Aggregate Consumption Spending, The Stock Market, and Asymmetric Error Correction

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Abstract
In this study, we show how changes in wealth resulting from unanticipated changes in the value of equity holdings begin a process whereby households alter consumption growth in order to close the gap between actual and target spending. Because of changing uncertainty or equity price volatility over the stock market cycle, we found the time path of this adjustment to exhibit near-random walk behaviour during stock market downturns. Conversely, during ‘boom’ periods, e.g. when the value of equities held by households was greater than the threshold, the growth in consumer spending was quick to eliminate the disparity between actual and target spending.

1. Introduction
Can the economic expansion in the latter period of the 1990s be explained by a burgeoning stock market? Most estimates of stock wealth effects indicate that for every $100k decline in stock market wealth, consumption falls by approximately $3–5k (Duca 2001). Between 1995 and 2000, the personal savings rate fell from 6.5% to 0.3%. During this same period, as the savings rate declined the proportion of household wealth to after tax personal income increased substantially. This rise in the net worth ratio also has obvious implications for changes in consumer spending and the subsequent growth in GDP. While there is controversy amongst economists regarding the magnitude of stock market ‘wealth effects’, the generally accepted hypothesis is that the underlying impact on consumption has risen over time—largely due to the growing popularity of mutual funds (Duca 2001).

The life cycle model has been used by economists to provide a theoretical basis for the relationship between consumption, income and wealth (Ando and Modigliani 1963). The theory predicts that non-structural changes in wealth could vary over time, but spending would be relatively stable (Davis and Palumbo 2001). Consumers will only devise a new plan that involves higher future spending if there is an unexpected change in wealth (Davis and Palumbo 2001). Thus, the life cycle theory would predict that the rise in household spending experienced between 1995 and 1999 was the result of an adjustment to unexpected changes in wealth, e.g., the appreciation in equity prices.

In this paper, both the short- and long-run behaviour of the relationship between aggregate consumption spending and the wealth of US households will be analysed. Our primary interest will lie with the dynamic behaviour of this relationship—e.g., if actual consumption is above or below target consumption, will this ‘gap’ be eliminated more or less rapidly during periods of a stock market boom (or bust)? Moreover, during this same period, will households alter consumption growth over the short-run or transitory period to allow actual spending to adjust to target or planned spending? These are important issues, since any theory that purports to explain consumption behaviour would predict that the gap between actual and target spending should be eliminated rapidly. In addition, we believe that the reason prior research...


National income and product accounts.
on this topic has yielded mixed results regarding the detection of a long-run relationship among consumption, income and wealth may be because of the tendency of these variables to display asymmetric error correction towards a cointegrating relationship (for reasons to be discussed below).

2. Literature review

There has been much written about the theoretical underpinnings and the empirical relationship between consumption and the effects of the stock market on household behaviour in the literature (Dynan and Maki 2000, Kiley 2000, Poterba 2000, Shivani and Wilbratte 2002, Starr-McCluer 2002). Although there have been differing empirical results, the consensus of the most recent literature has been that wealth in the form of stock ownership does indeed influence consumption and this stock wealth effect has increased significantly in the 1990s. The magnitude of the empirical estimates is about a three to seven cent increase in consumption given a dollar increase in stock wealth.

It is important to note that, in this paper, we are concerned neither with the existence nor the magnitude of the stock market effect on consumption. As mentioned previously, there has already been a wealth of research on these topics. Rather, the approach taken here is to examine the nature of the dynamic response of consumer spending to changes in equity prices. It is not surprising that there are some econometric problems associated with many of these analyses of the consumption–wealth relationship that have not been adequately addressed in the literature. For instance, in a review of the statistical approach taken here is to examine the nature of the dynamic response of consumer spending to changes in equity prices. It is our contention that perhaps another approach is one explanation for the failure of consumption to respond to the 1987 stock market crash and the 1998 fall in equity prices. It is our contention that perhaps another explanation for this phenomenon may be that households resist decreases in spending because of the uncertainty and volatility that exists in equity prices during stock market downturns. This will be discussed shortly.

Equations (1) and (2) represent two alternative long-run consumption equations, while equation (3) is an error-correction model. Davis and Palumbo (2001) conclude, on the basis of the estimation results for (1) and (2), that the long-run relationships between consumption, income and wealth are consistent with a wealth effect of three to six cents to the dollar, depending upon the model specification. This translated into additional consumer spending from 1995 to 1999 of approximately $250 billion to $500 billion. They further conclude that there are really no ‘short-run’ effects involving changes in consumption, income and wealth (equation (3))—only increases in income and wealth that are sustained for long periods of time, such as the performance of the stock market from 1995 to 1999, noticeably affect consumption spending (Davis and Palumbo 2001).

Unfortunately, a problem with their approach and the corresponding conclusions that are reached was the inability to estimate a ‘stable’ error-correction model. In the absence of an error-correction relationship, it would be impossible to tell whether consumption moves in response to changes in wealth or whether the estimates reflect the changes in wealth due to a change in consumption. In addition, it was also unclear as to whether or not cointegration tests were run and the nature of these tests. This should be mentioned, since the tests we present in the next section yield results that conflict with some of the results presented by Davis and Palumbo (2001). An earlier study of the consumption–wealth relationship indicates that the results and conclusions drawn by Davis and Palumbo (2001) may indeed be problematic. Using the model (variables are expressed as per capita values):

\[ C_t = \alpha_0 + \alpha_1 Y_t + \alpha_2 W_t + u_t, \] 

and utilizing both the Phillips–Ouliaris (1990) and the Johansen (1996) procedure, Ludvigson and Steindel (1998) have failed to reject the null hypothesis of no cointegration among consumption, income and wealth. In addition, various specifications of equation (4) are estimated (first differences, log transformations), and some techniques are incorporated such as instrumental variables. They conclude that there is no stable relationship among the variables in equation (4), and therefore the ‘jury is still out’ concerning the stock market affect on consumption. Of course, the results presented in the Ludvigson–Steindel (1998) article were based upon the model as specified in equation (4)—cointegration tests were not performed for any other models.

Lettau et al (2001) further argue that the approach taken by Davis and Palumbo (2001) is problematic because their use of a single regression equation yielded incorrect estimates of the adjustment parameter. Once the dynamic response of all interrelated variables is taken into account and all conditioning variables are properly incorporated, they find that consumption spending adjusts to movements in wealth not over many quarters, but within the span of one quarter (Lettau et al 2001). Alternatively, Lettau and Ludvigson (2003) find that quarterly oscillations in asset values are predominantly due to transitory variations that are not associated with consumption spending—only permanent changes in wealth affect consumption. Cointegration is used to identify the permanent and transitory components of consumption, wealth and labour earnings. The authors point to the fact that their approach is one explanation for the failure of consumption to respond to the 1987 stock market crash and the 1998 fall in equity prices. It is our contention that perhaps another explanation for this phenomenon may be that households resist decreases in spending because of the uncertainty and volatility that exists in equity prices during stock market downturns. This will be discussed shortly.
In this paper, we first perform tests of cointegration on four model specifications. Moreover, given that a change in wealth may be ‘large’ because of a sustained change in the value of equity holdings, there will be disequilibrium among the consumption, income and wealth relationship. Unplanned changes in wealth due to a sudden change in equity values may perturb the long-run equilibrium adjustment, causing the process to exhibit more (or less) hysteresis during a period of changing equity prices (see below). If this is the case, then the standard cointegration tests are misspecified and we will utilize an alternative specification that involves estimating a modification of the momentum threshold autoregressive (M-TAR) model applied in a multivariate context (Enders and Siklos 2001). Following this allowance for asymmetric adjustment, an error-correction model will be estimated.

There remains a question as to why consumers react in an asymmetric fashion to changes in the stock market. One explanation may lie in the volatility or uncertainty that exists in equity prices during stock market downturns. Since consumers are also investors, changing uncertainty in equity markets may affect the level of spending and its time path. According to Mishkin (1997), stock market crashes increase asymmetric information in such a way that there is interference with the flow of funds channelled to economic activity. Increased uncertainty or price volatility leads to enhanced adverse selection, since lenders cannot distinguish ‘good’ from ‘bad’ borrowers—leading to a decline in lending, borrowing and spending. The rise in asymmetric information will also affect the time path towards the lower target spending level. Thus, during stock market downturns more uncertainty would be associated with increased hysteresis in consumer spending, while during periods of rising equity prices less uncertainty would lead to a smoother adjustment process—eliminating the gap between actual and target spending relatively quickly.

Another explanation that would rationalize why consumption is ‘sticky’ in the downward direction during periods of falling equity prices is presented in Sundaresan (1989). He invokes the notion of ‘habit persistence’—when a consumer’s utility depends on the consumption history. Simulating consumption over a period of time, it was found that a general equilibrium model with non-separable utility functions generated more ‘sticky’ consumption than a model in which the utility functions were separable (Sundaresan 1989). However, it is important to keep in mind that this study essentially involves a simulation with no empirical testing and allowances were not made for any non-linear adjustment mechanisms.

3. Empirical specifications

We begin by applying both single and multiple equation standard cointegration tests to four different sets of consumption models that have appeared in the literature. The results are presented in table 1. In applying the augmented Dickey– Fuller (ADF) residual-based method, we use the Phillips–Ouliaris critical values (Phillips and Ouliaris 1990), to test the null hypothesis of no cointegration. The hypothesis is not rejected for each set of variables, except for the first specification involving the ratio of consumption to income (albeit at the $\alpha = 0.10$ level). In using this approach, we estimated the four models by using a dynamic regression to achieve estimates of the cointegrating parameter (Phillips and Hansen 1990). It is interesting to note that our results contrast with what was found by Lettau and Ludvigson (2003). But, we believe that there are problems with their results.

It is important to note that while the first model involving the ratio of consumption to income was found to be marginally significant at $\alpha = 0.10$ for the residual based test, we failed to reject the null of no cointegration for this model using the Johansen (1996) system based test. In fact, the alternative hypothesis of one cointegrating relationship is never accepted for every set of variables in table 1. The general inability to reject the null hypothesis of no cointegration among these variables is not surprising. As mentioned by Enders and Siklos (2001), these cointegration tests and their extensions are misspecified if adjustment to the long-run equilibrium relationship is asymmetric.

A number of studies have indicated that many macroeconomic time series, such as GDP, unemployment, etc., display asymmetric adjustment over the course of the business cycle (Teravanij and Anderson 1992, Sichel 1993, Beaudry and Koop 1993, Ramsey and Rothman 1996, Bradley and Jensen 1997). In addition to these univariate approaches, Granger and Lee (1989), Siklos and Granger (1997), Balke and Fomby (1997), and Enders and Granger (1998) have all examined the process of non-linear adjustment in a multivariate structure. We will use the cointegration test developed by Enders and Siklos (2001) that recognizes the possibility of asymmetric error correction and threshold adjustment. If the hypothesis of no cointegration is rejected using this method, we will then estimate an error-correction model incorporating the threshold effect. It is important to note that one limitation of this approach is the a priori assumption that there is only one cointegrating relationship among consumption, wealth and income. If there are more cointegrating relationships, then it is likely that the model would suffer from misspecification error.

We identify the long-run relationship among consumption, income and wealth as

$$f(C_t) = \beta_0 + \beta_1 f(Y_t) + \beta_2 f(W_t) + \epsilon_t. \quad (5)$$

The $f(\cdot)$ notation denotes a function and is a realization that we have four sets of variables and thus four different models.

5 It should be noted that although the null of no cointegration is rejected for this model, when the system based approach is used, the alternative hypothesis of one cointegrating relationship is not accepted.

6 We included a differenced term at lag one, zero and a differenced term of lead one for each explanatory variable which amounted to eight explanatory variables altogether for each model.

7 Lettau and Ludvigson (2003) did not take into account that there were three regressors when using the table of Phillips–Ouliaris critical values. Correctly determined, the null hypothesis of no cointegration would be rejected at $\alpha = 0.10$, not at $\alpha = 0.01$ as is reported in their paper.

8 Once again, Lettau and Ludvigson (2003) find in favour of one cointegrating relationship using an L-max test with one lag. However, the AIC value was smaller for the model using two lags which would yield a conclusion of zero cointegrating relations. We found a model with four lags to be the best according to the AIC criterion.
The rise in equity prices has an effect on long-run equilibrium, since the interest is in determining whether a sudden, sustained plateau can be written as a momentum threshold autoregressive (M-TAR) process:

\[ \Delta \varepsilon_t = \delta_1 I_{\varepsilon_{t-1}} + \delta_2 (1-I)_{\varepsilon_{t-1}} + \sum_{i=1}^{p} \delta_i \varepsilon_t \Delta \varepsilon_{t-i} + \eta_t \]  

(6)

where

\[ I = 1 \quad \text{if} \quad \Delta q_{t-1} \geq \lambda, \]

\[ I = 0 \quad \text{if} \quad \Delta q_{t-1} < \lambda. \]

\( \delta_1 \) is any known function of the data and \( \lambda \) is the threshold. Since the interest is in determining whether a sudden, sustained rise in equity prices has an effect on long-run equilibrium, \( \varepsilon_t \), we will set \( \Delta q_{t-1} = \Delta S_{t-1} \). \( S_t \) is the value of corporate stock and mutual funds held by households. If consumption, income and wealth are not cointegrated, then there is no threshold, \( \lambda \), and the value of \( \delta_1 = \delta_2 = 0 \). Under these conditions, the nuisance parameters are not identified under the null hypothesis, so inference is complex. Fortunately, Enders and Siklos (2001) have developed a method through Monte Carlo simulation that can be utilized to test the null hypothesis of no cointegration versus the alternative of cointegration with a threshold. In the presence of asymmetry, the power of the M-TAR test that is developed by Enders and Siklos (2001) is greater than the Engle–Granger (1987) approach (Enders and Siklos 2001).

In order to apply the Enders–Siklos (2001) method, we had to make some additions and slight changes to their method.\(^9\) Under the null hypothesis of no cointegration, the following random walk processes were simulated:

\[ y_{1t} = y_{1t-1} + \varepsilon_1, \]

\[ y_{2t} = y_{2t-1} + \varepsilon_2, \]

\[ y_{3t} = y_{3t-1} + \varepsilon_3, \]

\[ y_{4t} = y_{4t-1} + (y_{1t} - y_{2t}) + \Delta y_{3t} \]

(8)

The error terms, \( \varepsilon_t \), are all standard normal variates. The last series, \( y_{4t} \), simulates wealth accumulation by households and represents the wealth accumulation identity.\(^{11}\) The second term, \( y_{1t} - y_{2t} \), represents household savings, and the third term, \( \Delta y_{3t} \), simulates the capital gain or loss of mutual fund and corporate stock holdings. The Monte Carlo simulation was repeated 50,000 times. For each of the 50,000 trials, the equation

\[ y_{1t} = \beta_0 + \beta_1 y_{2t} + \beta_2 y_{4t} + \varepsilon_t \]

(9)

was estimated and the residuals, \( \hat{\varepsilon}_t \), obtained. Since the threshold, \( \lambda \), is not known, it must be estimated using the methodology developed by Chan (1993). \( \Delta y_{3t} \) is sorted in ascending order, \( \Delta y_{31} < \Delta y_{32} < \Delta y_{33} < \cdots < \Delta y_{3T} \) (the top and bottom 15% were excluded to ensure that the model is identified for all thresholds). For each possible threshold, equation (6) was estimated (using the residuals from...
equation (9)) with possible lag lengths of zero, one and four and incorporating (7). The model with the lowest sum of squared errors also yielded a consistent estimate of the threshold, $\lambda$. Using this model and for each trial, the $F$ statistic for the hypothesis $\delta_1 = \delta_2 = 0$ was recorded. The critical values of the nonstandard $F$ statistic for $T = 50$, 100 and 200 are reported in table 2 and they can be used to test the null hypothesis of no cointegration versus the alternative hypothesis of an M-TAR model.

4. Empirical results

4.1. Long-run behaviour

In order to determine whether consumption, income and wealth are cointegrated and, analogously, whether a sudden, sustained rise in equity prices has an effect on long-run equilibrium, we estimated equations (5) and (6) using data for each of the variable sets in table 1. The parameter estimates for the long-run regressions are in table 3. The equations were estimated using the Phillips–Hansen (1990) method which amounts to including a differenced term at lag one, zero and a differenced term of lead one for each explanatory variable. As was found in previous studies, the wealth effect coefficients in equations (1), (2) and (4) (table 3) indicate that consumption increases by approximately four cents for every dollar increase in wealth.

The residuals from each of the models in table 3 were utilized to construct equation (6) and, since the value of $\lambda$ is unknown, we used Chan’s (1993) technique to find a consistent estimator of the threshold. The change in equity value variable, $\Delta S_{t-1}$, was sorted in ascending order, $\Delta S_1 < \Delta S_2 < \Delta S_3 < \cdots < \Delta S_T$, with the top and bottom 15% of the observations excluded. Equation (6) was then estimated for each possible threshold by incorporating the indicator function (7) and the model with the smallest error sum of squares yielded the consistent estimate of the threshold, $\hat{\lambda}$. The results of this procedure for each of four models may be found in table 4 for $\hat{\delta}_1$, $\hat{\delta}_2$, $\hat{\epsilon}_2$ and $\hat{\epsilon}_4$, respectively, which represent the residuals of the four models presented in table 3.

First and foremost, our original supposition concerning the possibility of asymmetric error correction towards a cointegrating relationship among consumption, income and wealth is supported by the empirical evidence. Comparing the $F$-statistics in table 4 with the non-standard critical $F$ values in table 2, the null hypothesis of no cointegration or, more formally, $\delta_1 = \delta_2 = 0$ is rejected in favour of the specific M-TAR alternative for each model. Once the alternative hypothesis of cointegration with an M-TAR threshold is accepted, we may then proceed to test for symmetric versus asymmetric adjustment. The null hypothesis of $\delta_1 = \delta_2$ can be tested utilizing the standard $F$-distribution. In each model, the null hypothesis of symmetric adjustment is rejected in favour of asymmetric adjustment. In sum, it appears that consumption, income and wealth are cointegrated (as is implied by the life cycle theory) but that the adjustment from long-run equilibrium is asymmetric. However, it is the nature of this adjustment process that requires some further discussion.

Table 3. Long-run parameter estimates.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std error</th>
<th>t-statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.696999</td>
<td>0.010824</td>
<td>64.39235</td>
<td>0.0000</td>
</tr>
<tr>
<td>$Y_t^f / Y_t$</td>
<td>0.033730</td>
<td>0.025047</td>
<td>1.346667</td>
<td>0.1798</td>
</tr>
<tr>
<td>$W_{t-1} / Y_t$</td>
<td>0.040959</td>
<td>0.002026</td>
<td>20.03521</td>
<td>0.0000</td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.648324</td>
<td>0.010480</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S.E. of regression</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>$-0.493893$</td>
<td>0.022222</td>
<td>$-22.22551$</td>
<td>0.0000</td>
</tr>
<tr>
<td>$\ln(Y_t)$</td>
<td>0.774125</td>
<td>0.010807</td>
<td>71.63405</td>
<td>0.0000</td>
</tr>
<tr>
<td>$\ln(W_{t-1})$</td>
<td>0.228952</td>
<td>0.010676</td>
<td>21.44565</td>
<td>0.0000</td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.999403</td>
<td>0.011686</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S.E. of regression</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>$-0.000191$</td>
<td>6.41E–05</td>
<td>$-2.983902$</td>
<td>0.0032</td>
</tr>
<tr>
<td>$Y_t / P_t$</td>
<td>0.705837</td>
<td>0.009863</td>
<td>71.56537</td>
<td>0.0000</td>
</tr>
<tr>
<td>$W_{t-1} / P_t$</td>
<td>0.041375</td>
<td>0.001887</td>
<td>21.92965</td>
<td>0.0000</td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.997869</td>
<td>0.000224</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S.E. of regression</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>$-24.59659$</td>
<td>7.361239</td>
<td>$-3.341365$</td>
<td>0.0010</td>
</tr>
<tr>
<td>$Y_t$</td>
<td>0.707270</td>
<td>0.010440</td>
<td>67.74414</td>
<td>0.0000</td>
</tr>
<tr>
<td>$W_t$</td>
<td>0.040837</td>
<td>0.002147</td>
<td>19.01639</td>
<td>0.0000</td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.999218</td>
<td>38.26531</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S.E. of regression</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hansen (1997) has shown that inferences concerning the individual estimates of $\delta_1$ and $\delta_2$ are problematic in finite samples and recommends using more conservative confidence regions.
Table 4. Threshold models.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std error</th>
<th>$t$-statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_t \cdot \hat{\delta}_1$</td>
<td>-0.181 300</td>
<td>0.059 641</td>
<td>-3.039 855</td>
<td>0.0027</td>
</tr>
<tr>
<td>$(1 - I_t) \cdot \hat{\delta}_{1t-1}$</td>
<td>-0.050 234</td>
<td>0.015 539</td>
<td>-3.232 769</td>
<td>0.0015</td>
</tr>
<tr>
<td>$\Delta \hat{\delta}_{1t}$</td>
<td>-0.194 697</td>
<td>0.082 710</td>
<td>-2.353 976</td>
<td>0.0196</td>
</tr>
</tbody>
</table>

Dependent variable: $\Delta \hat{\delta}_{1t}$

Included observations: 188 after adjusting endpoints

| $I_t \cdot \hat{\delta}_2$ | -0.133 483 | 0.041 991 | -3.178 848 | 0.0017 |
| $(1 - I_t) \cdot \hat{\delta}_{2t-1}$ | -0.047 585 | 0.015 397 | -3.090 537 | 0.0023 |

Dependent variable: $\Delta \hat{\delta}_{2t}$

Included observations: 189 after adjusting endpoints

| $I_t \cdot \hat{\delta}_3$ | -0.122 436 | 0.033 040 | -3.705 673 | 0.0003 |
| $(1 - I_t) \cdot \hat{\delta}_{3t-1}$ | -0.169 276 | 0.095 981 | -1.763 653 | 0.0794 |

Dependent variable: $\Delta \hat{\delta}_{3t}$

Included observations: 189 after adjusting endpoints

| $I_t \cdot \hat{\delta}_4$ | -0.151 908 | 0.074 960 | -2.026 522 | 0.0441 |
| $(1 - I_t) \cdot \hat{\delta}_{4t-1}$ | -0.031 298 | 0.010 800 | -2.897 963 | 0.0041 |

Dependent variable: $\Delta \hat{\delta}_{4t}$

Included observations: 189 after adjusting endpoints

As may be noted in all of the dynamic models in table 4 (except the per capita model residuals $(\hat{\delta}_3)$), the relative magnitude of the parameter estimates, $|\hat{\delta}_1| > |\hat{\delta}_2|$, imply convergence such that the adjustment mechanism is more rapid for periods when there are large stock market gains. In other words, discrepancies from long-run equilibrium during periods when the threshold is exceeded are eliminated relatively quickly, while the remaining discrepancies exhibit a degree of persistence. Near random walk behaviour transpires in disequilibrium adjustments when changes in the value of stock are below the threshold. Selecting one example from table 4, from 1995 to 1999 when the threshold of $200.7$ billion in model no 4 was exceeded 70% of the time (see figure 1), negative differences between ‘actual’ and ‘planned’ consumption were quick to adjust to unexpected changes in stock market wealth ($\hat{\delta}_1 = -0.151 908$). However, during those periods in which the threshold was not exceeded, the error in consumption was slow to adjust, which is indicative of a near non-stationary process ($\hat{\delta}_2 = -0.031 298$).\(^{14}\)

4.2. Short-run behaviour

Previous studies have found that empirical models in the form of equation (5) estimate the effects of income and wealth on consumption over the long run with a degree of accuracy. While this may be true, we have also established that any differences between actual and planned consumption occurring during stock market ‘booms’ tend to be quickly reversed. Given the existence of this asymmetric, cointegrating behaviour found amongst the variables in table 4, there are short-run, error correction representations which can be written as the three-equation system

\[
\Delta f(C_t) = \phi_{10} + \kappa_{11} I \varepsilon_{t-1} + \kappa_{12} (1 - I) \varepsilon_{t-1}
+ A_{11}(L) \Delta f(C_{t-1}) + A_{12}(L) \Delta f(Y_{t-1})
+ A_{13}(L) \Delta f(W_{t-1}) + \vartheta_{1t}
\]

\[
\Delta f(Y_t) = \phi_{20} + \kappa_{21} I \varepsilon_{t-1} + \kappa_{22} (1 - I) \varepsilon_{t-1}
+ A_{21}(L) \Delta f(Y_{t-1}) + A_{22}(L) \Delta f(C_{t-1})
+ A_{23}(L) \Delta f(W_{t-1}) + \vartheta_{2t}
\]

\[
\Delta f(W_t) = \phi_{30} + \kappa_{31} I \varepsilon_{t-1} + \kappa_{32} (1 - I) \varepsilon_{t-1}
+ A_{31}(L) \Delta f(W_{t-1}) + A_{32}(L) \Delta f(Y_{t-1})
+ A_{33}(L) \Delta f(C_{t-1}) + \vartheta_{3t}
\]

The $\kappa_{ij}$ are the speed of adjustment parameters and the $A_{ij}(L)$ are first-order polynomials with the lag operator $L$.\(^{15}\) The

\(^{14}\) The red ‘spikes’ from 1995 to 1999 in figure 1 represent the periods when the threshold was exceeded.

\(^{15}\) Lag lengths were chosen using the AIC criterion.
parameter estimates are below. For brevity, we have chosen to present error-correction results for the logarithmic model only

\[
\Delta \ln(C_t) = 0.004 - 0.24I\hat{\delta}_{t-1} - 0.09(1 - I)\hat{\delta}_{t-1} \\
+ A_{11}(L)\Delta \ln(C_{t-1}) + A_{12}(L)\Delta \ln(Y_{t-1}) \\
+ A_{13}(L)\Delta \ln(W_{t-1}) + \hat{\alpha}_I \\
(4.45)*** (-3.10)***(-1.67)^*
\]

\[
\Delta \ln(Y_t) = 0.004 - 0.20I\hat{\epsilon}_{t-1} - 0.01(1 - I)\hat{\epsilon}_{t-1} \\
+ A_{21}(L)\Delta \ln(Y_{t-1}) + A_{22}(L)\Delta \ln(C_{t-1}) \\
+ A_{23}(L)\Delta \ln(W_{t-1}) + \hat{\delta}_{2I} \\
(4.22)*** (-2.07)***(-2.14)**
\]

\[
\Delta \ln(W_t) = 0.008 - 0.28I\hat{\delta}_{t-1} + 0.02(1 - I)\hat{\epsilon}_{t-1} \\
+ A_{31}(L)\Delta \ln(W_{t-1}) + A_{32}(L)\Delta \ln(Y_{t-1}) \\
+ A_{33}(L)\Delta \ln(C_{t-1}) + \hat{\delta}_{3Y} \\
(3.27)*** (-1.26) (0.13)
\]

** — Significant at \(\alpha = 0.05\)
* * * — Significant at \(\alpha = 0.01\).

It is indicated by the speed of adjustment parameter estimates in the first error correction model that, during ‘bull’ and ‘bear’ markets, households adjust consumption growth in the short run to allow their spending to correct to the new target level. For example, when there is an increase in wealth as a result of an unanticipated increase in equity prices (which is above the estimated threshold), an additional negative one per cent consumption error in the previous quarter is associated with an increase in the consumption growth rate of 0.24% in the present quarter. Note that the short-term adjustment is slower when the value of stock is below the threshold. During periods of declining wealth and equity prices, an additional positive one per cent consumption error is coupled with only a 0.09% decline in the consumption growth rate. In sum, during stock market ‘booms’, households increase consumption growth to allow actual spending to adjust to the new target level.

However, when equity prices are declining, the growth in short-run consumption spending is slow to close the positive gap between actual and target spending.

5. Conclusion

In this study, we have shown that changes in wealth that result from unanticipated changes in the value of equity holdings begin a process whereby households alter consumption growth in order to close the gap between actual spending and the new target level. Because of an increase in asymmetric information during downturns in the stock market, consumers appear to resist sizeable decreases in their spending growth. Conversely, the gap was eliminated relatively rapidly during periods of stock market ‘booms’, e.g. when the value of equities held by households was greater than the threshold. As a result, throughout the periods when the value of equities was less than the threshold, the time path of the disparity between actual and target spending exhibited near random walk behaviour and this error was eliminated relatively slowly. The implication for economic growth is clear. During an ‘upswing’ in equity prices, the increase in GDP would respond quickly and fully to changes in consumption spending. However, during stock market downturns, while the reduction in economic growth may be less than it would be because of consumers’ resistance to reduce spending in a timely manner, the time path of GDP may also exhibit more hysteresis.

Lettau and Ludvigson (2003) provide evidence that 88% of the post-war variation in household wealth is to be considered ‘transitory’ and due to fluctuations in stock prices. These transitory changes have a slight effect on consumption spending, while a one dollar change in ‘permanent’ wealth is associated with a four to five cent change in consumption (Lettau and Ludvigson 2003). While we did not distinguish between ‘transitory’ and ‘permanent’ forms of wealth, it was found that the magnitudes of the speed of adjustment estimates for the threshold conditions in the error-correction model indicate that consumers change their spending rather slowly as gains (or losses) are realized. Only proliferations in income or wealth that are sustained for a long period of time, such as the 1995–1999 performance of the stock market, can be expected to noticeably affect consumption spending.

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Appendix. Variable descriptions

\(C\) — total personal consumption expenditures

\(Y\) — personal disposable income

• Quarterly data seasonally adjusted at annual rates.
• Measured in billions of chain-weighted 1996 dollars.

\[16\] Estimation results for the remaining three models will be made available upon request.
$Y_t$—federal, state and local transfer payments
- Quarterly data seasonally adjusted at annual rates.
- Measured in billions of chain-weighted 1996 dollars.

$W_t$—federal reserve flow of funds net worth
- Quarterly data.
- Measured in billions of chain-weighted 1996 dollars.

$P_t$—civilian non-institutionalized population
- Quarterly data.
- Measured in thousands.

All data were downloaded from Haver Analytics, http://www.haver.com

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