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An error correction model of US consumption expenditure

by

I R Harnett

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ABSTRACT

This paper examines the use of an error correction mechanism (ECM) model to characterise US personal sector consumption expenditure. Most recent estimations of US consumption functions has concentrated on the use of the rational expectations permanent income hypothesis (REPIH). One notable exception is the work of Bean who estimates an ECM formulation and contrasts this with an REPIH model, concluding that the REPIH model encompasses the ECM model, despite the variance of the latter dominating that of the former.

This study shows that the ECM model can be estimated with either current price or constant price data to yield an acceptable model of US consumption. It is also shown that the basic US ECM model has parameters that are very close to those found for UK data, and, therefore, given the dissimilarities in the saving ratios of the two countries, there must be some omitted variables.

The investigation attempts to show that the Bean model is not the optimal ECM model that can be derived from the data. Hence it is tested against a more recent set of data, as well as being estimated over two subsamples. This shows that there is some parameter instability in the formulation. The weakness of the Bean model is further demonstrated by the estimation of an unrestricted model, which shows that there are large potential gains to be made from alternative specifications. It is also the case that the Bean model fails to take account of the financial position of the US personal sector.

The next stage of the study is the introduction of Federal Reserve Board Flow of Funds data. The data are examined, and then an unrestricted model estimated that produces significant financial effects. In the restricted model a significant role is found for the ratio of personal sector liabilities to financial assets as a correction mechanism. This result is in contrast to the model of Hendry and von Ungern Sternberg for the UK where there is a role for the ratio of liquid assets to income.

The restricted model is also interesting in that it incorporates significant interest rate, hours of work, and tangible assets effects as well as the liability to assets ratio and the basic error correction terms, thus incorporating many additional interesting variables that economists often cite as influencing consumption but that have not previously been successfully incorporated in consumption functions. Not only does this model improve on the SER of the Bean model by 10% for the full sample, and 20% for the more recent period (1972-1982), but it also has the same basic structure as an analogous model for the UK; the differential responses to the inflationary shocks of the 1970s are explained by a differential response to the acquisition of liabilities and assets.

AN ERROR CORRECTION MODEL OF US CONSUMPTION EXPENDITURE

Introduction

Since the late 1950s most econometric models of US aggregate consumption expenditure have been based on some adaptation of the permanent income, or life cycle, hypotheses of consumption, but since the seminal work of Hall [1978] the majority of the studies of US consumption data have tested elements of the rational expectations permanent income hypothesis, where current consumption is primarily determined by consumption in the previous period. Despite the popularity of the REPIH model the results of the estimation work have led its originator Hall [1987] to the conclusion:

> "It is reasonably well established that the simple conclusion from the rational expectations permanent income model .... is inconsistent with the data" p.29

An alternative representation of the life cycle model, popular in aggregate studies of UK consumption data, is the error correction mechanism (ECM) approach, originally developed in Davidson, Hendry, Srba, and Yeo [1978] (DHSY), and subsequently extended by Hendry and Von Ungern Sternberg [1982] (HUS). In this class of models the change in consumption is a function of the change in income, and a measure of the disequilibrium between income and consumption. Despite the success of the ECM class of models in characterising UK consumption data, there have only recently been some attempts to use ECM type models to characterise the US data, cf Bean [1986], Muellbauer [1986], and Campbell [1987].

The Bean model is currently the most rigourous study available using the ECM approach with US data and therefore forms the benchmark against which this study is measured. The basic aim of this paper is to show that the simple DHSY model can characterise both UK and US consumption data, and that it can be extended by the use of financial variables to provide a variance encompassing characterisation of US consumption. The first part of the paper estimates the basic DHSY model with US consumption data. Then an extended error correction mechanism model incorporating the effects of financial variables is used to characterise US consumption. Finally, this model is compared with the results found for the UK by the author, Harnett [1988].

The DHSY consumption function with US data

This section reports the results of estimating the DHSY type equations with data for the US personal sector consumption expenditure.

The DHSY model was originally estimated for the UK using unadjusted constant price data. However, several studies (Harnett [1984,1988] and Patterson [1986]) have extended the DHSY model both to estimation with current price data, and also to include seasonal factors and a constant; this model is referred to as the seasonally extended correction mechanism (SECM) model.

The data used in this study are taken from the Federal Reserve Board MPS data base, based on the Survey of Current Business (see Appendix). However, data limitations meant that seasonally unadjusted data were only available in current price form (these data had to be derived from flow of funds sources). The use of current price data is justified by the isomorphic property of the DHSY consumption function, by which it should be capable of estimation in current prices or constant prices whilst maintaining the integrity of all the coefficients except those on the price terms. The use of current price data also has the advantage that it is not subject to data vintage rebasing, nor is it subject to as large revisions as constant price data. Table 1 reports the result of estimating the basic SECM model using seasonally unadjusted current price US data over the period 1955.1-1982.2. Lower case letters denote log variables.

Table 1. SECM model with US unadjusted nominal data

$$\Delta_4 c_t = \underset{(9.12)}{0.454}\,\Delta_4 y_t - \underset{(1.74)}{0.103}\,\Delta_1\Delta_4 y_t - \underset{(4.29)}{0.212}\,(c-y)_{t-4} + \underset{(9.92)}{0.351}\,\Delta_4 p_t$$
$$+ \underset{(0.03)}{0.047}\,\Delta_1\Delta_4 p_t - \underset{(2.28)}{0.029} + \underset{(3.51)}{0.010}\,S1 + \underset{(3.84)}{0.014}\,S2 + \underset{(2.22)}{0.006}\,S3.$$

SER = 0.0086, DW = 1.15, N = 113, $\bar{R}^2$ = 0.878.

These results suggest that the SECM model can explain the change in UK and US non-durable consumption with very similar coefficients. The coefficients on the US model are all within the range of the UK coefficients $\pm$ two standard errors of the UK estimates. However, the worrying feature of this model is the poor performance in the DW statistic which indicates that there is some residual serial correlation.

By way of comparison, the same form of model, though without seasonal dummies for obvious reasons, was estimated with the more reliable seasonally adjusted US data, but changing the lag structure, so that the $\Delta_4 x_t$ terms were replaced by first difference terms. The ECM model yielded the following results with current price data for 1952.2-1982.2.

Table 2. DHSY model US adjusted current price data

$$\Delta_1 c_t = \underset{(6.55)}{0.400}\, \Delta_1 y_t - \underset{(1.28)}{0.070}\, \Delta_1 \Delta_1 y_t - \underset{(6.62)}{0.025}\, (c-y)_{t-1} + \underset{(7.16)}{0.487}\, \Delta_1 p_t - \underset{(1.32)}{0.142}\, \Delta_1^2 p_t$$

SER = 0.00410, DW = 1.88, N = 121, $\bar{R}^2$ = 0.685.

The same model was also estimated with constant price data in order to check on the isomorphic properties of the model.

Table 3. DHSY model estimated with US adjusted real data

$$\Delta_1 c_t = \underset{(6.27)}{0.402}\, \Delta_1 y_t - \underset{(1.28)}{0.072}\, \Delta_1^2 y_t - \underset{(6.62)}{0.026}\, (c-y)_{t-1} - \underset{(2.88)}{0.188}\, \Delta_1 p_t - \underset{(0.90)}{0.011}\, \Delta_1^2 p_t$$

SER = 0.00414, DW = 2.02, N = 121, $\bar{R}^2$ = 0.390.

As expected the results of Tables 2 and 3 give almost identical coefficients on all but the price terms. However, the presence of <u>any</u> change in the income and error correction terms means that there is inconsistency in the price deflation process, and this motivates the use of current price data throughout the estimation work. The ECM model is also slightly better specified in Table 2 than in Table 3 in terms of the SER. When these models were estimated for the 1972-1982 period the SER remained largely similar, with the current price model having a smaller absolute size of SER. The simple REPIH formulation of a fourth order autoregression of the log of real per capita consumption (only the first lag was significant) yielded a substantially higher SER of 0.0053 over the full sample period.

Given that the unadjusted data used above had to be derived from secondary sources, and that constant and current price data were only available for the seasonally adjusted data, the rest of the analysis will be conducted using adjusted data, in common with all other studies of US consumption data, despite the problems that the Wallis [1974] critique suggests may be present.

The properties of the US consumption data

In assessing the ability of the ECM model to characterise US consumption it is important that the properties of the data to be explained are understood. The seasonally adjusted ECM models estimated above have used $\Delta_1 c_t$, as the dependent variable, for comparison the $\Delta_1 y_t$ term is also shown, since this was shown to be a significant variable in the restricted model.

Figure 1. $\Delta_1 c_t$ and $\Delta_1 y_t$: Constant price data

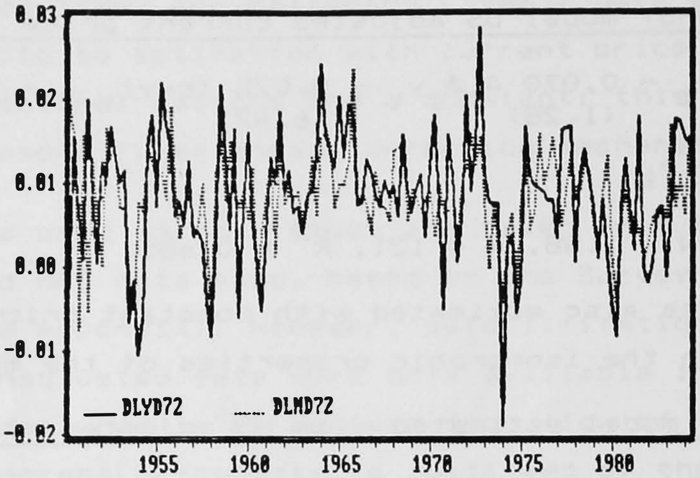
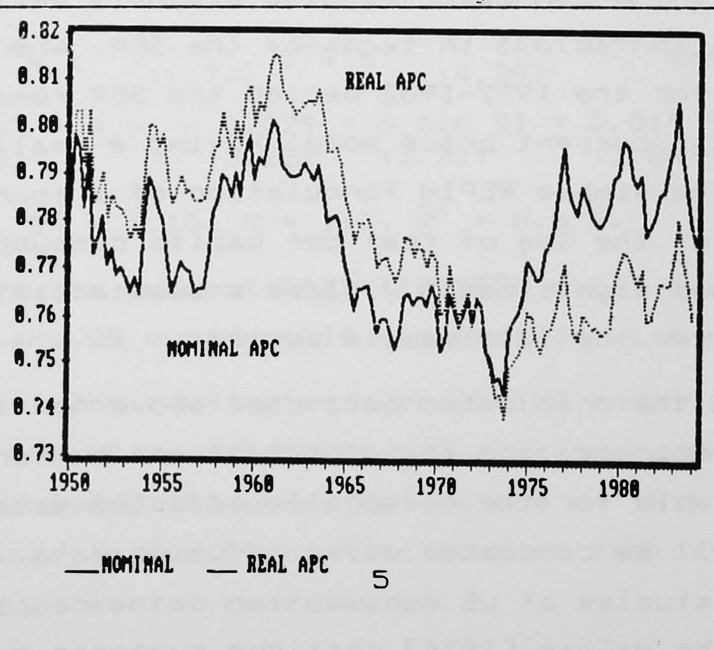


Figure 1 shows that there was a fairly strong cyclical trend in both consumption and income during the 1950s and 1960s. However. since the 1970s there has been a degree of growth in both of the series. as well as an increase in the variability of the series from quarter to quarter.

In the ECM model the other important term is the disequilibrium term $(c-y)_{t-1}$, the average propensity to consume (APC), which is used as a proportional control mechanism. The path of the US APC since 1950 presents an interesting picture.

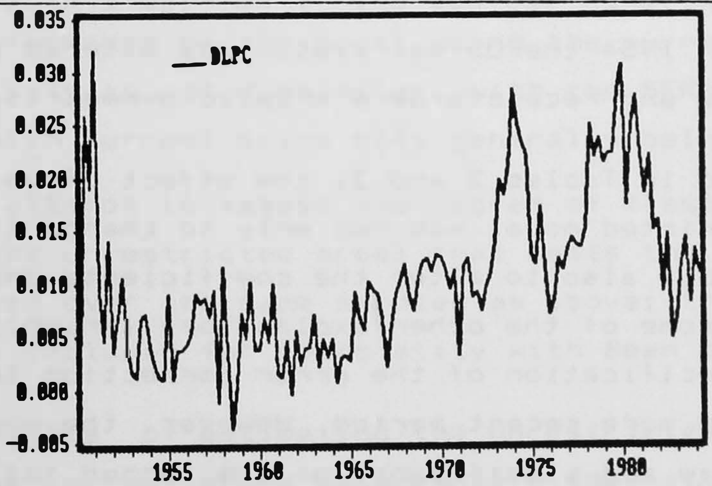
Figure 2. The US APC for non-durable goods and services 1950.1-1984.2



From the late 1960s there is a continual decline in consumption relative to disposable income, until the last quarter of 1973. After that time the trend is reversed until the consumption levels of the 1950s are re-established in the 1980s. Such a pattern is in contrast to the United Kingdom where the oil price rise of the mid-1970s saw a deceleration in non-durable consumption with historically high levels of saving. Any successful model of US consumption must therefore be capable of explaining why the APC changed so dramatically in 1973. Because of this obvious break in personal sector behaviour, split sample testing or recursive estimation will be essential.

One explanation that has been advanced in order to explain the change in consumption behaviour in the UK has been the rate of inflation (see Deaton [1977] and Bulkley [1982]). However, as Figure 3 shows, the rate of price inflation in the US was highly variable during the 1970s and 1980s. The series peaks in 1974.1 and 1980.1 (note that $\Delta_1 p_t$ is used as opposed to $\Delta_4 p_t$ due to the seasonal adjustment in the data). Although the gradual increase in inflation may well account for the decline in the APC over the 1960s, it is difficult to assess how the highly variable nature of inflation since 1973 should be the prime factor in promoting a continuing growth of the consumption to income ratio. Thus we have to look elsewhere for our explanation of US consumption behaviour.

Figure 3. Price inflation on all goods calculated by $\Delta_1 \ln P_t$



This brief look at the data has shown that without a thorough investigation of the data, it is not possible to know why our model performs well, or even what is the appropriate way of testing our model, for example where important structural breaks may occur: thus even though we may have a good statistical fit over the entire sample, there may be offsetting influences in the sub-samples (see Muellbauer [1983] for an example).

Towards a full ECM model of US consumption

In this section of the paper an unrestricted model of US consumption is estimated that incorporates the same variables that were found to be significant in the study of Bean [1986]. The Bean study is currently the most rigourous error correction model that has been tested, thus if any model is to improve upon it, it must be shown to be capable of at least variance dominating it, if not encompassing it. Bean's model was estimated with 1972 constant price data, and included the number of hours worked H_t, and the real level of share prices, S_t (as measured by the standard and Poor 500 index) as additional regressors. However, because of the previous discussion on the properties of the constant price and current price data, the model was re-estimated using both 1972 constant price and current price data in order to test the validity of the restrictions that Bean imposed, in an attempt to assess the extent to which Bean's model is data specific. Unlike the Bean study, the start date for the estimation work was 1954.1 rather than 1950.1. This is in keeping with the estimation work of Muellbauer and Bover [1986] and Blinder and Deaton [1985]. The reason for this is that it avoids the period of the Korean war, when (as was seen from Figure 2) the APC fell rapidly. Also, in 1954 the US tax system was altered so that interest payments and receipts were treated symmetrically.

As was found in Tables 2 and 3, the effect of using nominal data in the restricted model was not only to change the sign of the price terms but also to alter the coefficients and significance of some of the other explanatory variables, notably improving the specification of the error correction term, especially in the more recent period. However, the most notable change is the size and significance of the lagged inflation term Π_{t-1} which is also notable for the difference of size of the variable in the current price data model in the sub sample estimates, even though the constant price data estimates are similar.

Table 4. Bean's "Restricted model" FRB data

DATA	54.1-82.2 1972	54.1-82.2 NOM	54.1-72.2 1972	54.1-72.2 NOM	72.2-82.2 1972	72.2-82.2 NOM
$\Delta_1 y_t$	0.255	0.215	0.194	0.169	0.311	0.215
	(4.6)	(3.9)	(2.5)	(2.1)	(3.6)	(2.8)
$(c-y)_{t-1}$	-0.021	-0.021	-0.022	-0.018	-0.026	-0.041
	(6.5)	(7.2)	(3.9)	(3.7)	(3.0)	(5.1)
$\Delta_1 H_t$	0.224	0.274	0.265	0.272	0.216	0.244
	(3.2)	(3.9)	(2.7)	(2.8)	(1.9)	(2.4)
$\Delta_1 S_{t-2}$	-0.012	-0.009	-0.011	-0.011	-0.013	-0.006
	(1.7)	(1.3)	(1.3)	(0.9)	(1.1)	(0.7)
$\Delta_1 \Pi_t$	-0.217	0.220	-0.191	0.137	-0.317	0.267
	(1.4)	(1.5)	(0.8)	(0.6)	(1.3)	(1.2)
$\Delta^2 \Pi_t$	0.019	0.147	-0.015	0.215	0.075	0.067
	(0.2)	(1.5)	(0.1)	(1.5)	(0.5)	(0.5)
Π_{t-1}	-0.173	0.676	-0.158	0.820	-0.243	0.419
	(2.8)	(9.7)	(0.9)	(4.3)	(2.0)	(3.9)
SER	0.378%	0.383%	0.384%	0.386%	0.370%	0.367%
DW	2.0750	1.8377	2.3192	2.1777	1.9338	1.4610
$\bar{R}^2$	0.4158	0.7400	0.3469	0.5010	0.5599	0.4521
N	114	114	74	74	41	41

The results for the full sample estimation with the constant price data are similar to those found by Bean. However, the sub sample estimates show that there is some parameter instability in the model, and that there may also be some misspecification, especially in the more recent period, where the Durbin Watson statistic is very low for the current price data model. The overall performance of the model using the current and constant price data sets is not dissimilar, with the SERs of the model estimated with current price data generally being marginally higher.

In an attempt to assess the degree of misspecification in the model the unrestricted model that nests the Bean formulation was estimated over the same samples as above; the Treasury bill rate R_t was included for commonality with Bean's unrestricted model.

The results of estimating the unrestricted model with both constant and current price data confirm that it is possible to model consumption in either nominal or constant price terms with there being little effect on the parameterization of the model except in the price term, thereby meeting the criteria in the design methodology of data admissibility. There is a suggestion, however, in the SER of the 1972-1982 estimates that the model has too few degrees of freedom.

Table 5. "Baseline model" Dependent variable $\Delta_1 c_t$

Variable	54.1-82.2		54.1-72.2		72.2-82.2	
DATA	1972	NOM	1972	NOM	1972	NOM
c_{t-1}	-0.121	-0.100	-0.349	-0.317	0.084	0.065
	(1.2)	(1.0)	(2.5)	(2.3)	(0.6)	(0.4)
c_{t-2}	-0.019	0.018	0.165	0.231	-0.503	-0.534
	(0.1)	(0.1)	(1.0)	(1.4)	(2.3)	(2.0)
c_{t-3}	0.084	-0.011	0.059	-0.057	0.264	0.529
	(0.8)	(0.1)	(0.5)	(0.5)	(1.5)	(2.3)
y_t	0.216	0.164	0.196	0.119	0.197	0.073
	(3.5)	(2.7)	(2.0)	(1.2)	(2.7)	(0.8)
y_{t-1}	-0.108	-0.069	0.088	0.127	-0.336	-0.250
	(1.2)	(0.8)	(0.6)	(0.9)	(3.4)	(2.1)
y_{t-2}	-0.068	-0.036	-0.043	-0.002	-0.079	-0.038
	(0.8)	(0.4)	(0.3)	(0.0)	(0.8)	(0.3)
y_{t-3}	0.028	0.045	-0.110	-0.097	0.128	0.148
	(0.4)	(0.6)	(1.0)	(0.8)	(1.5)	(1.5)
S_t	0.013	0.011	0.008	0.006	0.014	0.011
	(1.9)	(1.6)	(0.9)	(0.5)	(1.4)	(1.3)
S_{t-1}	0.001	-0.003	0.011	0.016	-0.044	-0.023
	(0.1)	(0.2)	(0.9)	(1.1)	(3.1)	(1.7)
S_{t-2}	-0.022	-0.014	-0.021	-0.021	-0.001	0.009
	(2.2)	(1.3)	(1.6)	(1.3)	(0.0)	(0.7)
S_{t-3}	-0.007	0.005	0.008	0.009	-0.016	-0.017
	(1.0)	(0.7)	(0.8)	(0.8)	(1.5)	(1.5)
Π_t	-0.312	0.273	-0.246	0.199	-0.672	0.277
	(2.5)	(2.5)	(1.2)	(1.1)	(4.1)	(1.3)
Π_{t-1}	0.064	0.153	-0.230	0.259	-0.091	0.116
	(0.5)	(1.3)	(1.0)	(1.4)	(0.5)	(0.5)
Π_{t-2}	-0.026	0.116	0.222	0.271	-0.486	0.214
	(0.2)	(0.9)	(1.0)	(1.4)	(2.3)	(1.0)
Π_{t-3}	-0.085	-0.052	0.082	0.108	-0.739	-0.415
	(0.7)	(0.4)	(0.5)	(0.6)	(4.2)	(1.8)
H_t	0.11	0.132	0.077	0.080	0.375	0.166
	(1.3)	(1.6)	(0.6)	(0.6)	(3.2)	(1.2)
H_{t-1}	-0.176	-0.222	-0.211	-0.236	-0.193	-0.192
	(1.5)	(2.0)	(1.3)	(1.4)	(1.3)	(1.1)
H_{t-2}	0.130	0.106	0.080	0.051	0.337	0.160
	(1.2)	(1.0)	(0.5)	(0.3)	(2.6)	(1.1)
H_{t-3}	-0.082	-0.042	0.146	0.139	-0.020	-0.044
	(1.0)	(0.6)	(1.1)	(1.0)	(0.2)	(0.4)
R_t	0.60	0.428	0.870	0.912	1.042	0.690
	(2.3)	(1.7)	(1.5)	(1.5)	(4.5)	(2.1)
R_{t-1}	-0.675	-0.568	-1.469	-1.516	-1.0463	-0.503
	(2.3)	(1.9)	(1.7)	(1.7)	(3.7)	(1.5)
R_{t-2}	0.296	0.233	1.568	1.615	1.010	0.689
	(1.0)	(0.8)	(1.9)	(1.9)	(3.2)	(1.8)
R_{t-3}	-0.276	-0.412	-1.673	-1.625	-0.487	-0.645
	(1.2)	(1.7)	(2.4)	(2.5)	(2.0)	(2.2)
const.	-0.005	-0.005	0.007	0.006	0.021	0.014
	(0.3)	(0.3)	(0.3)	(0.2)	(0.4)	(0.2)
SER = σ	0.3662%	0.3600%	0.3691%	0.3699%	0.2286%	0.269%
DW	1.9986	1.9832	2.0943	2.0396	1.9539	1.8871
R^2	0.4518	0.7719	0.3980	0.5459	0.8300	0.6937
N	114	114	74	74	41	41

The unrestricted model reported in Table 5 suggests that there are likely to be only limited impacts from the stock market price in the form that Bean introduces and that a $\Delta_2 S_t$ restriction might be more appropriate. The extensive use of the price terms that Bean employs also appears to be optimistic, since the only obviously significant restriction is that of the current inflation rate. The imposition of the $\Delta_1 H_t$ restriction appears valid in all but the earlier sub sample, whereas it appears that the interest rate that Bean omits from his restricted model is significant in all the estimation periods and that it would be significantly negative in either levels or difference form. Another interesting result was that the size of the inflation term in Table 4 was reproduced in the unrestricted equation for the most recent period.

The fact that the SER of the restricted model is much greater than that for the unrestricted model in the more recent period, as well as the size of the DW statistic previously mentioned, confirms that there are likely to be important influences missing from the present analysis, and by implication, from the analvses of US consumption that Bean and others have conducted. The natural extension of the ECM model that has not been examined in any other study is the incorporation of the financial position of the US personal sector in the model, in the same way that the liquid asset to income ratio, used by HUS, proved an important additional regressor in the analysis of UK consumption.

Financial influences in the US consumption function

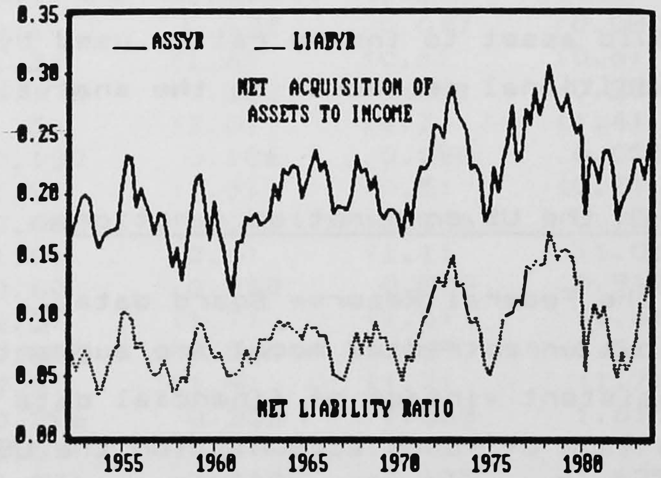
In this section the Federal Reserve Board data examined in the previous unrestricted model are augmented by the introduction of a consistent vintage of financial data from the Federal Reserve Board flow of funds accounts for the US.

The life cycle hypothesis places great weight on the role of the wealth of individuals in the determination of consumption, and a criticism of most econometric models of the UK consumption function, including DHSY [1978], was that they ignored personal sector wealth. The same omission is also found in most empirical studies of US consumption. Using the flow of funds data it is possible to investigate the effects of variables such as the stock of total outstanding liabilities and financial assets, as well as the role of the flows associated with these stocks and tangible assets in the determination of non-durable goods and services expenditure in the US.

The above results showed that even the extended ECM model could not fully explain US consumption behaviour, especially in the more recent period. In the US the response of consumers to the high inflation of the mid 1970s was a small temporary rise in the savings ratio during 1973-75, followed by increased consumption of both non-durables and durables, in contrast to the UK where there was a sustained large rise in the savings ratio. In contrast to the UK therefore we should not expect to find any substantial increase in the holding of financial assets during this period, but rather a switch away from financial assets and a growth in personal sector holdings of tangible assets.

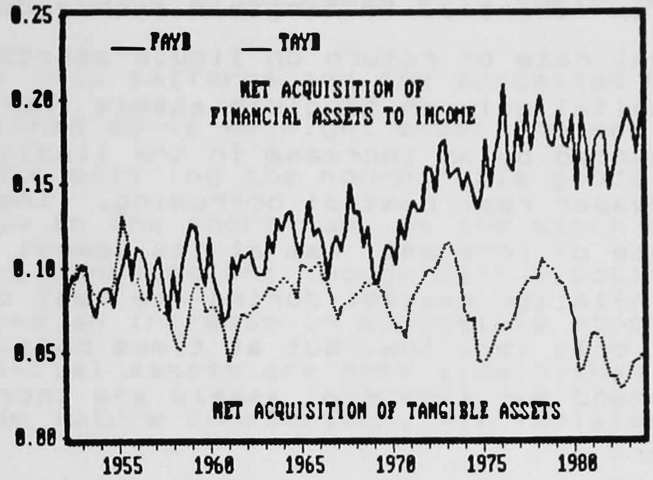
Although there have been substantial acquisitions of financial and tangible assets, the growth of the stock of financial assets appears to have accelerated only in the 1975-1980 period, and actually fell in 1973, in contrast to what is found in the UK. However, when these series are examined in ratio to income form, they yield a very different picture. Figure 4 examines the acquisition of total assets (financial and tangible) to income ratio and the net liability to income ratios.

Figure 4. Acquisition of total assets and liabilities to income



Contrary to expectations there have been simultaneous increases in the net acquisitions of total assets and liabilities relative to income in the periods of high inflation. The question is whether the increased net investment has been financed by the increased liabilities, and if so, what assets have been purchased? Figure 5 suggests that during periods of high inflation the net acquisition of tangible assets has increased at a faster rate than the acquisition of net financial assets, and, when linked with the information in figure 4, this suggests that the rise in the proportion of income spent on tangible assets has been financed by an increase in the levels of liabilities held by the personal sector, relative to their income.

Figure 5. Tangible and financial assets to income ratios



Apart from during the periods of high inflation, the proportion of income going towards tangible assets has fallen while the ratio of net acquisitions of financial assets to income has tended to rise over time, peaking in 1976 and subsequently levelling off. If we look at the stock of financial assets to income and the stock of outstanding liabilities to income ratios we can see the different attitudes to assets and liabilities.

Figure 6. Stock of liabilities & assets to income ratios

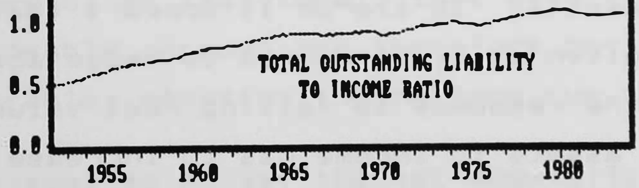


Figure 6 shows that the ratio of the stock of financial assets to income has fallen, whilst the ratio of liabilities to income has risen steadily over the whole of the period. The financial assets ratio peaks in 1968 and falls by 30% over the next 15 years, with what appears to be only limited attempts at rebuilding the stock of financial assets relative to income during the high inflation periods in the mid 1970s and 1980. This is in contrast to the UK where, after the fall in the liquid assets to income ratio seen during the mid 1970s, there was a substantial rebuilding of the stock. Thus there has been a switching between asset types by the US personal sector in response to high inflation. There appears to have been a switching away from financial to tangible assets during the period, as the real rate of return on liquid assets has been eroded and the capital gain on tangible assets increased, and this has been financed by an increase in the liability to income ratio due to a cheaper real cost of borrowing. The real ex-post, pre-tax, rate of interest was at its lowest in 1974.1 and 1980.1, when US inflation peaked; during the rest of the sample period it was not only very low, but at times negative, thus depressing the demand for financial assets and increasing the demand for credit.

Another factor contributing to the depression of the demand for financial assets is that the real value of the stock of liquid financial assets will have been eroded by the direct effect of inflation. The problem with this hypothesis is that this same argument has been employed to demonstrate why the UK saving ratio had risen over this period, while in the US what we are attempting to explain is a fall in the saving ratio.

One answer to this apparent paradox may lie in the effect of credit rationing in the two countries. In the UK there is considerable, albeit mainly anecdotal, evidence that individuals were credit rationed during the 1970s and early 1980s, and that, unlike in the US, they were unable to build up their liabilities. Alternatively the answer may be found in differing motives for holding financial assets. In the UK it appears that individuals attempt to hold a given stock of assets to hedge against future uncertainty. Thus the response to falling real values of the stock of financial assets to income was to increase nominal saving in financial assets. It appears that in the US individuals have reacted to the effects of inflation on their asset holdings in a portfolio adjustment manner. As the real rate of return on financial assets declined, their stock of financial assets to income declined, despite net acquisitions taking a higher proportion of their current income. The ability of consumers to borrow at low real rates of interest enabled individuals to increase their liabilities to either make additions to tangible assets, (where the effect of expected inflationary pressures should be to encourage current period consumption in order to take advantage of capital gains), or else to increase consumption of non-durable goods (in nominal terms the value of expenditure on "necessities" tends to increase with the effect of inflation).

Given the data patterns and the suggested behavioural rationale outlined above we might expect to see the stock of financial assets entering the non-durable goods equation with a negative sign in the short run, as the stock of assets are run down to finance consumption; though with a positive sign in the long run because an increase in accessible stocks of assets (assuming financial assets are more liquid than tangible assets) should increase future consumption, via familiar life cycle arguments.

The increased stock of liabilities should have had some impact on consumption decisions as individuals presumably incur liabilities in order to finance consumption of particular goods. These will normally be tangible assets, such as housing, with its corresponding mortgage debt, an automobile, or some other large durable good. Because liabilities are mainly incurred to finance tangible assets there should be little direct effect on the consumption of non-durable goods. However, with the extension of credit facilities, much more consumption of so-called "non-durables" has been financed by an increase in liabilities. Any effect on non-durable consumption should only arise after a fairly long lag as the liability will have to be repaid, and as is argued in Harnett [1988], this liability should make a prior claim on income of an individual, thus effectively reducing the level of disposable income, and therefore having a negative sign in any non-durables equation in the long run.

As was suggested above, the net acquisition of tangible assets has been increasing in nominal value but falling in relation to income. One possible explanation would be that the deflator on tangible assets was rising less rapidly than that on income. Though there has been some cheapening in the prices of durable goods relative to income, this is not the case for housing. However, this should bring forward the purchase decisions of individuals, where the greatest benefits from purchase, as against rental, are to be made. It is true that there has been an acceleration in the value of the stock of housing in this period. However, the data suggest that the increase in the level of investment in tangible assets has been evenly spread throughout housing, other fixed assets, and consumer durables, in both gross or net investment terms. Thus there is a problem in explaining the growth of tangible assets and the decline in the tangible assets ratio. The tangible assets term could therefore enter the non-durables equation with either sign. However, if tangible assets were being accumulated it is likely that non-durable expenditure would also grow, due to purchases of furnishings etc. being correlated with the acquisition of houses. We should expect a small positive coefficient, though the dynamics of the effect might mean that this was a lagged relationship.

The error correction model with US financial variables

In order to quantify the impact of the financial variables in the determination of US consumption, the unrestricted model reported in Table 5 was extended to include the various financial influences examined above and was estimated over 1954.1-1982.2, due to restrictions on the availability of the assets data, with current price data. The assets terms are introduced excluding the current level, due to the problem of endogeneity. The results of Table 5 largely confirm what the previous analysis had suggested. Due to the size of the model the sub sample estimation is not helpful.

Overall the performance of the model is not significantly improved. In fact, due to the introduction of more terms, the SER is increased even though the SSR is reduced relative to that reported in Table 5. In terms of the influence of the individual variables on the model, the tangible assets effect is small but negative, (although a positive $\Delta_1 ta_t$ effect is suggested by the data). The effects of liabilities are small but positive in total, despite the largest effect occurring in the fifth lag, and this being negative. The financial assets term yields a small and negative long-run effect with the largest coefficient being negative in the fifth lag position.

Table 6. "Baseline model": Flow of Funds data

lag	0	1	2	3	4	5
c_t		-0.186	0.113	-0.219	0.027	0.134
		(1.6)	(0.7)	(1.4)	(0.2)	(1.2)
y_t	0.153	-0.057	-0.074	-0.039	0.078	0.047
	(2.0)	(0.5)	(0.7)	(0.4)	(0.7)	(0.5)
H_t	0.168	-0.001	0.001	0.0	0.001	-0.001
	(1.4)	(1.3)	(0.8)	(0.5)	(1.1)	(1.1)
S_t	0.0001	0.0	0.0	-0.0002	-0.0	0.0002
	(1.4)	(0.4)	(0.2)	(1.1)	(0.2)	(1.0)
$\Delta_1 p_t$	0.209	0.217	-0.011	-0.072	0.108	-0.012
	(1.4)	(1.4)	(0.1)	(0.5)	(0.7)	(0.1)
r^*_t	0.0012	-0.0016	0.0011	0.0009	-0.0008	0.0007
	(1.6)	(1.7)	(1.0)	(0.7)	(0.7)	(0.8)
fa_t		0.006	-0.050	0.053	0.034	-0.062
		(0.2)	(1.1)	(1.1)	(0.7)	(1.7)
ta_t		-0.006	-0.001	0.008	-0.009	0.004
		(1.0)	(0.2)	(1.2)	(1.3)	(0.7)
lb_t		0.087	-0.048	0.075	0.047	-0.111
		(0.9)	(0.5)	(0.9)	(0.6)	(1.2)
const	-0.074					
	(1.3)					

SER = 0.37%; DW = 1.8505; N = 114; R2 = 0.86:

The results from Table 6 suggested that the $\Delta_1 X_t$ restrictions imposed in the basic ECM model estimated with seasonally adjusted data were appropriate, but that this was not generally the case for the financial variables.

Table 7. Restricted model with financial variables

	54.1-82.2	54.1-72.2	72.2-82.2
$\Delta_1 y_t$	0.177	0.143	0.175
	(3.3)	(1.9)	(2.4)
$(c-y)_{t-1}$	-0.086	-0.110	-0.093
	(4.2)	(4.0)	(2.4)
$\Delta_1 p_t$	0.374	0.088	0.420
	(4.5)	(0.6)	(3.9)
fa_{t-5}	-0.012	-0.016	-0.016
	(3.1)	(3.3)	(1.6)
$\Delta_1 ta_{t-3}$	0.005	0.011	-0.0005
	(1.8)	(2.8)	(0.1)
lb_{t-1}	0.013	0.014	0.021
	(4.8)	(3.6)	(2.4)
R_{t-1}	-0.194	0.186	-0.405
	(2.0)	(0.8)	(3.2)
$\Delta_1 H_t$	0.115	0.128	0.041
	(1.9)	(1.4)	(0.5)
SER	0.3497%	0.3546%	0.3116%
DW	1.9727	2.2048	1.8487
$\bar{R}^2$	0.7849	0.5820	0.5897
N	114	74	41

The model containing the assets and liabilities terms gives large improvements in performance over the whole data set as well as the sub sample periods. The model is generally well specified, although greater parsimony might be obtained by omitting the $\Delta_1 H_t$ term. In the course of the restriction process the other variables that stayed in the longest were $\Delta_1 fa_{t-1}$ and $\Delta_1 p_{t-1}$. The effect of using shorter lags on the financial assets term was investigated, but always produced inferior results to those reported here, as did the restriction of employing an integral control term (found in HUS) of the stock of liquid assets to income of up to five lags. One interesting effect is the negative sign on the financial assets term in all three estimates, and the significance of the variable in the earlier period. Unexpected is the insignificance of the tangible assets term in the most recent period, suggesting that, contrary to expectations, there is no evidence to support the hypothesis that there has been switching between durables and non-durables during the recent period of high inflation.

Also interesting are the broadly equal and opposite elasticities on the financial assets and liabilities terms. This suggests that the ratio of financial assets to liabilities is important to Americans in the determination of their consumption. Due to the nature of observed lags this was modelled as $(lb-fa)_{t-1}$ and $\Delta_4 fa_{t-1}$ to incorporate all three terms.

Figure 7. Liabilities to assets ratio

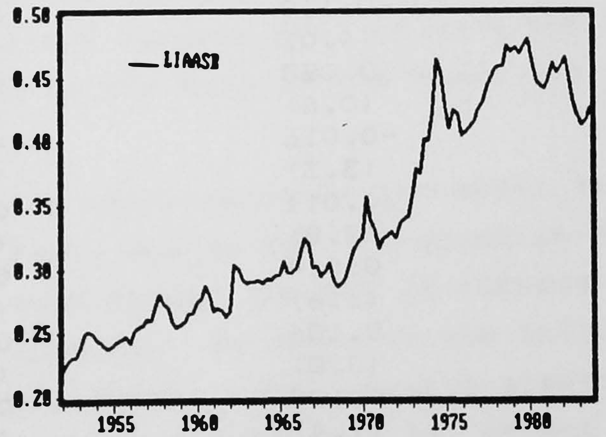


Figure 7 suggests that there has been a sizeable increase in the ratio of liabilities to assets post 1973, and appears to confirm the view that there was a jump down in the level of the stock of financial assets that consumers wished to hold, at the same time as liabilities increased. Thus we can see that there is a new 'plateau' level of liabilities to assets of 45%, rather than the 25% level found pre 1973. Far from being concerned at the impact of higher inflation per se, and therefore increasing precautionary saving, Americans appear to have taken advantage of the cheaper real cost of borrowing and used loans to advance their purchases of goods, both durable and non-durable, rather than attempting to maintain the real value of their stocks of liquid assets. The results also suggests that the type of equity extraction argument that has been advanced for the growth of UK consumption in recent years has been important in the determination of US consumers' expenditure for some time.

In an attempt to maintain the isomorphic nature of the equation both $\Delta_4 p_{t-1}$ and $\Delta_1 p_{t-3}$ were tested, however, the latter was insignificant in all samples, while the former was only significant in the full sample, and both were therefore dropped. The hours term and the constant were kept in the model for logical, rather than data based reasons.

Table 8. Restricted model: liability to assets ratio

	54.1-82.2	54.1-72.2	72.2-82.2
$\Delta_1 y_t$	0.216	0.152	0.236
	(4.3)	(2.0)	(3.1)
$(c-y)_{t-1}$	-0.075	-0.129	-0.045
	(3.6)	(4.0)	(0.8)
$\Delta_1 p_t$	0.353	-0.011	0.443
	(3.7)	(0.1)	(3.3)
$\Delta_4 fa_{t-1}$	0.014	0.011	0.020
	(2.0)	(1.1)	(1.4)
$\Delta_1 ta_{t-3}$	0.005	0.011	0.0002
	(1.9)	(2.8)	(0.0)
$(lb-fa)_{t-1}$	0.016	0.006	0.015
	(4.7)	(0.8)	(1.5)
R_{t-1}	-0.171	0.207	-0.275
	(2.0)	(0.9)	(2.7)
$\Delta_1 H_t$	0.105	0.117	0.065
	(1.6)	(1.2)	(0.6)
const	0.009	-0.018	0.015
	(1.4)	(1.3)	(1.5)
SER	0.3561%	0.3555%	0.3265%
DW	2.02	2.22	1.85
$\bar{R}^2$	0.7927	0.6265	0.6400
N	114	74	41

The results of Table 8 are encouraging in that over the entire sample the model is well specified, with the full sample

SER being almost 10% smaller than found in the Bean restricted model, and almost 20% smaller in the more recent sub sample. One disappointment was that the liability to assets ratio is insignificant in the sub samples. The fit of this model shows that there is no heteroscedasticity, and the model is capable of passing all the split sample tests for parameter constancy as is shown by the RLS results reported in Figure 8. This shows that the one step ahead residuals confirm that the model reported in Table 8 is well capable of modelling the developments in US consumption over the past thirty years. The flat bands for the standard errors of the equation show that the model parameters have largely been constant since the early 1960s. This was confirmed by the RLS estimates of the individual coefficients.

Figure 8. Fitted and actuals with one step ahead residuals

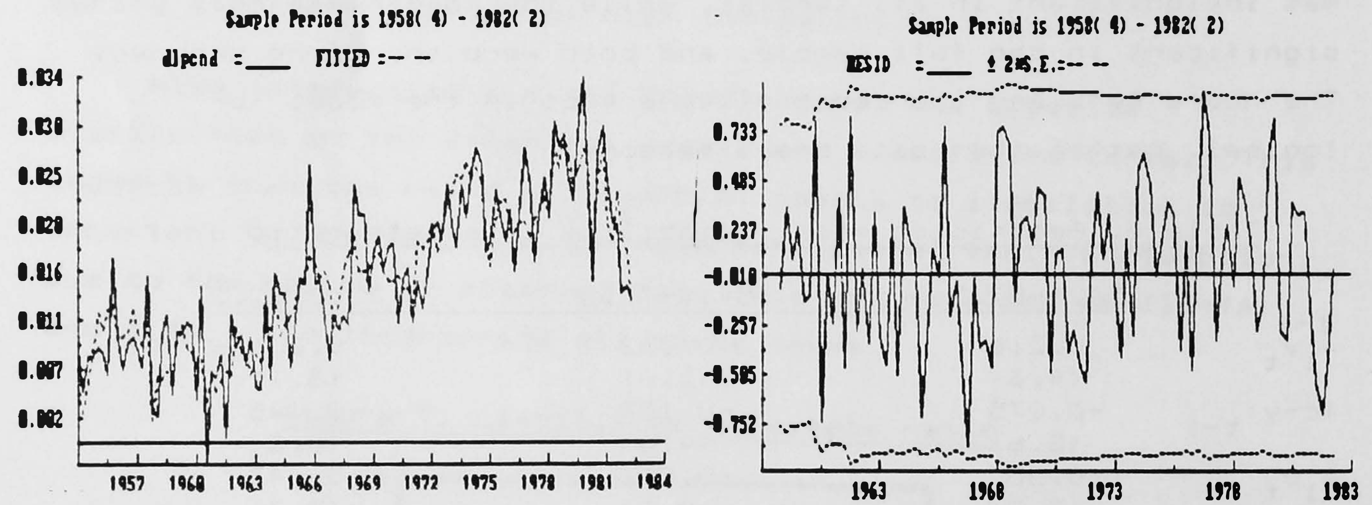
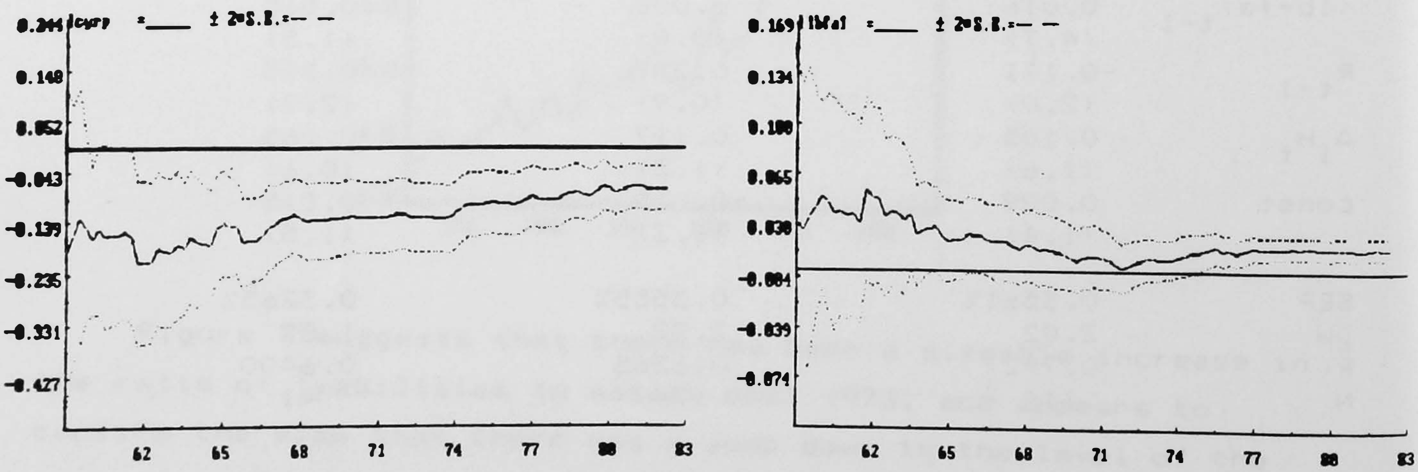


Figure 9. The RLS coefficients on the error correction terms

$(c-y)_{t-1}$ $(lb-fa)_{t-1}$



One interesting feature of the model reported here is how similar it is to the restricted model derived for the UK by Harnett [1988]. This is also estimated with current price data and includes the basic DHSY variables, interest rates, an unemployment term (analogous to the hours of work term used in the US model), and the liquid assets to income ratio, as opposed to the financial assets and liability position in the US. However, no role was found for a tangible assets term in the UK model.

Conclusion

The results of this paper have shown that the error correction mechanism formulation of US consumption is well able to characterise US personal sector consumption expenditure. It was shown that the basic DHSY type model was capable of being estimated with current price seasonally unadjusted data and yielding very similar coefficients to those typifying the United Kingdom, highlighting the general usefulness of the model as the basic data generation process determining consumption behaviour. It was also shown that the ECM class of model was capable of estimation with either current price or constant price data, and that, due to goodness of fit arguments and the well known problems of price deflation generally, current price data was to be preferred. The basic ECM model was also shown to variance dominate the simple REPIH model (although not too much should be made of this point as the information sets used in the two models differ). The use of both current price and constant price data also allowed a test of the data specificty of the Bean ECM model. It was shown that although the Bean model was the best currently available ECM model of US consumption, the unrestricted regression in which it was nested suggested there were important omissions, and potential misspecifications, the most important omission being an analysis of the wealth position of the US personal sector.

The use of flow of funds data on the asset and liability of the US personal sector allowed us to construct a model based more on the HUS approach which clearly variance dominated the Bean specification of the error correction mechanism model. It is also interesting to note that this specification also variance dominates the model of Muellbauer and Bover [1986] which was estimated constant price data (which Harnett [1988] shows is consistent with the data used here).

The fact that the coefficients on the basic DHSY variables in the UK and the US models are robust to re-estimation with not only different vintages of data but across countries is an important result. The differential savings ratios must therefore be due to factors not included in the DHSY model, and this study has identified two important factors. The first of these is the differential response of consumers' portfolio allocation to inflation between the two countries. The investigation of the wealth position of US consumers suggests that they reacted to inflation by increasing their levels of debt, running down their stock of financial assets and consuming more. The second factor is that the net acquisition of tangible assets relative to income slowed during this period and suggests that much of this increase in liability went in current consumption on non-durables and services as well as in the increase in consumption on housing and durables. Such behaviour is in stark contrast to the UK where consumers held back from consuming to maintain their financial assets relative to income.

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DATA APPENDIX

The data used were per capita non-durable goods and services consumption for C_t, per capita personal disposable income, Y_t, the real and nominal values of the Standard and Poor 500 index taken from Bean's data, S_t, the total consumption deflator for P_t which is then transformed by $\Delta_1 p_t = \Pi_t$; per capita hours of work as in the Bean data for H_t; and the quarterly nominal Treasury bill interest rate for R_t. The flow of funds data are taken from Flow of Funds Accounts. The stock of household financial assets, FA (174090005). The stock of households liabilities, LB_t (174190005), and the net acquisition of tangible assets, TA_t (175005005).

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