

The American University in London

Journal AUL

March 2004

No. 63



INVESTIGATING THE DYNAMICS OF NONDURABLE CONSUMPTION IN THE UK

Intithal AL-Thumairi

**The American University in London
97-101 Seven Sister Road – N7 7Q P, England**

INVESTIGATING THE DYNAMICS OF NONDURABLE CONSUMPTION IN THE UK

I. Introduction

During the past twenty years equilibrium correction models (ECMs) have successfully been applied to describing macroeconomic relationships. The advantage of such methodology is that it makes it possible to model the short-run as well as the long-run dynamics of integrated/cointegrated macroeconomic time-series and avoid running into the problem of spurious correlation. Moreover, this methodology was appealing to economists because it allows to analyze the behaviour of a system out of its equilibrium and to describe the mechanism by which the system adjusts to its long-run steady state. The best known example in equilibrium correction modelling is the pioneering work of Davidson, Hendry, Srba and Yeo (1978) of nondurable consumption in the UK, which has become to be known as the DHSY model.

Recent evaluations of the DHSY model have questioned its out-of-sample performance. Some studies have shown that the DHSY model performs poorly outside the sample. Various explanations of this poor performance have been suggested. For example, Harvey and Scott (1994) argued that the out-of-sample performance of the DHSY is affected by the changing seasonality. Others such as Carruth and Henly (1990) and Gausden and Brice (1995) relate it to non-linearity in the parameters.

The aim of this study is to reconsider the dynamic analysis of nondurable consumption in the UK. In particular, we propose an alternative error-correction model that extends the analysis of Davidson *et al.* in two different ways; (i) we first extend the

macroeconomic determinants of nondurable consumption in the UK by incorporating the effects of financial wealth, housing wealth, interest rates, and stock market volatility, (ii) second, we use the Engle-Granger two-step cointegration methodology and analyze the inter-temporal dynamics of consumption within an error-correction model.

To do this, we use a methodology based on unit root testing and cointegration. This methodology is applied herein to estimate nondurable consumption in the UK during the period 1976:1 – 1997:4. The main findings from the empirical results are: (i) The long-run dynamics indicate that consumption, income, financial wealth, housing wealth, the interest rate, and stock market volatility are cointegrated, (ii) There is a unique equilibrium relationship where nondurable consumption is positively affected by income, financial wealth, housing wealth, stock market volatility but negatively affected by the interest rate, (iii) The short-run dynamics indicate that consumption is adjusting to its long-run equilibrium with positive feedbacks coming from income, financial wealth, and housing wealth.

The remaining of the study is organized as follows. Section II provides a review of the recent literature dealing with nondurable consumption in the UK. Section III describes the model and the econometric methodology. Section IV describes the data used in the study. Section V reports the empirical results and validation of the model, and section VI concludes.

II. Review of the Literature

The empirical literature contains several studies on nondurable consumption in the UK. These studies can be characterized by the high diversity in methodology. These can be

classified into four categories. The DHSY model introduced by Hendry et al. (1978), The HUS-models introduced by Hendry and von Uergern-Sternberg (1981), the periodic autoregressive models (PAR) used by Osborn (1988), and the “structural models” estimated by Harvey and Scott (1994).

In the DHSY model the authors estimated an ECM of nondurable consumption for the period 1958:2 – 1970:4. The authors specified the short-run dynamics as annual changes and justified this by their finding that this is a sensible choice for capturing the consumption behaviour in different quarters. The long-run dynamics were specified using the fourth lag of the equilibrium error-correction term. The resulting DHSY model is of the form:

$$\Delta_4 c_t = \alpha \Delta_4 y_t + \alpha_2 \Delta_1 \Delta_4 y_t + \alpha_3 (c - y)_{t-4} + \alpha_4 \Delta_4 D_t + \alpha_5 \Delta_4 p_t + \alpha_6 \Delta_1 \Delta_4 p_t + \varepsilon_t \quad (1)$$

Where c_t is consumption of goods and services, y_t is real personal disposable income, $\Delta_1 \Delta_4 y_t$ is the first difference of the annual change of income, $(c - y)_{t-4}$ is the equilibrium correction term, D_t is a dummy variable, $\Delta_4 p_t$ is the level of inflation and $\Delta_1 \Delta_4 p_t$ is the rate of change of inflation. The dummy variable was included to capture the change in consumption as a result of information of a purchase tax increase in the 1968 budget. Moreover, Δ_j is the difference operator, $\Delta_j = x_t - x_{t-j}$. All the variables in the model were expressed in natural logarithm.

Hendry (1994) pointed out the importance of data revisions and stressed that recent data vintages are not cointegrated with earlier vintages.

Hendry, Muellbauer and Murphy (1990) found that consumption, income and inflation are cointegrated, which implies that $(c - y)_{t-4}$ has a unit root cointegrated, and hence instable,

Carruth and Henley (1990) check whether or not the existing consumption models, such as HUS and DHSY, are adequate for describing quarterly UK nondurable consumption behaviour beyond the sample period. They concluded that most of the models they evaluated are inadequate for forecasting UK consumption.

Harvey and Scott (1994) argued that nondurable consumption exhibits seasonality over time. Therefore they suggested accounting for that by estimating a “structural model”. This model was estimated using quarterly changes instead of annual changes in the short-run dynamics and the dummy variables were used to capture the seasonality in consumption. They found that the structural model outperforms the DHSY model.

Gausden and Brice (1995) used seasonally adjusted and seasonally unadjusted data over the period 1956:2-1984:4. Their study considered both consumption of nondurable goods and services and total expenditures. According to their results, it is the effect of income growth that changes over time. For this, they used a time-varying parameters model and provided evidence that it improves the goodness of fit within the sample period.

Song (1995) re-estimated both the DHSY and HUS models using time-varying parameters over the period 1961 – 1991. They proved that the time varying parameter model yields better forecasts than the original models.

III. The Model and the Econometric Methodology

III.1 The Model

The consumption model that we use here takes into account life-cycle theory which, as Deaton (1992) pointed out, should be the basis for modern research on consumption and saving. Hendry et al. (1990) among others have shown that the level of real nondurable consumption is a function of the relative price of durable to nondurable consumption, the real rate of return, real non-property income, and the financial and physical wealth. Church et al. (1994) argue that this basic formulation omits five potentially important influences on consumers' behaviour. These are income uncertainty, credit constraints, demographic changes, liquidity, and dynamic adjustments.

Within this framework, we adopt a specification for real nondurable consumption in the UK that allows for the inclusion of disposable income (y), net financial wealth (FW), Housing Wealth (HW), the interest rate (r), and stock market volatility (v).

$$C_t = f(Y_t, FW_t, HW_t, r_t, V_t) \quad (2)$$

The main contribution of the model in (2) is the explicit inclusion of the effects of financial wealth and stock market volatility on consumption. Recent theoretical contributions suggest that stock markets may promote long-run economic growth and prosperity. Stock markets encourage acquisition and dissemination of information (Greenwood and Jovanovic 1990) and may reduce the cost of mobilizing savings, thereby facilitating investment (Greenwood and Smith 1997).

III.2 The Econometric Methodology

Researchers have often fitted first-differences regressions, since first differences would likely generate stationary variables in most economic time series. However, as Engle and Granger (1987) pointed out, although first differencing may induce stationarity, it can also filter out long-run information if the variables in levels are cointegrated. Therefore, equation (2) estimated in first differences may also be inappropriate (misspecified) because it ignores the long-run relationships that may exist among the logged levels of the variables.

In sum, although first differenced regressions probably do not yield spurious correlation that plagues log-level regressions, they too suffer from potential misspecification. Consequently, more recent research has attempted to integrate the two alternative specifications (log-levels and first differences) using the theories of cointegration and error-correction.

The first step is to investigate the stationarity property of each variable proposed in the model and, hence, determine its order of integration. In this study, we use both the augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests to check the integration properties of the variables in the model. There are two possible outcomes. One possibility is that the variables are stationary in different orders (they have different orders of integration), in which case they cannot be cointegrated. Another possibility is that the variables have the same order of integration. In this case, further testing is needed in order to check whether the variables share the same common unit root (cointegrated) or possess different unit roots (noncointegrated). For this, we need a second step in which we estimate the associated cointegrating regressions using the variables with the same order of integration. As Banerjee, Dolado, Hendry and Smith (1986) have shown, when

the number of variables is more than two, the cointegrating equation may not be unique. Following Hall (1986) and Miller (1991), we identify the optimal cointegrating equation as the one which maximizes the adjusted R-square.

The third step in building the cointegration-based error-correction model is to examine the stationarity property of the residuals obtained from the cointegrating equation. If these residuals prove to be stationary then the variables involved are said to be cointegrated or, have a stationary long-run relationship. The stationarity of the residuals can be tested using similar ADF and PP tests.

The final stage in the process of model building is the specification of a dynamic error-correction equation. Using the Granger (1986) representation theorem, Engle and Granger (1987) demonstrate that a dynamic error-correction model can represent a system of cointegrated variables. The error-correction model consists of the model containing the stationary variables to which are added the stationary residuals extracted from the cointegrating equation. This additional regressor is called the error-correction term, and its coefficient in the ECM indicates how, in the short-run, consumption is adjusting to its long-run equilibrium position.

IV. The Data

The data used in the study are quarterly data for the UK and cover the period 1976:1 – 1997:4. The variables' definitions and notations are as follows:

C = Real Nondurable consumption

Y = Real Disposable Income

FW = Net Financial Wealth

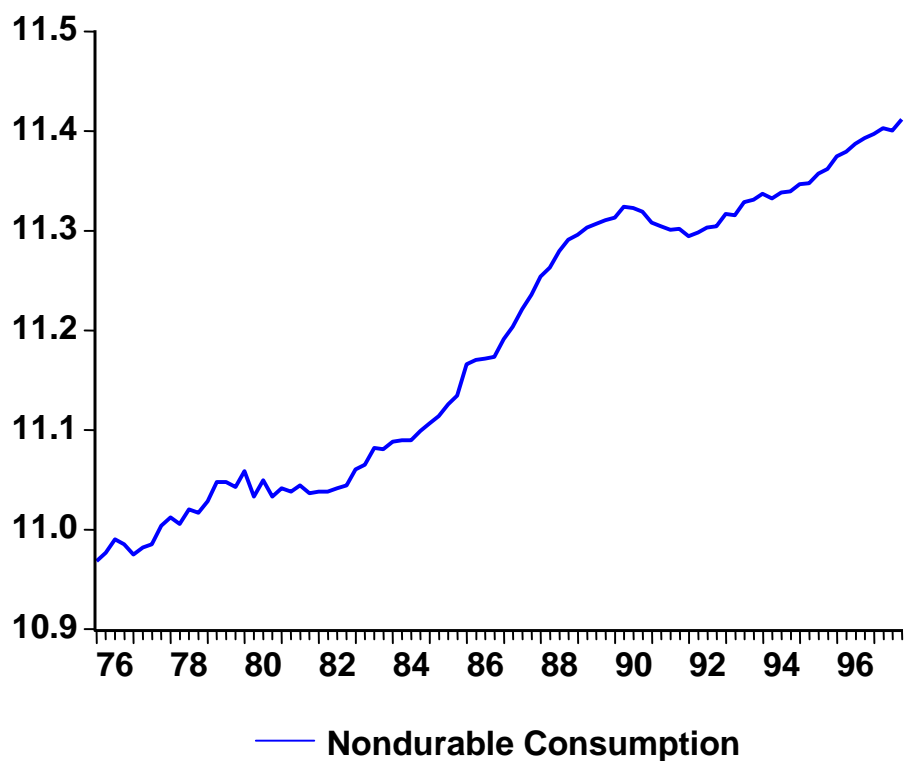
HW = Housing Wealth

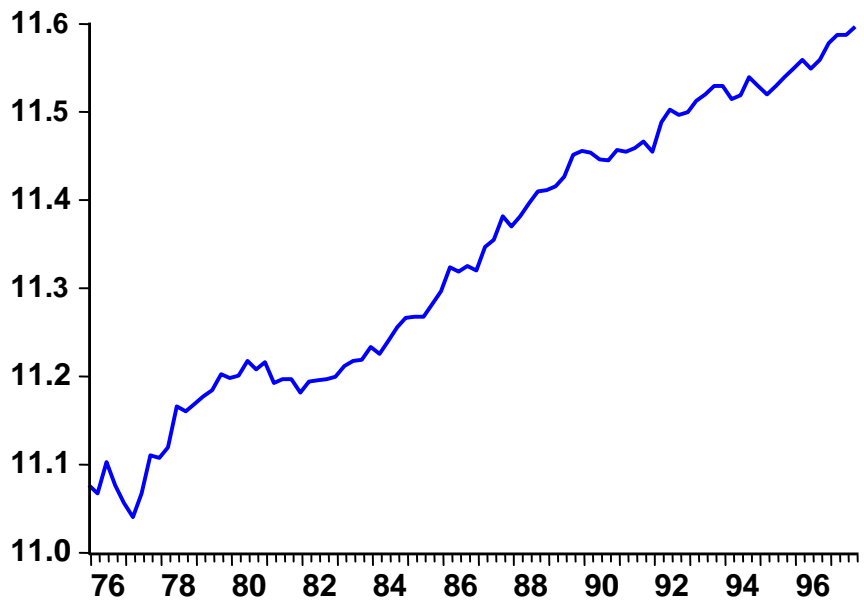
R = Three-month Treasury-Bill Rate

V= Stock Market Volatility Index

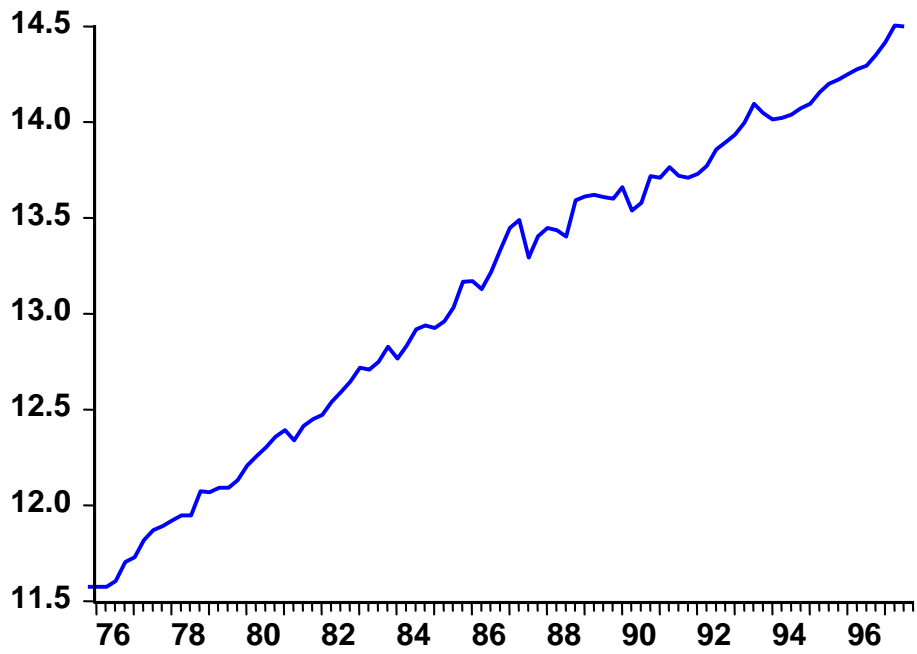
The stock market volatility index is measured by the standard deviation of the stock market index. First, the logarithmic first differences of the end-of-quarter stock market price index were calculated, then a moving eight quarter standard deviation was computed as a measure of the stock market volatility. The data on the stock market prices were directly extracted from the online information service *Data Stream International*.

All the variables are transformed to their natural logarithm. The graphs below provide the plots of the variables over the sample period.

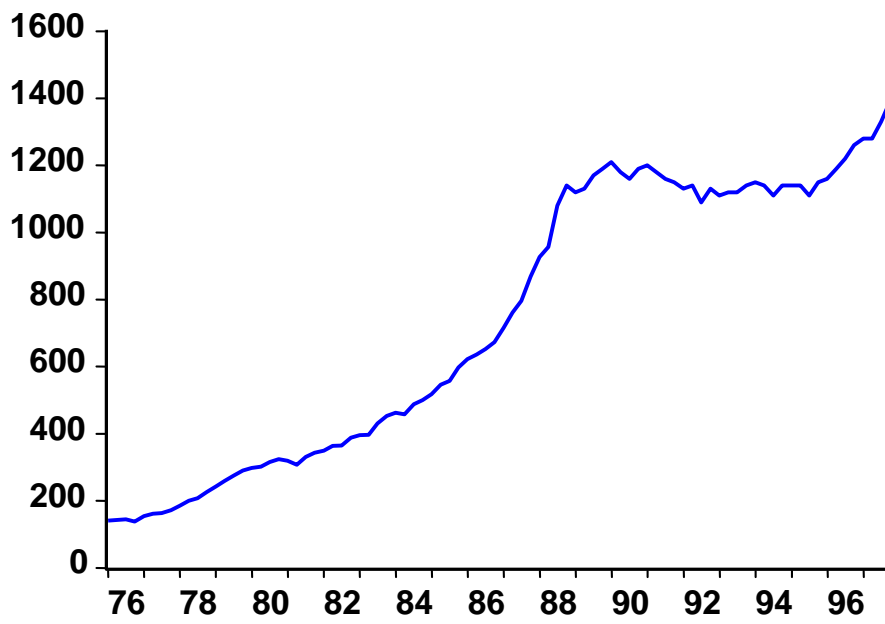




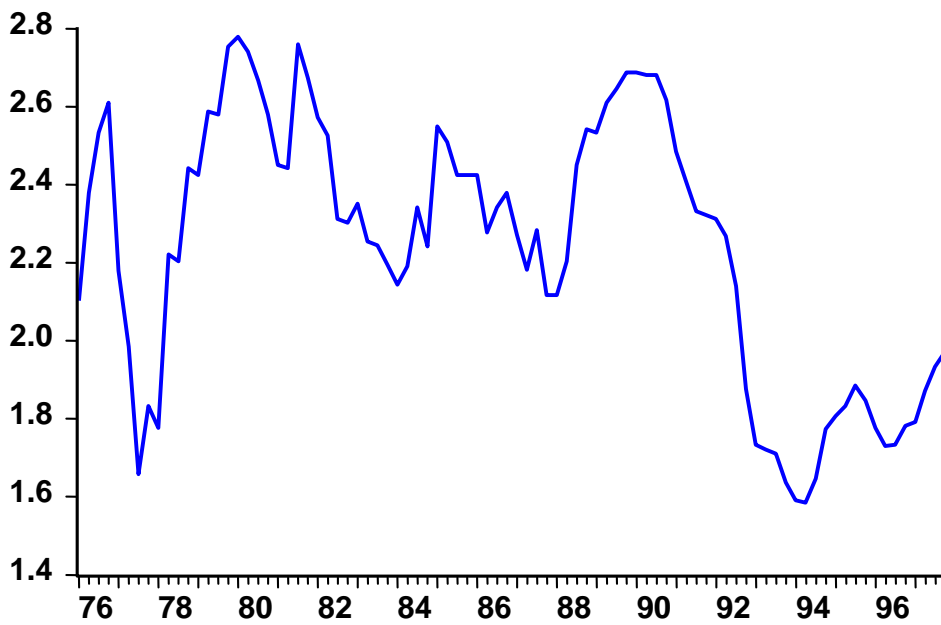
— Disposable Income



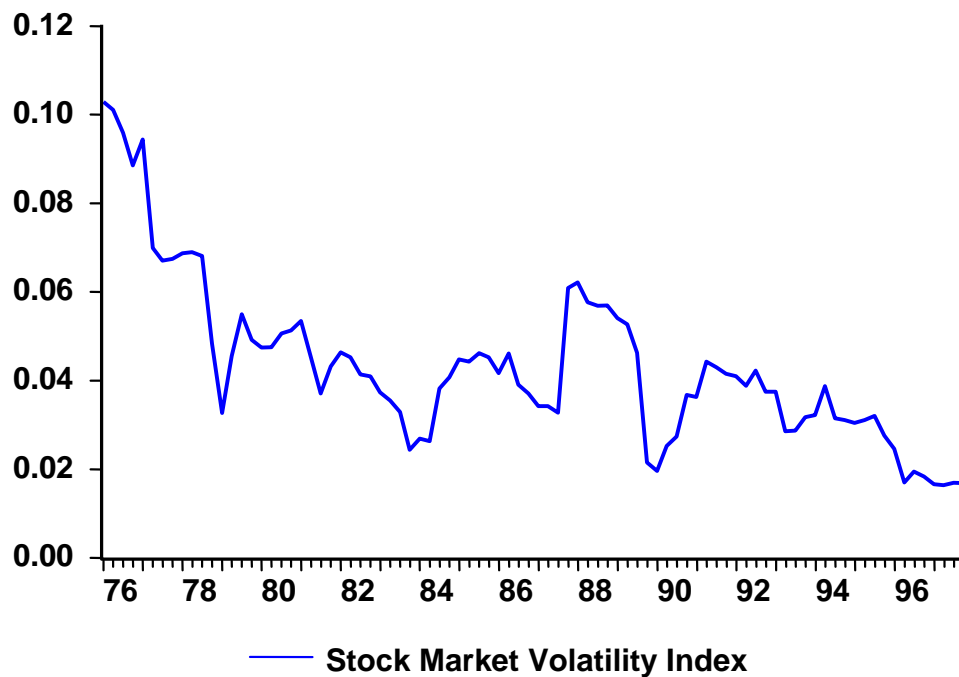
— Financial Wealth



— HWEALTH



— Three-Month T-Bill Rate



V. Empirical Results

We first start by investigating the stationarity status of the variables included in the model using the augmented Dickey-Fuller (ADF) test. This test is applied on the level variables as well as on their first differences. The results of these tests are summarized in table 1. As can be seen, the results in table 1 indicate that the null hypothesis of nonstationarity could not be rejected when the variables are expressed in their level form. However, when these variables are expressed in their first-differences, the null hypothesis is consistently rejected at both the 5 percent and the 1 percent significance levels. Thus we conclude that the variables C , Y , W , r , H , and V are all integrated of order (1).

Table1. Test Results for Unit Roots

Variable	Augmented Dickey Fuller ADF)
C	-1.020
Y	-0.104
W	-1.303
H	-1.033
r	-1.294
V	-1.377
$\Delta(C)$	-3.696**
$\Delta(Y)$	-4.131**
$\Delta(W)$	-3.630**
$\Delta(H)$	-3.209**
$\Delta(r)$	-4.556**
$\Delta(V)$	-5.013**

Notes: The variables are as defined in the text.

** Indicates significance at the 1-percent level.

* Indicates significance at the 5-percent level.

Given the results above, we now conduct cointegration tests and estimate the appropriate cointegrating equation. As described earlier, the estimated residuals from the preferred equation are recovered and examined for stationarity as required by the cointegration test. The objective is to check whether the nonstationary level variables share a common unit root (i.e. cointegrated) or they exhibit different unit roots (i.e. noncointegrated). A cointegrating relationship was confirmed for the C, Y, W, H, r, and

V variables with C as the dependent variable. Results from the ADF test suggest stationarity of the residuals of this equation at least at the 1 percent level. Specifically, the ADF statistic is -3.169. In addition, we tested for the existence of up to the tenth order serial correlation in these residuals. These tests reject the null hypothesis of serial correlation. Hence, our results consistently reject the null hypothesis of nonstationary residuals, thus supporting the assumption of cointegration.

The estimated long-run relationship where *t*-statistics are in parentheses is as follows:

$$C_t = 2.018 + 0.631 Y_t + 0.0566W_t + 0.0972H_t - 0.0237r_t + 0.885V_t \quad (3)$$

(4.596) (8.886) (4.219) (3.761) (2.744) (5.901)

Sample:1976:1-1997:4 Adj-R² = 0.986 SE = 0.0172 DW = 1.98

Equation (3) indicates that nondurable consumption has a long-run equilibrium relationship with income, financial wealth, housing wealth, the interest rate and stock market volatility. Looking at the sign effects of the variables, we notice that all variables have the correct sign. In particular, it is noticeable that stock market volatility, which can be seen as indicating uncertainty about future investments, has a high positive effect on consumption. It is also noticeable that the one-to-one correspondence between consumption and income is not supported by the data.

A Dynamic Error-Correction Model

Given the results above we construct a dynamic error-correction model for nondurable consumption in the UK. This is done by taking into account the long-run relationship between the variables as embedded in the residuals of the cointegrating equation in (3).

The error-correction model (ECM) that we estimate is of the form:

$$\Delta C_t = \beta_0 + \sum_{i=0} (\beta_{1i} \Delta Y_{t-i} + \beta_{2i} \Delta W_{t-i} + \beta_{3i} \Delta H_{t-i} + \beta_{4i} \Delta r_{t-i} + \beta_{5i} \Delta V_{t-i}) + \sum_{i=1} (\beta_{6i} \Delta C_{t-i}) + \beta_7 EC_{t-1} + U_t \quad (4)$$

where Δ denotes the first-difference operator, EC is the error-correction term obtained from the underlying cointegration regression in (3), and U is a white noise disturbance term.

Table 2 reports the OLS estimates of the error-correction model in (4). Since the equation is estimated in first-difference, the high value of the adjusted R-square indicates that the model does not suffer from a “spurious correlation” problem. The highly significant regression F-statistic supports this result.

Further evidence in support of the statistical adequacy of the proposed model follows. In particular, the estimated equation does not suffer from autocorrelation according to several tests. The Durbin-*h* and Durbin-*m* tests do not suggest the presence of first order serial correlation in the residuals. In addition the Breush-Godfrey test which is capable of revealing autoregressive and moving-average processes of the residual suggests absence of first-, fourth-, and fifth-orders of serial correlation.

We further check the presence of heteroscedasticity and the possibility of misspecification using the ARCH and the White procedures, and both tests could not reject the hypothesis of homoscedastic residuals.

The results in table 2 indicate that, in the short-run, nondurable consumption is influenced by income, financial wealth, and housing wealth. However, while stock market volatility and the interest rate have the correct sign, their effects are not significant in the short-run. It is also important to note that, in the short-run, nondurable consumption is adjusting to its long-run equilibrium. This is indicated in table 2 by the

coefficient of adjustment, which is the coefficient on the lagged error-correction term. It is worth noticing, however, that although it is significant, this coefficient is small. This indicates that nondurable consumption is adjusting slowly to feedbacks coming from income, financial wealth, and housing wealth.

Table2. Regression Estimates of the Error-correction Model for Nondurable Consumption in the UK

Variable	Coefficient Estimates	Absolute t-Statistics
Intercept	-0.166	2.008
ΔC_{-1}	-0.401	2.361
ΔY_{-1}	0.165	2.086
ΔY_{-6}	0.185	2.199
ΔW_{-4}	0.0402	2.242
ΔH_t	0.0887	3.104
Δr_{-1}	-0.0014	0.181
ΔV_{-2}	-0.144	1.009
U_{-1}	-0.0866	3.130

Summary Statistics:

Adj- $R^2 = 0.803$ S.E. = 0.0045 F = 195.679

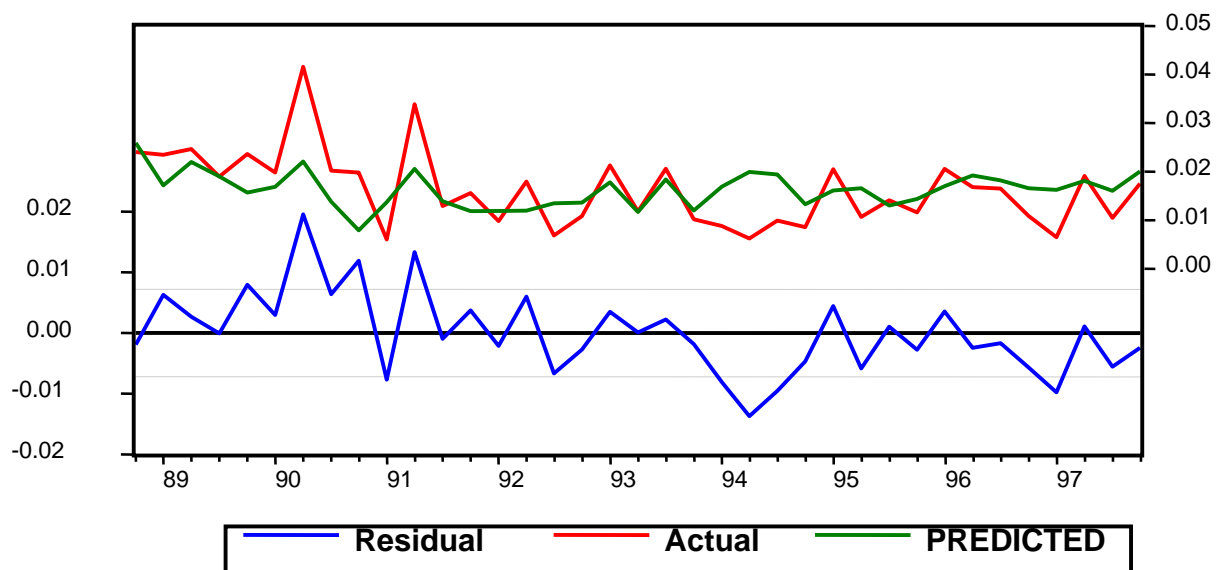
Diagnostic Statistics:

Durbin-h = 0.24 Durbin-m = 0.26
 BG- $\lambda^2(1) = 2.11$ BG- $\lambda^2(4) = 7.65$ BG- $\lambda^2(5) = 10.72$
 ARCH- $\lambda^2(4) = 18.334$ White- $\lambda^2(82) = 38.90$ RESET-F = 0.059

Note: BG is the Breush-Godfrey test, ARCH is the autoregressive conditional heteroscedasticity test, White- λ^2 is the White test of heteroscedasticity, and RESET is the Ramsey regression specification error test.

Model Forecasts

In this section, we assess the forecasting performance of the model for the change in durable consumption. We do this by estimating the model up until the end of 1988 and then compute the one-step-ahead forecast for the remaining sample period. In general, the forecast is following the movement in durable consumption. However, for some periods, especially in the beginning, the forecast is underestimating consumption. For other periods, especially at the end of the forecast period, the forecast is overestimating consumption.



VI. Conclusion

This study empirically investigated the short-run and the long-run dynamics of nondurable consumption in the UK during the period 1976:1 – 1997:4. The methodology is based on unit root testing and cointegration within the Engle-Granger two-step procedure. The main findings from the empirical results are: (i) The long-run dynamics indicate that consumption, income, financial wealth, housing wealth, the interest rate, and stock market volatility are cointegrated, (ii) There is a unique equilibrium relationship where nondurable consumption is positively affected by income, financial wealth, housing wealth, and stock market volatility but negatively affected by the interest rate, (iii) The short-run dynamics indicate that consumption is adjusting to its long-run equilibrium with positive feedbacks coming from income, financial wealth, and housing wealth.

References

- Bollerslev, T. and Hylleberg, S. “A Note on the Relation Between Consumers’ Expenditures and Income in the United Kingdom”, *Oxford Bulletin of Economics and Statistics*, vol. 47 (1985), pp. 153-170.
- Carruth, A. and Henley, A. “Can Existing Consumption Functions Forecast Consumer Spending in the Late 1980’s? *Oxford Bulletin of Economics and Statistics*, vol. 52 (1990), pp. 211-222.
- Church, K.B. P.N. Smith and K.F. Wallis “Econometric Evaluation of Consumers’ Expenditure Equations”, *Oxford Review of Economic Policy*, vol. 10 No.2 (1994), pp. 71-85.

- Davidson, J.E.H. and Hendry, D.F. "Interpreting Econometric evidence: The Behaviour of Consumer Expenditure in the UK", *European Economic Review*, vol. 16 (1981), pp. 177-92.
- Davidson, J.E.H., Hendry, D.F., Srba, F. and Yeo, S. "Econometric Modelling of the Aggregate Time Series Relationship Between Consumers' Expenditures and Income in the United Kingdom", *Economic Journal*, vol. 88 (1978), pp. 661-92.
- Banerjee, A., J.J. Dolado, D.F. Hendry and S.W. Smith, "Exploring Equilibrium Relationships in Econometrics Through Static Models", *Oxford Bulletin of Economics and Statistics*, Vol. 48 (1986), pp. 253-277.
- Engle, R.F. and C.W.J. Granger, "Cointegration and Error Correction: Representation, Estimation, and Testing", *Econometrica*, Vol. 55 (1987), pp. 251-276.
- Gausden, R. and Brice, S.J. "Forecasting Aggregate Consumers' Expenditure in the UK Using the DHSY Model", *Applied Economics*, vol. 27 (1995), pp. 1059-1067.
- Granger, C.W.J., "Developments in the Study of Cointegrated Economic Variables", *Oxford Bulletin of Economics and Statistics*, Vol. 48 (1986), pp. 213-28.
- Greenwood, J. and B. Jovanovic, "Financial Development, Growth, and the Distribution of Income", *Journal of Political Economy*, vol. 98 (1990), pp. 1076-1107.
- Greenwood, J. and B. Smith, "Financial Markets in Development and the Development of Financial Markets", *Journal of Economic Dynamics and Control*, vol. 21 (1997), pp. 145-82.
- Hall, S.G., "An Application of the Granger and Engle Two-Step Procedure to the United Kingdom Aggregate Wage Data", *Oxford Bulletin of Economics and Statistics*, Vol. 48 (1986), pp. 229-239.

Miller, S.M., "Monetary Dynamics: An Application of Cointegration and Error-Correction Modelling", *Journal of Money, Credit and Banking*, Vol. 23(1991), pp. 139-154.

Phillips, P.C. B., and Perron, P., "Testing for a Unit Root in Time Series Regression", *Biometrika*, 75, (1988), pp. 335-346.

Song, H. "A Time-Varying Parameter Consumption Model for the UK", *Applied Economic Letters*, vol. 2 (1995), pp. 339-42.