to Wealth, Uncertainty, and Credit

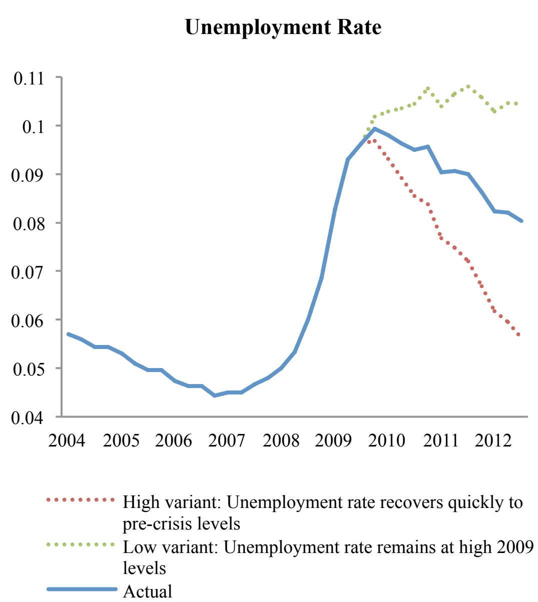
Finally, some implications for consumption forecasting are presented. In order to gauge the size of potential forecasting errors, it is important to understand the sensitivity of the consumption rate to each of its determinants. To this end, I use the dynamic baseline model to evaluate the sensitivity of consumption with respect to housing and financial wealth, uncertainty, and credit under several counterfactual scenarios. The analysis centers on the crisis recovery period,[24] and I vary the paths of the housing and financial wealth series, the credit conditions index, and the unemployment rate according to the scenarios in **Figures 5** to **8**. Each scenario contains a high and low variant. For example, in the high variant for financial wealth, financial wealth as a fraction of income recovers quickly to pre-crisis levels by the end of 2012; in the low variant, it remains fairly constant at low 2009 levels. The scenarios are similar for housing wealth, the CCI, and the unemployment rate.

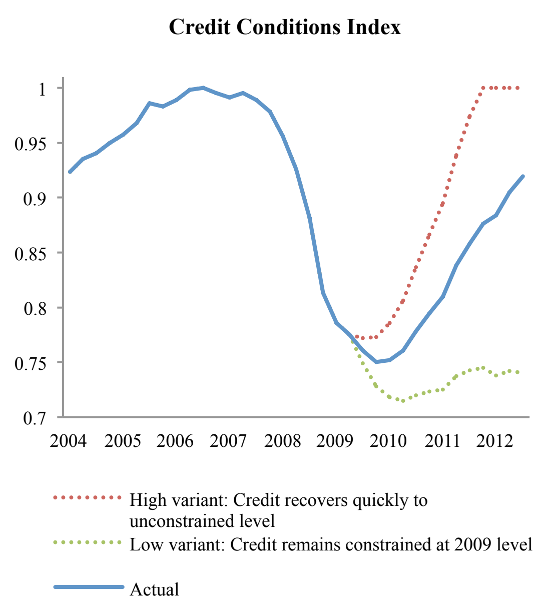
[23] The log real income variable makes very little difference to the explained decrease, so it is excluded here.
[24] Specifically, from 2009Q3 to 2012Q3.

Figures 5 to 8: Alternative Projections Used in the Scenarios



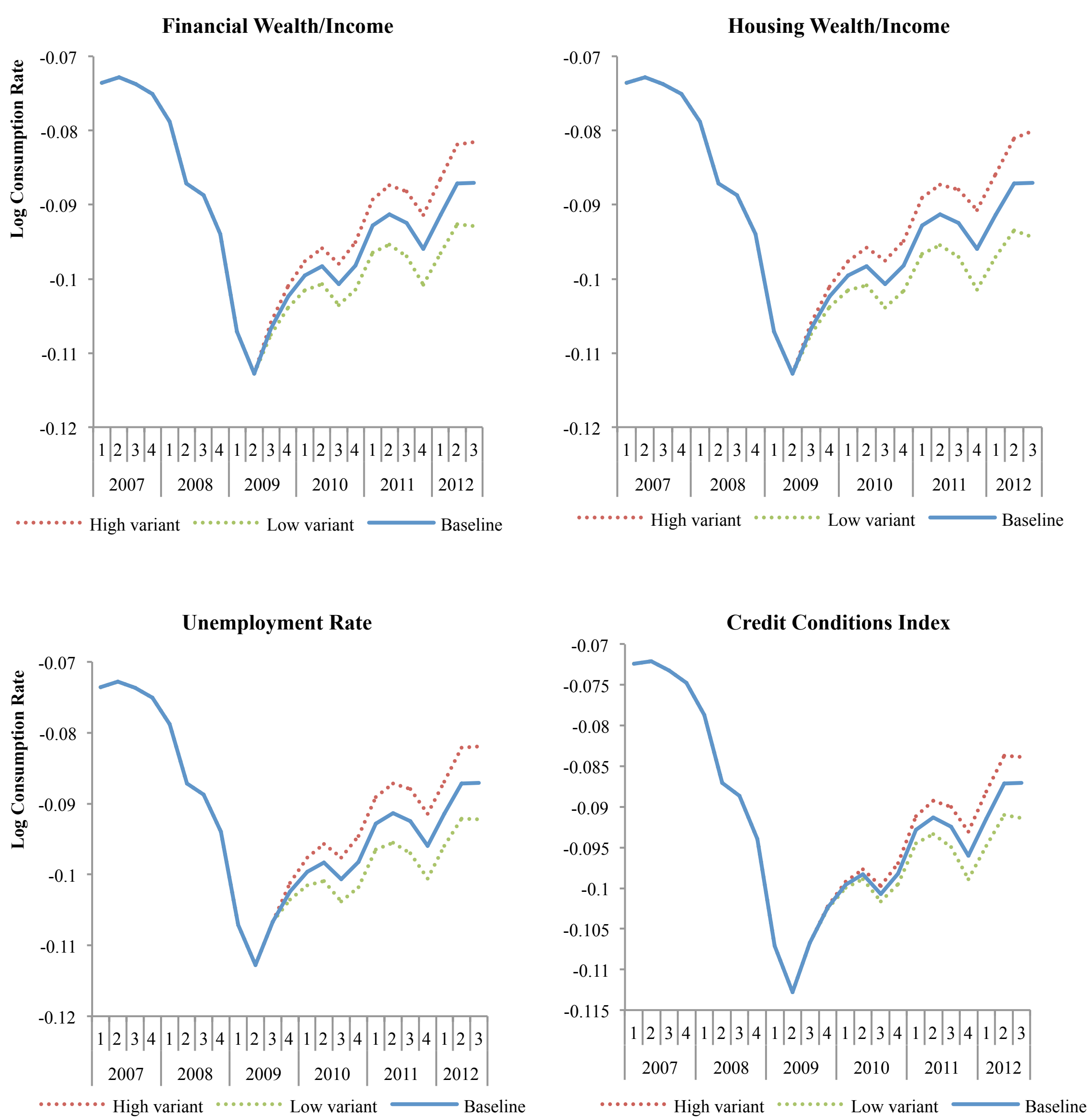






The effects of these alternate scenarios on the consumption rate are explored in **Figures 9** to **12**. The baseline scenario refers to the fitted values of the dynamic model, which are based on the actual values of the variables. The results indicate that the consumption rate is about 1.4 percent higher by the end of the period in the high housing variant than in the low variant. This error falls to about 1 percent for financial wealth and the unemployment rate, and to 0.75 percent for the credit conditions index. These estimates demonstrate the importance of taking all of these variables into account in long and short run consumption forecasting exercises, especially housing wealth, going forward.

Figures 9 to 12: Sensitivity of Consumption to Wealth, Unemployment, and Credit Conditions

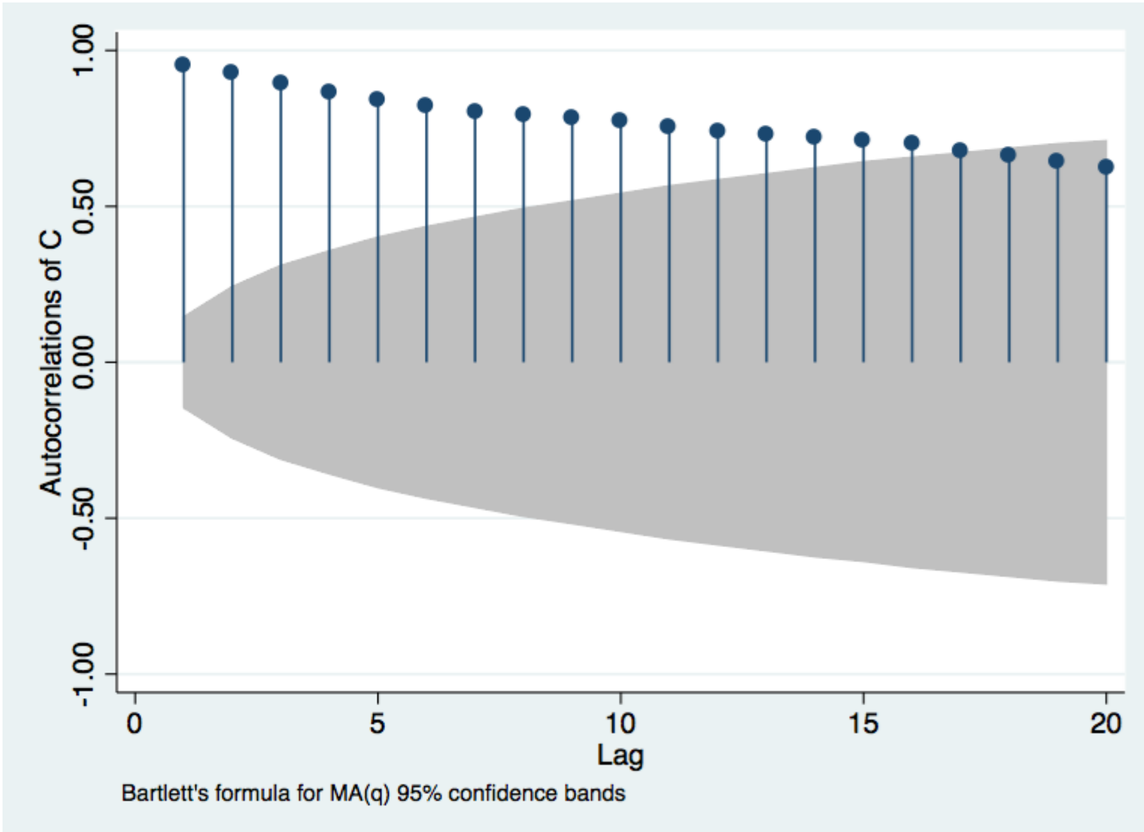


VIII. Conclusion and Further Work

Classical aggregate models of household consumption often use simplified forms of wealth and ignore entirely shifts in credit conditions and income uncertainty. Using an error correction specification that attempts to control for all of these factors, the baseline model formulated in this study tracks the variation in the household consumption rate closely over the last forty-five years, and is able to explain about eighty percent of the fall in the consumption rate during the recent financial crisis of 2007 to 2009. Additionally, the model proves robust to multiple checks such as Chow and CUSUM stability tests and alternate methods of estimation. Exploring the roles of risk aversion, demographics, shifts in national pension schemes, rising income inequality, and changing taxation rates could shed additional light on the results presented in the study.

My baseline estimates suggest that the household consumption rate leading up to the financial crisis was artificially high due to the housing bubble and the corresponding easy availability of credit. Since neither of these factors is likely to return soon, and the unemployment rate may remain elevated for a long time, there seems to be little chance that the personal consumption rate could return to its high pre-crisis value anytime in the near future.

Appendix A: Autocorrelation Function for Consumption Rate



Appendix B: Bewley Transformation

Suppose we have a simple consumption-income ECM:

$$\Delta c_t = \alpha \Delta y_t - \lambda c_{t-1} + \gamma_1 y_{t-1} + \gamma_0 + \varepsilon_{1t} \quad (1)$$

The Bewley transformation is a re-parameterization that directly estimates the long-run effect of income on consumption, $\frac{\gamma_1}{\lambda}$, with the following steps:

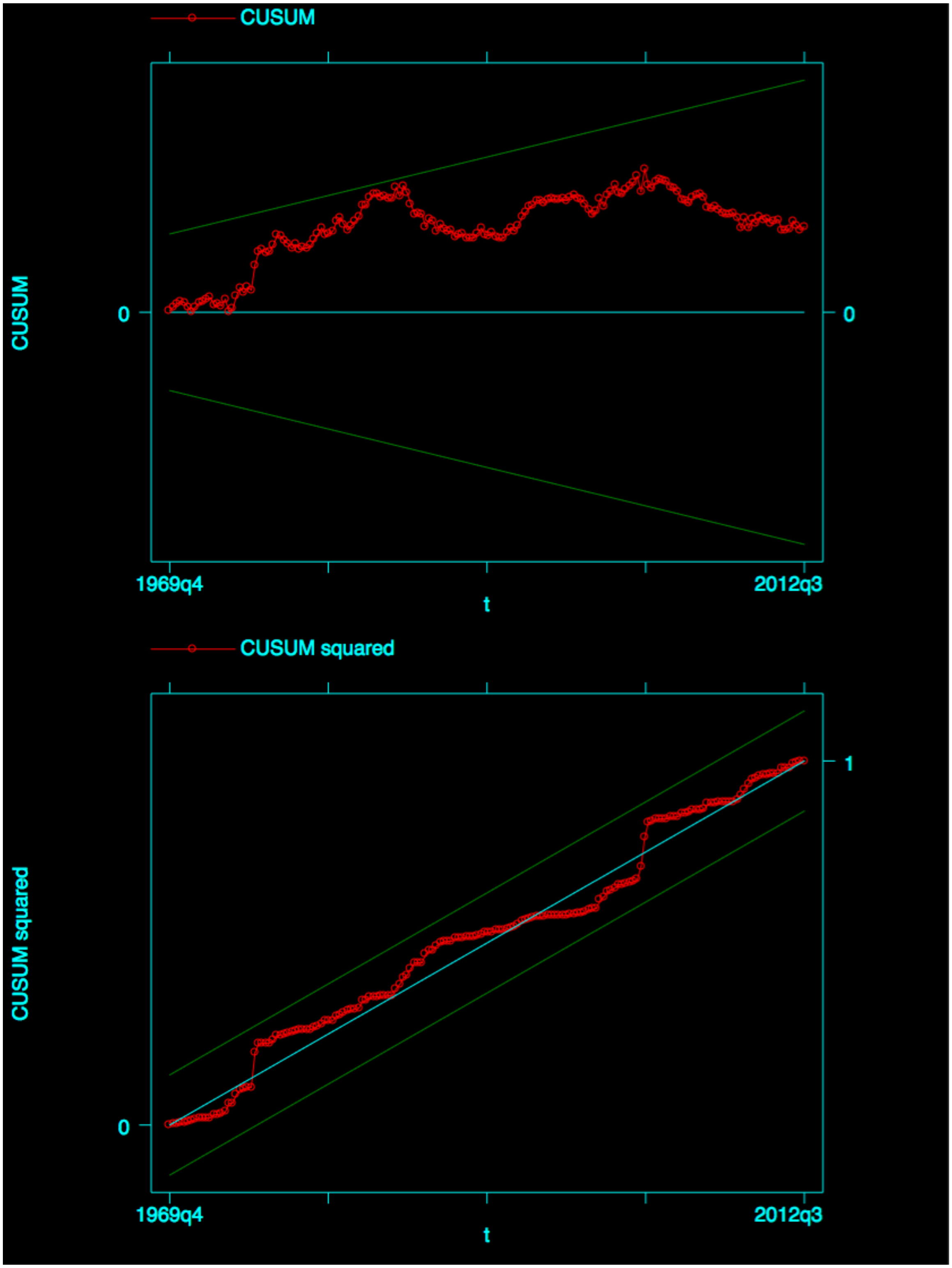
1. Divide both sides by λ:
$$\frac{\Delta c_t}{\lambda} = \frac{\alpha}{\lambda}\Delta y_t - c_{t-1} + \frac{\gamma_1}{\lambda} y_{t-1} + \frac{\gamma_0}{\lambda} + \frac{\varepsilon_{1t}}{\lambda}$$

2. Substitute $c_{t-1} = c_t - \Delta c_t$ and rearrange:
$$\frac{\Delta c_t}{\lambda} = \frac{\alpha}{\lambda}\Delta y_t - (c_t - \Delta c_t) + \frac{\gamma_1}{\lambda} y_{t-1} + \frac{\gamma_0}{\lambda} + \varepsilon_{2t}$$
$$c_t = \left(1 - \frac{1}{\lambda}\right)\Delta c_t + \frac{\alpha}{\lambda}\Delta y_t + \frac{\gamma_1}{\lambda} y_{t-1} + \frac{\gamma_0}{\lambda} + \varepsilon_{2t}$$

3. Estimate the following model, using $\widehat{\Delta c_t}$ (fitted values from Model 1) as an instrument for Δc_t:
$$c_t = \delta_1 \widehat{\Delta c_t} + \delta_2 \Delta y_t + \delta_3 y_{t-1} + \delta_0 + \varepsilon_{2t} \quad (2)$$

Equation 2 directly estimates the long-run coefficient on income so that accurate standard errors and t-ratios can be calculated.

Appendix C: CUSUM and CUSUM-Squared Plots for Equation 2



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