Rational habit modification: The role of credit.*

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Abstract

This paper proposes an asymmetric model within which consumer credit facilitates both consumption smoothing and rational habit modification. The model provides a better description of aggregate time series consumption data than competeting models. In particular, the model can account for the various aggregate consumption anomalies that have led to repeated rejections of Hall's (1978) random walk model of consumption. The model is applied to US data using a GMM approach. The evidence suggests that new credit can predict short-run changes in consumption and has assisted consumers to become more forward-looking since 1975.

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1 Introduction

This paper examines the role that consumer credit plays in modifying habitual consumption. We derive a model characterised by credit induced habit modification and show that it provides a better description of aggregate time series consumption data than competing models. In particular, the model can account for the various aggregate consumption anomalies that have led to repeated rejections of Hall's (1978) random walk model of consumption.

These anomalies are: 'excess sensitivity' (consumption is overly sensitive to changes in expected income); 'excess smoothness' (consumption weakly responds to news about permanent income); the asymmetry of the excess sensitivity effect (income declines induce a stronger response than income increases), and inadequate dissaving in retirement (wealthy households do not consume enough and even continue to save in retirement). The inability of the random walk model to account for these anomalies has led to an intensive search for alternative hypotheses. Two principal research directions have been explored. The first involves attempts to rescue and refine the life cycle-permanent income hypothesis (LC-PIH) via the relaxation of certain secondary assumptions. Researchers have pursued several of these possibilities: (a) external constraints due to credit market imperfections - 'liquidity constraints'; (b) income and life uncertainty - 'precautionary saving'; (c) time nonseparable preferences - 'habit formation', and (d) intergenerational time horizons - 'bequests'.[1] The second research direction constitutes a more radical departure from the LC-PIH model, dispensing with the core assumptions of rationality (expected utility) and time-consistent preferences. This has been motivated by evidence in experimental research pointing to an asymmetric treatment of gains and losses and 'preference reversals' (Loewenstein and Prelec

[1] As documented in Deaton (1992) and Hayashi (1997).

1992). In response to these observations, this literature has drawn on 'prospect theory' (i.e., the value function being steeper for losses than for gains) and 'self-control' problems (i.e., the agent is a two-self entity with conflicting objectives).[2] The former idea has led to models of 'loss aversion' (Shea 1995), the latter to 'hyperbolic discounting' (Laibson 1998 and Laibson *et al.*1998).

These theoretical developments have proceeded against a background of mounting evidence suggesting that financial deregulation has played an important role in transforming consumer behaviour. For instance, there is evidence that countries with higher levels of indebtedness exhibit lower 'excess sensitivity' (Jappelli and Pagano 1994, 1989). Furthermore, the rejections of Hall's (1978) model occur mainly in studies which use pre-deregulation time-series data. Detecting 'excess sensitivity' becomes increasingly difficult when post-deregulation data are employed (see Olekalns 1997 and De Brouwer, 1996 *inter alia*). These findings have lent some support to the view that past rejections of Hall's (1978) model were simply due to liquidity constraints and that the LC-PIH will undergo a revival in the post-deregulation era. Yet, the fact that standard tests have failed to detect 'excess sensitivity' does not necessarily imply the revival of the LC-PIH. This is due to evidence suggesting that 'excess sensitivity' is asymmetric (Shea 1995) and that credit constraints may be time-varying (Bacchetta and Gerlach 1997).

In this paper, we develop a new model of aggregate consumption with its basis in the idea that credit facilitates both (a) consumption smoothing, and (b) habit modification in consumer behaviour. The model predicts that new household credit produces a beneficial externality, leading to the depletion of consumers' memory of past consumption standards. As a result, consumer behaviour becomes more forward looking. Since it is the contractual

[2] See Hoch and Loewestein (1991) and Shefrin and Thaler (1988).

nature of debt instruments that modifies behaviour, the model is asymmetric; only when household indebtedness increases is there habit modification. We examine the capacity of the model to predict short-run changes in consumption expenditure using quarterly data for the U.S.A.

The paper is organised as follows. Section two provides an outline of the model. Section three applies Generalised Method of Moments (GMM) estimation to test the model. Section four relates the results to the previous empirical literature and section five concludes.

2 Credit and habit modification

2.1 The model

The principal idea of habit formation is the relativity of utility: consumers value consumption by reference to a certain subjective standard of consumption. The consumption standard is assumed to depend on past consumption. The notion of a consumption standard has its origins in the theory of growth where the stock of physical capital is determined by new output and depreciation. However, the concept of a consumption standard is purely psychological. Thus, there is no *a priori* reason to exclude other factors in the evolution of the habit stock.

We extend the literature on habit formation by introducing the concept of habit modification in consumer behaviour. The central idea is that habits can be modified as a result of stimuli or experiences other than past consumption. Our conjecture is that credit markets play an important role in modifying habitual behaviour. More precisely, consumers' participation in debt contracts allows them to break away from the past and become more forward looking. This positive externality is due to three factors. First, the decision to commit to a loan involves intertemporal planning. Second, the cost of borrowing imposes discipline, forcing the consumer to think about current and future conditions. Third, regular loan repayments impose a new routine which leads to the breakdown of old habits.[3]

We begin with a general representative-agent model describing the consumption of non-durables and services, with durability and habit formation. Formally, the consumer maximises utility derived from a composite good, or 'relative consumption', $\bar{C}_t$:

$$E_t \sum_{i=0}^{\infty} (1+\sigma)^{-i} U(\bar{C}_{t+i}) \tag{1}$$

subject to

$$\sum_{i=0}^{\infty} \frac{1}{(1+r)^i} E_t C_{t+i} = A_t + \sum_{i=0}^{\infty} \frac{1}{(1+r)^i} E_t Y_{t+i} \equiv W_t \tag{2}$$

and

$$\bar{C}_t = C_t^F - hH_t = \sum_{j=0}^{\infty} \delta^j C_{t-j} - h\left[\sum_{s=1}^{\infty} a^s C_{t-s}^F - \sum_{s=1}^{\infty} z^s NL_{t-s}\right] \tag{3}$$

where E_t is an expectations operator, σ is the pure rate of time preference, $U(\cdot)$ is a felicity

[3]Although this approach is new, it does have some antecedants in the existing literature. In particular, it is in the spirit of Veblen (1899) who stressed the importance of habit formation and institutional change. Duesenberry (1949) also dealt with the effect of socialisation on consumer behaviour.

function, C_t is consumption expenditure, A is net worth, W_t is real wealth, $\bar{C}_t$ is the composite good or relative consumption, C_t^F is a flow of services, Y_t is labour income, H_t is the habit stock or 'customary' consumption, $0 < \delta < 1$ is the durability rate, $h > 0$ is the weight attached to the habit stock, $a > 0$ describes the rate at which the habit stock is formed, $z > 0$ is the rate of depreciation or memory loss due to past experience in new debt and NL_t is newly acquired debt, which will be set to zero when the new debt is non-positive. Note that the asymmetry in NL_t is due to the irreversable effect of new debt on the habit stock.

Several standard assumptions are imposed upon the model. First we assume that $E_t A_{t+i} \geq N > -\infty$ for all i, where N is a large negative number. This assumption serves to rule out an unbounded volume of indebtedness on the part of the consumer. Second we assume that credit markets are perfect which permits consumption smoothing. Third we assume quadratic utility to enable a closed-form solution. We also assume that the expected value of discounted future labour income is less than, C^*, the bliss level of consumption, that the consumer forms rational expectations, and that r_t, the real rate of return on assets, $r_t = \sigma = r > 0$, is fixed.

Given the above theoretical structure, it is easy to show that $\bar{C}_t$ is a random walk and that a closed-form solution exists given by[4]:

$$\begin{aligned} \Delta C_t &= \phi_1 \Delta C_{t-1} - \phi_2 \Delta C_{t-2} - \psi_0 \Delta NL_{t-1} + \\ &\quad \psi_1 \Delta NL_{t-2} - \psi_2 \Delta NL_{t-3} + (1 - \sum_{s=1}^{3} \rho_s B^s) u_t \end{aligned} \tag{4}$$

where $\phi_1 = (1+h)a + z$, $\phi_2 = (1+h)az$, $\psi_0 = hz$, $\psi_1 = (a+\delta)hz$, $\psi_2 = a\delta hz$, $\rho_1 = a + \delta + z$,

[4]See Appendix A for a derivation of (4)

$\rho_2 = -a(\delta + z) - \delta z$, $\rho_3 = a\delta z$ and u_t represents a white noise error term. Past values of ΔNL_t capture the habit modification effect: they moderate the effect of lagged changes in consumption.

Equation (4) is a general model of habit modification that nests the following hypotheses:

1. the random walk model of Hall (1978), when $h = a = z = \delta = 0$ and $C_t^F = C_t$;
2. the pure durable hypothesis of Mankiw (1982), when $h = a = z = 0$ and $\delta > 0$;
3. the standard habit formation model, when $h, a > 0$, $C_t^F = C_t$ and $z = 0$; and
4. Ermini's (1997) model of habits with durability, when $h, a, \delta > 0$ and $z = 0$.

We adapt Shea's (1995) procedure to test whether the consumption response to positive and negative changes in anticipated income is asymmetric. We can express our model as

$$\begin{aligned}\Delta C_t &= \phi_1 \Delta C_{t-1} + \phi_2 \Delta C_{t-2} + \psi_0^* D^+ \Delta NL_{t-1} + \\ &\quad \psi_1^* D^+ \Delta NL_{t-2} + \psi_2^* D^+ \Delta NL_{t-3} + \psi_0^{**} D^- \Delta NL_{t-1} + \\ &\quad \psi_1^{**} D^- \Delta NL_{t-2} + \psi_2^{**} D^- \Delta NL_{t-3} + (1 - \sum_{s=1}^{3} \rho_s^* B^s) u_t \qquad (5)\end{aligned}$$

where $\phi_1^* = hz\phi_1$, $\phi_2^* = hz\phi_2$, $\phi_3^* = hz\phi_3$, D^+ and D^- are dummy variables: $D_t^+ = 1$ if $\Delta NL_t > 0$, and zero otherwise and $D_t^- = 1$ if $\Delta NL_t < 0$ and zero otherwise. A test of the habit modification hypothesis involves the parameter restrictions: $\phi_1 > 0$, $\phi_2 < 0$, $\psi_0^* < 0$, $\psi_1^* > 0$, $\psi_2^* < 0$ and $\psi^* *_0 = \psi_1^{**} = \psi_2^{**} = 0$.

3 The evidence: USA, 1959-1997

3.1 The Data

Quarterly time-series data for the U.S.A. from the National Income and Product Accounts (NIPA) and the Flow of Funds Accounts are used to test the maintained hypothesis. These data are per capita and in constant-prices ($1992 = 100$) over the period 1959:1-1997:4. The NIPA series are seasonally adjusted revised estimates by the Bureau of Economic Analysis. Seasonally adjusted flow of funds estimates are also available but, for total liabilities, they come at annual rates. Therefore, we used unadjusted total liabilities figures which we adjusted by the Census $X - 11Q.2$ technique.

Personal consumption expenditure on non-durables and services is our measure of consumption, C_t. In the previous section, we referred to new liabilities as the variable responsible for habit modification. Since, however, it is not clear which particular characteristic of credit impacts most on habits, we now take a broader view, using four measures as proxies for NL_t: the flow of total liabilities (FL_t), the flow of consumer credit (FCC_t), outstanding household debt (L_t) and outstanding consumer credit (CC_t). In order to test for asymmetries, we construct two new series for each one of the above proxies; FL_t^+, FL_t^-, FCC_t^+, FCC_t^-, ΔFL_t^+, ΔFL_t^-, ΔFCC_t^+ and ΔFCC_t^-, where $FL_t^+ = FL_t$ when $FL_t > 0$ and zero otherwise, $FL_t^- = FL_t$ when $FL_t \leq 0$ and zero otherwise, and so on.

An important assumption in our dynamic model (5) is that ΔC_t and ΔNL_t are stationary. Thus, it is important to confirm that the data series in levels are at most integrated of order 1. Two alternative testing procedures are adopted. The first is the Augmented Dickey-Fuller

(ADF) (Dickey and Fuller 1981) test which assumes a unit root as the null hypothesis. The second test is derived using stationarity as the null (Kwiatowski *et al.* 1992); hereafter KPSS.

Table 1 reports the results. Columns 1 and 2 contain t-values for the ADF tests for the series in levels and in first differences respectively. As expected, the results indicate that the flow of total credit, FL_t, and outstanding liabilities, L_t, are $I(1)$. Also, the consumer credit flow, FCC_t and the asymmetric constructs are stationary. The surprises are that consumption, C_t, and outstanding consumer credit, CC_t, seem to be stationary. In a growing economy, one would expect both consumer credit and consumption to be $I(1)$ processes. The $I(0)$ result may be associated with the fact that the data are contaminated by outliers which makes ADF tests unreliable (see next section). Note, however, that the KPSS test results confirm most of the ADF results, except that both C_t and CC_t are now $I(1)$. We, thus, conclude that C_t L_t, FL_t and CC_t are all $I(1)$ while FCC_t and the asymmetric series are $I(0)$.

3.2 GMM Estimation

This section examines the hypothesis that new credit leads to habit modification. To begin with, we test the adequacy of model (4). Note that $h > 0$ is the habit formation parameter which captures the psychological effect of the habit stock on current utility. The model predicts that $\phi_1 > 0$, $\phi_2 < 0$, $\psi_0 < 0$, $\psi_1 > 0$ and $\psi_2 < 0$.

There is an important econometric issue to consider prior to estimation of the model. This relates to the use of lagged values of the endogenous variable, ΔNL, as explanatory variables in a regression having an MA(3) component in the error term. As a result, the regressors will potentially correlate with the error term and application of OLS will produce biased and inconsistent estimates. The solution to this problem involves the use of instrumental variables. We use the Generalised Method of Moments (GMM) procedure, since it can also deal with non-linearities. Moreover, when the number of moment restrictions, p, is greater than the number of parameters to be estimated, k, the GMM estimation procedure also provides a simple test for overidentifying restrictions. Hansen (1982) has demonstrated that the minimised value of the objective function times n is asymptotically distributed as a chi-square with (p-k) degrees of freedom:

$$nJ_n(\widehat{\boldsymbol{\beta}}_{GMM}) \xrightarrow{d} \chi^2(p-k) \tag{6}$$

which can be used to test for the validity of these restrictions. If the $nJ_n(\widehat{\boldsymbol{\beta}}_{GMM})$ value is significant, it would indicate that at least some of the sample moment restrictions are violated (i.e., some instrumental variables are not valid) and that the model is not consistent with the data.

We begin our empirical analysis by examining the distribution of the first difference of consumption, ΔC. This is estimated by an OLS regression using a constant and lagged values. Given the theoretical results in section (2.1), three lags are used. Normality tests indicate that the series is not normally distributed.[5] Upon examination, the excess kurtosis problem is due to an outlier associated with the second quarter of 1980, which coincides with the deregulation of depository institutions and the Monetary Control Act. When a dummy variable is included in the regression, the residuals become normal; the Jarque-Bera test statistic becomes 0.34[0.84] (p-values in brackets). However, within the context of ARMAX

[5] As a remedy, extra autoregressive terms were added but the problem remained.

estimation, the use of a dummy is suspended until GMM estimation results are obtained.

Next, we define our information set. The instruments chosen are as follows.

- lags $2-5$ of ΔC. Although there is some question about the validity of the second lag as an instrument, its inclusion is based on the following reasons. First, ΔC_{t-1} is a statistically significant predictor of ΔC_t and thus substantial information is lost if we fail to use ΔC_{t-2} as an instrument for ΔC_{t-1}. Second, within the framework of ARMAX estimation, it is possible to use the second lag and not violate the orthogonality condition, as it is the instrument set, $\mathbf{Z}$, as a whole that has to be orthogonal to the residuals. Later in the paper, we test the validity of this assumption.
- lags $2-5$ of the change in the index of consumer sentiment, the change in the seasonally adjusted unemployment rate, the change in the Standard and Poors 500 stock price index and the change in the 3-month treasury bill rate[6,7],
- lags $1-3$ of the credit variable in consideration.

Table 2 reports the results of GMM estimation when the flow credit variables are used.[8] Columns 1 to 2 of the table provide GMM estimates of equation (4) when the variables are

[6] These variables are often used as instruments in the consumption literature. See, for example, Ferson and Constantinides (1991) and Carroll, Fuhrer and Wilcox (1994).

[7] ADF and KPSS tests suggest that the index of consumer sentiment, the unemployment rate, the Standard and Poors 500 stock price index and the 3-month treasury bill rate are all *locally* $I(1)$ processes; here, the term 'locally' is used to convey the idea that these variables can be $I(1)$ even though they are bounded.

[8] The heteroskedasticity and autocorrelation consistent Newey-West estimator was used to obtain an optimal estimate for W. For the kernel, the *Dirichlet* lag window was used and the bandwith was fixed at $l = 2$. The former is defined as $(l+1- \mid k \mid)/(l+1)$ where $k = -l, ..., 0, 1, ...l$ and l is the lag length. According to the Newey and West (1987) selection criteria, a consistent estimator of the weighting matrix is obtained if the weight, $w(l)$, approaches one as l is free to grow with the sample size; in particular, they suggest that $l(n)$ must grow by less than $n^{1/5}$. With 150 observations, this would suggest that $l = 4$ would be appropriate. However, the GMM results are robust to this and are available from the authors upon request.

in levels and a constant is included. As a measure of ΔNL_t, we use the change in the flow of total liabilities, ΔFL_t, in regression 1 and the change in the flow of consumer credit, ΔFCC_t in regression 2. Regressions 3 to 4 are based on equation (5), which admits asymmetries in habit modification, using ΔFL_t and ΔFCC_t, respectively.

Prior to GMM estimation, however, we are interested to know whether the appearance of ΔC_{t-2} and $\sum_{i=1}^{3} \Delta NL_{t-i}$ in $\mathbf{Z}$, violates the orthogonality conditions and impinges on the consistency of $\widehat{\boldsymbol{\beta}}$. To address this concern, we apply Hausman's (1978) H specification test (estimates of H appear at the lower part of table 2). All Hausman tests indicate that the orthogonality conditions are unaffected by the presence of ΔC_{t-2} and $\sum_{i=1}^{3} \Delta NL_{t-i}$ in (5). This allows us to treat the credit variables as exogenous.

The findings from the GMM estimation can be summarised as follows. Firstly, the coefficients of both ΔC_{t-1} and ΔC_{t-2} have the correct sign in all regressions but only the first is significant (i.e., consumer inertia). Secondly, only for ΔFCC_{t-1} is the coefficient significantly less than zero as expected. Thirdly, regression 4 provides some support for the hypothesis of asymmetric habit modification; the coefficients of the first two lags of ΔFCC_t are both significant and of the right sign when new consumer credit is positive. Note also that all regressions pass the Hausman and Hansen tests indicating that the orthogonality conditions hold and the overidentifying restrictions are valid.

However, the results do not completely conform to the predictions of the model in several respects. First, ΔC_{t-2} is never a significant predictor of consumption movements. Second, the coefficients of ΔFCC_{t-2} are not significant while that of ΔFCC_{t-3} is positive. Third, the first and third lagged values of ΔFCC_t^- are also significant which suggest weak evidence of asymmetric habit modification.

Next, we proceed with GMM estimation using the outstanding debt series. Table 3 presents evidence that is more supportive of the habit modification hypothesis. Regression 4, in particular, suggests that **outstanding** consumer credit, in levels, is consistent with asymmetric habit modification This because the coefficients of FCC^{+}_{t-1}, FCC^{+}_{t-2} and FCC^{+}_{t-3} are all significant with the correct signs. Further, the coefficients of FCC^{-}_{t-1} and FCC^{-}_{t-2} are not significant, and FCC^{-}_{t-3} appears with the wrong sign.

We now examine whether the above supportive evidence holds for particular sample periods. We select the mid-1970s to split the sample into two and test the maintained hypothesis again. Our partition of the data is based on the following considerations. First, there has been a substantial increase in the level of household indebtedness since that period. Second, since the mid-1970s there have been relatively high levels of unemployment which imply an increased level of income uncertainty.

The first sub-sample is between 1959:1 and 1974:4, the second between 1975:1 and 1997:4. To conserve space, we only report the results associated with the latter sample (see table 4), noting in passing that the evidence from the first sub-sample is not consistent with the predictions of the model.[9] When the more recent data are used, the strong supportive evidence found for the full sample is reproduced. Table 4, however, is more informative than the full sample results in two respects. It indicates that asymmetric habit modification via consumer credit is mainly associated with data in levels, for the coefficient of ΔC_{t-2} is not negative in regression 1. Moreover, it provides some evidence of **permanent** habit modification. This can be inferred by the fact that the coefficient of ΔC_{t-1} has become much

[9] Results from the first sub-sample are available on request from the authors.

smaller in magnitude in the most recent period; it reduces from 0.65 in regression (4), table 3, to 0.33 in regression 2, table 4. This constitutes about 50% reduction in the degree of habit formation.

These results, however, should be interpreted with caution since all the above GMM estimates are subject to an anomaly. This relates to the distribution of the residuals. Tests of skewness and kurtosis reveal that these residuals are not normally distributed. The latter test statistic is reported at the end of each table and is significant in all regressions. We noted this problem earlier and alluded to an outlier problem. The culprit appears to be the financial reforms in the second quarter of 1980. As a remedy for this, we repeated the GMM procedure for each of the regressions discussed above by using a dummy, $D1$, which takes the value of one in 1980:2 and zero in other periods. However, the problem of non-normal residuals persisted in most of the regressions and this is probably due to an additional outlier in 1980 : 3. As a result, we constructed an alternative dummy variable, $D2$ which takes the value of -1 in 1980 : 2, 1 in 1980 : 3 and zero otherwise. With the inclusion of this dummy, the non-normality problem disappears. The results themselves do not appear to be affected by the addition of the dummies.[10]

Overall, GMM estimation has provided strong evidence in favour of the habit modification hypothesis. The results also indicate that new consumer credit is more important than new liabilities in modifying consumer habits. We also find that asymmetric habit modification is consistent with the data, when consumer credit outstanding is used as a credit measure.[11] This behavioural difference between consumer credit and mortgage credit could be attributed to the fact that consumer credit is short-term finance and is more regularly used by the typical

[10] These results are available upon request.

[11] The results are quite encouraging in view of the restrictive assumptions imposed on the model; e.g., quadratic preferences, the constancy of real interest rates etc.

consumer. This acts as a frequent stimulus for more long-term planning. Moreover, credit constraints are less binding for consumer credit, and consumer credit is more directly related to the flow of services from consumption expenditure.

The evidence presented here is also consistent with the view that the availability of consumer credit has had a long-lasting effect on consumer behaviour. As predicted by our model, financial liberalisation has not eliminated habits altogether. However consumer credit has reduced consumer dependence on past consumption levels and has assisted consumers in becoming **more** forward-looking.

Finally, we note two reasons why the evidence is supportive of the habit modification hypothesis via credit. First, there is a lagged credit effect on consumption. This cannot be explained by the alternative hypothesis of liquidity constraints since the latter only predicts a contemporaneous effect of credit on consumption. Second, there is an asymmetric relationship between new credit and changes in consumption expenditure which, again, cannot be explained by the liquidity constraints hypothesis.

4 Habit modification and the existing evidence

How do the predictions of the rational habit modification model relate to the previous empirical literature? First, the evidence of 'excess sensitivity' seems weaker in the post-deregulation era. This can be interpreted as evidence in support of Hall's (1978) hypothesis. The evidence is also consistent with habit modification via credit: the relaxation of liquidity constraints has enabled consumers to moderate their habits. In doing so, consumer behaviour has approximated that predicted by the LC-PIH. Also, by offsetting habit persistence, new debt has obscured the link between consumption changes and anticipated income changes and has provided empirical support for the random walk hypothesis. Therefore, it is possible to empirically reject the 'excess sensitivity' hypothesis when the underlying model is one of habit modification.

If the 'excess sensitivity' effect has in fact been asymmetric (Shea 1995) the response to income declines is stronger than that associated with income increases. This asymmetry is inconsistent with liquidity constraints, Keynesian behaviour and existing habit formation models. Our model provides an alternative to Shea's (1995) use of loss aversion to rationalise the asymmetry. Recall that in equation (4) habits are modified only when consumer debt rises. In this case the link between ΔC_t and expected income changes, ΔY_t^e, will be weak and consumption will tend to behave as if a random walk.[12] On the other hand, when $\Delta NL_{t-1} = \Delta NL_{t-2} = \Delta NL_{t-3} = 0$, our model reduces to a standard habit formation model where ΔC_{t-1} will be more likely to correlate with ΔY_t^e. Therefore, if it can be established that ΔNL_{t-1} and ΔY_t^e correlate positively, then the observable link between expected income changes and lags of ΔC_t will mainly be associated with $NL_{t-1} \leq 0$. This positive correlation can be established in two steps. First, observe that ΔC_t responds positively to ΔC_{t-1} and to innovations in permanent income. Upward adjustments imply smoothing which is facilitated by credit or by running down assets. This suggests a positive but **weak** association between ΔNL_t and ΔC_t. Second, recall that a positive correlation between ΔC_{t-1} and predictable income is to be expected due to persistence. Hence, there exists a weak, positive correlation between ΔNL_{t-1} and ΔY_t^e and the asymmetry can be attributed to habit modification via credit.

[12] Strictly speaking, however, the MA(3) component should still be present.

The finding that the 'excess sensitivity' effect is time-varying (Bacchetta and Gerlach 1997 *inter alia*) has been attributed to time-varying credit constraints. However, it is also consistent with the habit modification hypothesis. This is because consumers' experience with debt and, thus, with habit modification, will tend to vary throughout the business cycle. In recessions (booms), consumers tend to revise their expectations of future income (upwards) downwards and rely (more) less on credit. Hence, the representative consumer will exhibit relatively more inertia and higher sensitivity to expected income in troughs and in recovery.

How do our results relate to recent findings attributing the revival of the LC-PIH to the easing of liquidity constraints? First note that it is unlikely that the change in credit is a good proxy for liquidity constraints. This becomes especially relevant in a deregulated financial environment where demand and supply depend on the price of credit.[13] Second, even if we accept the view that credit is a good proxy for time-varying liquidity constraints, the liquidity constraints hypothesis predicts only a contemporaneous credit effect on changes in consumption, as shown by Bacchetta and Gerlach (1997). This instantaneous effect has also been established by Hayashi (1987) who showed that liquidity-constrained consumers increase their current spending at the time constraints are lifted.[14] Third, the liquidity constraints effect of credit is solely confined to the short-run while the habit modification hypothesis also has implications for long-run consumption. Fourth, in the habit modification hypothesis it is the contractual nature of credit that is important and not liquidity. Thus, one would

[13] Previous studies have used a variety of variables as indirect estimates of liquidity constraints. These include income growth or the unemployment rate (Flavin 1985), the borrowing/lending wedge (King 1986 and De Brouwer 1996), the debt to consumption ratio or the down-payment ratio in housing mortgages (Jappelli and Pagano 1989), and the value of durables (Chah *et al.* 1995)

[14] In practice, a lagged credit effect is possible since new credit itself exhibits persistence. However, under liquidity constraints, the sign of the ΔNL_{t-1} coefficient should be the opposite of what we would expect in the habit modification model since constrained consumers should increase consumption as more credit becomes available.

expect household credit as well as consumer credit to relate to consumption expenditure. The liquidity constraints hypothesis, on the other hand, has emphasised consumer credit (Ludvigson 1999 and Bacchetta and Gerlach 1997).[15] Finally, the prediction of a habit modification via credit suggests that credit will continue to be important even under a regime of perfect capital markets.

5 Conclusion

The empirical consumption literature in the 1990s has observed an important shift in consumer behaviour since the deregulation of financial markets. In the absence of an alternative hypothesis, the literature has attributed this phenomenon to a supply effect of credit availability. However models of 'self-control' also assign a role to credit. Moreover, household credit is a device towards the restraint of an irrational or myopic self and/or a defense mechanism against 'hyperbolic discounting', as in Ainslie (1992).

In this paper we have argued that credit can also play a role within the habit formation framework. Credit motivates consumers to become detached from past consumption by depleting the habit stock. This form of consumption externality leads to a model where past commitments to credit moderate dependence on past levels of consumption.

In this paper, we test for the validity of the habit modification hypothesis in the short-run using US data for the period 1959:1-1997:4. The overall evidence provides strong support for the maintained hypothesis of habit modification. Further, the evidence is consistent with

[15] Still, Wirjanto (1995) has advanced the idea that total household debt can capture time-varying liquidity constraints if it positively correlates with the borrowing rate.

the view that consumer debt leads to asymmetric habit modification where only a positive change in consumer debt impacts on habitual behaviour. Finally, the paper shows that consumer participation in credit markets has permanently raised consumption since 1975.

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Appendix A

Derivation of Equation (4)

Since marginal utility is linear, $\bar{C}_t$ is a random walk: $\Delta\bar{C}_t = u_t$. Therefore,

$$\sum_{j=0}^{\infty} \delta^j \Delta C_{t-j} = ah \sum_{j=0}^{\infty} a^j \Delta C^F_{t-1-j} - zh \sum_{j=0}^{\infty} z^j \Delta NL_{t-1-j} + u_t \tag{A.1}$$

Subtracting $a \sum_{j=0}^{\infty} \Delta C_{t-1-j}$ from both sides of $(A.1)$ and substituting to obtain:

$$\begin{aligned} \sum_{j=0}^{\infty} \delta^j \Delta C_{t-j} &= a \sum_{j=0}^{\infty} \delta^j \Delta C_{t-1-j} + ah\Delta C^F_{t-1} - zh \Big[\sum_{j=0}^{\infty} z^j \Delta NL_{t-1-j} - \\ & \quad a \sum_{j=0}^{\infty} z^j \Delta NL_{t-2-j} \Big] + [1 - aB]u_t \end{aligned} \tag{A.2}$$

where B is the backshift operator, $BX_t = X_{t-1}$. Since $\sum_{j=0}^{\infty} \delta^j \Delta C_{t-j} = \delta \sum_{j=0}^{\infty} \delta^j \Delta C_{t-1-j} + \Delta C_t$ and $\Delta C^F_{t-1} = \sum_{j=0}^{\infty} \delta^j \Delta C_{t-1-j}$ it follows that,

$$\begin{aligned} \Delta C_t &= [(1+h)a - \delta] \sum_{j=0}^{\infty} \delta^j \Delta C_{t-1-j} - h(z-a) \sum_{j=0}^{\infty} z^j \Delta NL_{t-1-j} - \\ & \quad ha\Delta NL_{t-1} + (1 - aB)u_t \end{aligned} \tag{A.3}$$

Subtracting $\delta \Delta C_{t-1}$ from $(A.3)$ and using $\sum_{j=0}^{\infty} z^j \Delta NL_{t-2-j} = 1/z(\sum_{j=0}^{\infty} z^j \Delta NL_{t-1-j} - \Delta NL_{t-1})$ to factorise, yields

$$\Delta C_t = (1+h)a\Delta C_{t-1} - hz \Big[\frac{(z-a)(z-\delta)}{z^2} \sum_{j=0}^{\infty} z^j \Delta NL_{t-1-j} +$$

$$\frac{(z-a)\delta + az}{z^2}\Delta NL_{t-1} - \frac{a\delta}{z}\Delta NL_{t-2}\Bigg] + (1-aB)(1-\delta B)u_t \tag{A.4}$$

Note that, when $z = 0$, this is Ermini's (1997) closed-form solution for ΔC_t. Next, we subtract $z\Delta C_{t-1}$:

$$\begin{aligned}
\Delta C_t \;=\; & [(1+h)a + z]\Delta C_{t-1} - (1+h)az\Delta C_{t-2} - \\
& \frac{(z-a)(z-\delta)h}{z}\Delta NL_{t-1} + \frac{[(z-a)\delta + az]h}{z}\Delta NL_{t-1} - \\
& [(z-a)\delta + az]h\Delta NL_{t-2} + ha\delta\Delta NL_{t-2} - \\
& ha\delta z\Delta NL_{t-3} + (1-aB)(1-\delta B)(1-zB)u_t
\end{aligned} \tag{A.5}$$

Which may be simplified to obtain,

$$\begin{aligned}
\Delta C_t \;=\; & \phi_1\Delta C_{t-1} + \phi_2\Delta C_{t-2} + \\
& \psi_0\Delta NL_{t-1} + \psi_1\Delta NL_{t-2} + \psi_2\Delta NL_{t-3} + \\
& (1 - \sum_{s=1}^{3}\rho_s B^s)u_t
\end{aligned} \tag{A.6}$$

where $\phi_1 = (1+h)a + z$, $\phi_2 = -(1+h)az$, $\psi_0 = -hz$, $\psi_1 = (a+\delta)hz$, $\psi_2 = -a\delta hz$, $\rho_1 = a + \delta + z$, $\rho_2 = -a(\delta + z) - \delta z$ and $\rho_3 = a\delta z$. which is equation (4) in the main text and may be written as the ARMAX model

$$(1 - \sum_{s=1}^{2}\phi_s B^s)\Delta C_t = -(hz - \sum_{s=1}^{2}\psi_s B^s)\Delta NL_{t-1} + (1 - \sum_{s=1}^{3}\rho_s B^s)u_t \tag{A.7}$$

Appendix B

Data sources and adjustments

Consumption expenditure data:

These are from tables 1.2 and 2 in NIPA at the National Accounts site of the Bureau of Economic Analysis, www.bea.doc.gov/bea/dn1.htm. The NIPA estimates are contained in the publication *Survey of Current Business* published by the Bureau. These are in Billions of chained (1992) dollars defined as the 'real' series (i.e., current-dollar value divided by the appropriate 1992-based implicit price deflator) multiplied by a corresponding quantity index number which is then divided by 100.

Flow of funds data:

Credit data are from the Board of Governors, FRB web page www.bog.frb.fed.usa. The flow of total liabilities, FL_t, and the flow of consumer credit, FCC_t, are from file 'utab100d.zip'; variables $FU154190005.Q$ and $FU153166000.Q$ respectively. The corresponding outstanding estimates, L_t and CC, are from file 'ltab100d.zip'; variables $FL154190005.Q$ and $FL153166000.Q$ respectively.

Seasonal adjustment of credit data

The Census X-11Q.2 package was used to adjust Flow of Funds data. The procedure is available in EVIEWS V. 2 but has a data limitation: it cannot deal with samples longer than 30 years in quarterly data. To overcome this problem, we split the sample into two 30-year sub-samples. The first covers the period 1959:1-1988:4, the second the period 1968:1-1997:4. For each of the three variables, we obtained an adjusted series and the associated factors. Next, we compared the two adjustment factor series over the overlapping period. Fortunately, all variables produced factors that were almost identical over the period 1976-1980. On that basis, the factors from the first sub-sample were employed to adjust the data over the period 1959:1-1977:4 and the factors from the second sub-sample were used to adjust the most recent data.

Table 1: ADF and KPSS test results

Variable X_t	Lags	ADF Tests		KPSS Tests					
		(1)	(2)	η_μ			η_τ		
Original		τ_τ	τ	0	2	4	0	2	4
C	3	-3.67*	-4.74*	15.41*	5.22*	3.17*	0.91*	0.32*	0.19*
FL	3	-3.55*	-6.44*	1.71*	0.74*	0.49*	0.29*	0.13	0.09
FCC	0	-3.69*	-15.1*	0.29	0.11	0.07	0.27*	0.10	0.07
L_t	4	-1.20	-3.20*	14.83*	5.05*	3.08*	3.00*	1.02*	0.63*
CC_t	2	-4.91*	-3.27*	13.96*	4.77*	2.93*	0.45*	0.16*	0.09
Asymmetric									
FL_t^+	7	-4.32*		2.25*	0.95*	0.63*	0.33*	0.14	0.09
FL_t^-	0	-9.52*		0.32	0.22	0.18	0.31*	0.22*	0.17*
FCC_t^+	0	-3.69*		0.70*	0.27	0.18	0.27*	0.10	0.07
FCC_t^-	0	-5.28*		0.85*	0.37	0.27	0.35*	0.15*	0.11

Note: * denotes significance at the 5% level. The 5% asymptotic (response surface) critical values for τ_τ and τ are -3.44 and -2.88 respectively. The 5% asymptotic critical values for η_μ and η_τ are 0.463 and 0.146 respectively. The ADF test includes a trend and constant in (1) and only a constant in (2). The BIC criterion was used to select the lag length. In the KPSS tests, the lengths of 0, 2 and 4 relate to the lag window.

Table 2: GMM estimation results: Credit Flows.

Regressions				
	(1)	(2)	(3)	(4)
constant	26.9 (3.68)*	27.5 (3.74)*	21.1 (3.05)*	27.5 (3.96)*
ΔC_{t-1}	0.59 (3.85)*	0.57 (4.30)*	0.61 (4.03)*	0.51 (4.14)*
ΔC_{t-2}	-0.05(-0.59)	-0.04(-0.54)	-0.02(-0.29)	-0.01(-0.15)
ΔFL_{t-1}	-0.08(-0.92)			
ΔFL_{t-2}	0.04 (0.42)			
ΔFL_{t-3}	0.14 (2.65)			
ΔFCC_{t-1}		-0.55(-3.32)*		
ΔFCC_{t-2}		0.25 (1.70)		
ΔFCC_{t-3}		0.51 (3.78)*		
Testing for Asymmetries				
ΔFL^{+}_{t-1}			-0.03(-0.51)	
ΔFL^{+}_{t-2}			-0.15(-1.86)	
ΔFL^{+}_{t-3}			-0.16(-2.73)*	
ΔFL^{-}_{t-1}			-0.22(-1.69)	
ΔFL^{-}_{t-2}			-0.14(-1.46)	
ΔFL^{-}_{t-3}			-0.12(-1.95)	
ΔFCC^{+}_{t-1}				-0.38(-2.29)*
ΔFCC^{+}_{t-2}				0.65 (3.51)*
ΔFCC^{+}_{t-3}				0.49 (2.65)*
ΔFCC^{-}_{t-1}				-0.56(-2.57)*
ΔFCC^{-}_{t-2}				-0.19(-0.80)
ΔFCC^{-}_{t-3}				0.65 (3.02)*
Hausman (H)	2.72 [0.84]	2.35 [0.88]	2.32 [0.98]	1.24 [0.99]
Hansen (nJ)	19.34 [0.37]	17.34 [0.49]	17.57 [0.48]	19.96 [0.39]
Kurtosis	0.75 [0.07]	0.98 [0.02]*	0.87 [0.03]*	1.38 [0.00]*

Note: t-statistics are in parentheses and p-values in square brackets. * denotes significance at the 5% level.

Table 3: GMM Estimation: Outstanding Debt.

	(1)	(2)	(3)	(4)
Regressions				
constant	23.5 (3.48)*	22.2 (3.06)*	9.29 (1.08)	19.9 (2.20)*
ΔC_{t-1}	0.62 (3.72)*	0.63 (4.63)*	0.66 (5.06)*	0.65 (4.75)*
ΔC_{t-2}	-0.06(-0.73)	-0.06 (-0.91)	0.01 (0.19)	-0.04 (0.66)
FL_{t-1}	-0.14(-1.49)			
FL_{t-2}	0.14 (2.24)*			
FL_{t-3}	0.03 (0.37)			
FCC_{t-1}		-0.54 (-2.88)*		
FCC_{t-2}		-0.82 (-3.70)*		
FCC_{t-3}		-0.18 (-1.23)		
Testing for Asymmetries				
FL^+_{t-1}			-0.05(-0.72)	
FL^+_{t-2}			0.16 (2.49)*	
FL^+_{t-3}			-0.06 (-0.83)	
FL^-_{t-1}			-0.63 (-3.93)*	
FL^-_{t-2}			-0.09 (-0.71)	
FL^-_{t-3}			0.26 (1.96)	
FCC^+_{t-1}				-0.42 (-2.05)*
FCC^+_{t-2}				1.14 (4.21)*
FCC^+_{t-3}				-0.63 (-3.41)*
FCC^-_{t-1}				-0.75 (-1.64)
FCC^-_{t-2}				-0.30 (-0.81)
FCC^-_{t-3}				0.58 (2.59)*
Hausman (H)	2.59 [0.86]	3.26 [0.77]	1.95 [0.99]	2.97 [0.96]
Hansen (nJ)	17.98 [0.46]	17.18 [0.51]	18.86 [0.40]	18.66 [0.41]
Kurtosis	0.85 [0.04]	0.97 [0.02]*	1.11 [0.01]*	1.19 [0.00]*

Note: t-statistics are in parentheses and p-values in square brackets. * denotes significance at the 5% level.

Table 4: GMM Estimation: Outstanding Debt, USA 1975:1-1997:4.

	Regressions	
	(1)	(2)
constant	39.0 (5.13)*	48.3 (3.72)*
ΔC_{t-1}	0.33 (2.84)*	0.33 (2.61)*
ΔC_{t-2}	0.01 (0.17)	-0.02 (-0.29)
ΔLC_{t-1}		
ΔLC_{t-2}		
ΔFCC^{+}_{t-1}	-0.38 (2.72)*	
ΔFCC^{+}_{t-2}	0.59 (2.66)*	
ΔFCC^{+}_{t-3}	0.38 (2.16)*	
ΔFCC^{-}_{t-1}	-0.48(-2.65)*	
ΔFCC^{-}_{t-2}	-0.24(-1.10)	
ΔFCC^{-}_{t-3}	0.53 (3.40)*	
FCC^{+}_{t-1}		-0.53 (-2.92)*
FCC^{+}_{t-2}		1.04 (4.47)*
FCC^{+}_{t-3}		-0.51 (-2.55)*
FCC^{-}_{t-1}		-0.12 (-0.34)
FCC^{-}_{t-2}		0.10 (0.32)
FCC^{-}_{t-3}		0.58 (2.56)*
Hausman (H)	0.08 [0.99]	0.19 [0.99]
Hansen (nJ)	15.23 [0.65]	23.05 [0.15]
Kurtosis	2.38 [0.00]*	3.19 [0.00]*

Note: t-statistics are in parentheses and p-values in square brackets. * denotes significance at the 5% level.