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EXCESS SENSITIVITY, LIQUIDITY CONSTRAINTS, AND THE COLLATERAL ROLE OF HOUSING

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We estimate consumption Euler equations using U.K. household-level data, employing a switching regression technique. We find excess sensitivity to income for one group of households but not for a second group. The likelihood of excess sensitivity is greater for the young, those without liquid assets, the degree-educated, ethnic minorities and those with negative home equity, consistent with liquidity constraints and buffer-stock saving. Housing capital gains affect the consumption plans of the excess sensitivity group of households, but not the other group. These results are consistent with a "collateral channel" for housing. Around 20%–40% of U.K. households display excess sensitivity.

Keywords: Consumption-Smoothing, Switching Regression, Collateral

1. INTRODUCTION

In recent years, there has been increasing interest in the role of housing and its relationship with consumption and the business cycle. On one view, house prices merely reflect macroeconomic conditions with no special role of their own. But, on another view, there is an important causal effect of housing in providing collateral that allows credit to be obtained on more favorable terms, which helps to support consumption. That role may be particularly strong for those that might otherwise have been constrained by the availability of credit. The collateral channel can be understood as relaxing a liquidity constraint directly or as providing equity that can be extracted at some point in the future, which also will affect current consumption plans. Among other things, this collateral channel could amplify the

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effects of monetary policy on the economy [Iacoviello (2005); Aoki, Proudman, and Vlieghe (2004)]. However, there is little evidence regarding whether housing equity fulfils this role as collateral and how it affects households' consumption plans. Confronting the collateral hypothesis with micro-data for the first time is one aim of this paper.

We also revisit some long-standing questions in the analysis of household consumption behavior. These include: How well do households smooth consumption over their life cycle? What determines the likelihood that a household fails to smooth consumption? And to what percentage of households does that apply? Does a departure from consumption smoothing reflect the existence of credit market imperfections? We address these questions as they apply in the United Kingdom using household-level data for the period 1992 to 2002.

Our paper makes the following contributions. First, we revisit the issue of excess sensitivity of consumption plans to income, but for a sample of U.K. households. Second, and more substantively, we model explicitly the likelihood that a household's behavior falls into one of two "regimes," which are, ex ante, unknown. Our results allow us to interpret this as the probability that a household's consumption displays excess sensitivity. There are only a small number of studies that have attempted to model that propensity. Third, we explore for the first time using micro-data the role of housing in facilitating consumption smoothing and the existence of the collateral channel. Significantly, that involves modeling the effect of housing equity as working through the likelihood of excess sensitivity as well as through a direct effect on consumption—where that effect on consumption distinguishes between constrained and unconstrained households. Under the collateral channel, house prices should have a stronger effect on the spending of the constrained than on the unconstrained group.

The remainder of the paper is organized as follows. Section 2 reviews the economic background in terms of the permanent income hypothesis and tests of excess sensitivity. Section 3 describes our switching regression estimation strategy, presents the household data from the British Household Panel Survey, and discusses the estimation results. Section 4 concludes.

2. ECONOMIC BACKGROUND

2.1. Theoretical Background

Our theoretical background draws on the optimization problem facing an unconstrained consumer subject only to a flow of funds constraint and a consumer also facing a borrowing constraint which may be tied to the value of its housing.

For the unconstrained household, the basic Euler equation under standard assumptions including the absence of liquidity constraints and habits in consumption but allowing for income uncertainty can be stated as

$$(1 + r_t)\beta E_t\left[\frac{u_c(c_{t+1}, z_{t+1})}{u'(c_t, z_t)}\right] = 1, \qquad \textbf{(1)}$$

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where r is the interest rate, β is the discount factor and $u_c(c_t, z_t)$ is the marginal utility of consumption, which depends on consumption (c) and a vector of observable variables (z). Those observable variables may include endogenous variables such as housing or durables consumption more generally. E_t is the expectations operator, conditional on information at t.[1] Assuming utility takes the constant relative risk-aversion form and dropping the set of observable characteristics (z), $u(c) = \frac{c^{1-\rho}}{1-\rho}$. where $\rho > 0$ and denotes the coefficient of relative risk-aversion, the following Euler equation can be derived as a first-order approximation [e.g., Carroll (2001a)]:

$$\Delta \ln c_{t+1} = \rho^{-1}(r_t - \delta) + \epsilon_{t+1}, \qquad (2)$$

where δ is the discount rate (i.e., $\beta = 1/(1+\delta)$) and ϵ_{t+1} is iid and uncorrelated with any variable known at t. Crucially, current or lagged income (and income growth) are absent from Equation (2) because all past and predictable information is incorporated in current consumption.

The constrained household faces a budget constraint that links its borrowing capacity to the collateral value of its home. For example, $B_t \leqslant mE_t q_{t+1}/(1+r_t)$, where B_t is the amount borrowed, which cannot exceed some fraction m of the expected value of the home, q_{t+1}. Iacoviello (2004) assumes the liquidity constrained households attach no weight to the future and simply consume their current income and borrow up to their borrowing limit. This is a similar view to Campbell and Mankiw's (1989) approach that the economy consists of unconstrained and rule-of-thumb consumers who consume their current income. For those that are constrained, their real estate demand condition implies that their marginal utility of consumption today is influenced by the Lagrange multiplier on this borrowing constraint that ties borrowing capacity to house prices. The model of Iacoviello (2004), although not allowing for income uncertainty, shows how increases in house prices and income enhance the household's borrowing capacity and, for the constrained household, implies bringing forward spending from the future to the present.[2]

In Zeldes's (1989) earlier model, the liquidity constraint takes the form of a nonnegative floor to the value of net assets. Zeldes (1989) emphasized that this modifies the Euler condition (1) through the addition of a Lagrange multiplier on that borrowing constraint:

$$u'(c_t, z_t) = (1+r_t)\beta E_t u_c(c_{t+1}, z_{t+1}) + \lambda_t, \qquad (3)$$

where λ_t is the Lagrange multiplier associated with the set of nonnegative asset constraints $A_{t+k} \geqslant 0$ for $k \geqslant 0, 1..T-t-1$. This represents a set of borrowing constraints that, as of t, the household experiences and anticipates for the future. If the borrowing constraint is binding then the Lagrange multiplier will be positive and this implies higher current marginal utility from consumption and a lower growth rate in consumption for $t+1$ than otherwise. Zeldes (1989) does not specifically highlight the role of housing in relaxing the liquidity constraint,

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although if an increase in collateral values relaxed the budget constraint then this would operate through the Lagrange multiplier, λ_t.

Tests of excess sensitivity, by Zeldes (1989) and others, have proceeded by estimating the following equation:

$$\Delta \ln c_{t+1} = \alpha \ln y_t + \varepsilon_{t+1}, \quad (4)$$

where y is household income. A number of other control variables might be added to Equation 4, but the key hypothesis is $H_0 : \alpha = 0$ under the permanent income model and rational expectations. In many studies [e.g., Hall (1978); Zeldes (1989); Jappelli, Pischke, and Souleles (1998)], the (log) level of income is used. Attanasio and Weber (1993) use the growth in income.[3] The income term can be considered as predictable income or income growth in t or $t + 1$, using instruments dated $t - 1$ or earlier.

Liquidity constraints have generally been emphasized as the most likely source of any excess sensitivity. Carroll and Kimball (2005) and Carroll (2001b) emphasize the observational equivalence between a model of liquidity constraints (given income uncertainty) and a model of precautionary saving because of income uncertainty. In fact, both of these types of models can be thought of as generating precautionary saving. In the liquidity constraints model that arises because of the possibility that a liquidity constraint binds in the future, the household's ability to respond to any shock is restricted, and this raises the expected value of holding precautionary assets.

Attanasio and Low (2004) outline the conditions under which estimated linearized Euler equations avoid substantial biases in the estimated underlying structural parameters. In so doing, they defend the estimation of linearized Euler equations against the critique of Carroll (2001a). Our approach is less formally derived from a specific model of household consumption. Instead, we aim to supplement the type of Euler equations previously found in the literature with a collateral role for housing. Our estimation also allows for the existence of different groups with differing capacities to smooth consumption.

2.2. Empirical Evidence

Following Hall's (1978) estimates of an aggregate Euler equation—which found no evidence that consumption growth was correlated with lagged levels of income—subsequent studies generally contested that conclusion, but with some notable exceptions.[4] Hall and Mishkin (1982) found evidence of excess sensitivity using household-level data.[5] An influential study was that by Zeldes (1989), who found that consumption growth was negatively related to lagged income for households with low wealth-to-income ratios. This was interpreted as evidence that such households faced borrowing constraints that impeded their ability to smooth consumption.

Some studies of liquidity constraints have employed an indicator for whether the household has been denied credit or believes they would be denied credit.[6]

Jappelli et al. (1998) found stronger excess sensitivity for that group, interpreted as evidence of liquidity constraints. A number of studies have been motivated by attempting to shed light on what determines the propensity for a household to face a credit constraint—at least in the United States. Jappelli (1990) estimated the likelihood for having been denied credit to be higher for the young, the less wealthy, and nonwhites. Garcia, Lusardi, and Ng (1997) modeled consumption as well as a probability of being constrained using a switching regression technique and found a similar pattern of results.[7]

The role of housing in these studies has been largely unexplored. This is despite the link between house prices and consumption being the subject of considerable debate. As an exception, Hurst and Stafford (2004) examined home equity release in the United States. They found that households with a low level of liquid assets that experienced a negative income shock (i.e., suffered unemployment) were more likely to refinance, consistent with consumption smoothing. Home equity loans in the United Kingdom have grown in importance since the mid-1980s, although they are less common among mortgage holders than in the United States. In our sample period, 7% of the households withdrew home equity (Benito, 2008).

In Iacoviello (2004), an aggregated Euler equation across constrained and unconstrained households is derived where constrained (borrower) households must borrow against housing equity. In addition to increasing the likelihood of being in the unconstrained regime, for those in that regime, consumption responds to capital gains on housing, but housing capital gains should not influence the consumption of the unconstrained households. When estimating an aggregate Euler equation for the United States, a role for house prices emerges. Around 20%–25% of aggregate consumption is accounted for by constrained households. The aggregate estimation could not distinguish directly between the consumption of constrained and unconstrained households and the suggested different role for housing in the case of each. We are able to address that issue later.[8]

A key hypothesis we wish to consider, we believe for the first time, is that those who are more likely to be credit constrained—based on objective and theoretically sound criteria rather than an ad hoc indicator—respond more strongly to capital gains on housing than the unconstrained. That hypothesis is the distinguishing feature of the collateral channel.[9]

Policy makers have also debated the role of debt and whether there are limits to the extent to which debt assists consumption smoothing. On one view, debt capacity is limited by already having a large amount of debt on the household balance sheet. One mechanism for this could be a risk premium added by lenders to those already highly leveraged. On an alternative view, debt does not influence a household's subsequent ability to smooth through any shock. We also consider these competing hypotheses. The fact that both factors may hold but differ in their intensity according to the level of debt, with debt capacity being restricted when debt is at especially high levels, for instance, suggests that the role of debt in influencing the probability of being credit constrained may be nonlinear, even nonmonotonic.

2.3. Explanations for Excess Sensitivity

The literature typically has focused on credit constraints as the rationale for any finding of excess sensitivity. Carroll (2001b) argues, however, that those studies may equally be interpreted as identifying which households have a stronger precautionary saving motive. Carroll and Kimball (2005) show the formal equivalence of a model with a liquidity constraint and income uncertainty with a model of precautionary saving. It is extremely difficult to identify separately liquidity constrained households from those saving for precautionary reasons more generally and the two effects interact with one another. An inability to borrow when income is low provides an additional motive for accumulating assets when income is high. Consequently, we prefer simply to indicate which households display greater evidence of excess sensitivity, and to try to establish which characteristics are associated with that propensity.

There are other models that might generate excess sensitivity. Following Garcia et al. (1997), we attempt to shed some light on which of these models appear to attract more support. In particular, we exploit different predictions for whether consumption responds in an asymmetric way to predicted income growth under some of these models of consumption. Under liquidity constraints (or precautionary saving) households are impeded in their ability (or are reluctant) to borrow ahead of rising expected income but not to save ahead of falling income. That implies a stronger response to anticipated positive income growth than to negative income growth. In contrast, "rule of thumb" behavior, would seem to suggest a similar response to anticipated rises and falls in income. A further possibility is a form of habits known as "loss aversion" where individuals are especially averse to revising their consumption plans downward [Tversky and Kahneman (1991)]. In this case, if a household anticipates a downturn in its income, rather than adjust consumption downward immediately it waits, in the hope that it may not need to. The reaction will be less strong for positive income growth and indeed may be entirely absent from anticipated positive income growth.[10]

3. ESTIMATION AND RESULTS

3.1. Estimation Strategy

3.1.1. The switching regression model. We employ a switching regression estimator for unknown regimes, estimated by maximum likelihood. This involves estimation of the standard consumption Euler equation, distinguishing between two groups of households.

$$\begin{aligned} \Delta \ln c_{i,t+1} &= a_c + \alpha_a \ln y_{i,t} + Z'_{i,t+1}\gamma + \varsigma_t + v_{i,t+1}, \\ &\qquad \text{if } \Phi(X'_{i,t+1}\delta + \epsilon_{i,t+1} > 0) \ \text{ Group A} \\ \Delta \ln c_{i,t+1} &= a_{uc} + \alpha_b \ln y_{i,t} + Z'_{i,t+1}\lambda + \chi_t + \varepsilon_{i,t+1}, \\ &\qquad \text{if } \Phi(X'_{i,t+1}\delta + \epsilon_{i,t+1} \leq 0), \ \text{ Group B} \end{aligned} \tag{5}$$

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where i indexes households $i = 1, 2 \ldots N$ and t indexes years $t = 1, 2, T$. y denotes household income and Z is a set of taste shifters, the change in family size, age of the household head and controls for changes in the number of full-time and part-time workers and changes in health status of household members. ς_t and χ_t are sets of time effects, reflecting aggregate effects on consumption growth, common across households in the two different groups.[11] These equations will later be supplemented by the addition of terms reflecting the housing market.

A key issue concerns the allocation of the Group A and Group B households. This is determined according to the probit model that allocates a household to one group or the other, given by

$$\Pr(X'_{i,t+1}\delta + \epsilon_{i,t+1} > 0) = \Phi(X'_{i,t+1}\delta), \tag{6}$$

where, as in (5), $\Phi(.)$ is the normal cumulative density function, whereas X is a vector of household characteristics including household income growth, liquid assets, age, educational attainment, marital status, gender, and race. Individual-level characteristics refer to the head of household. The rationales for these terms should be relatively clear from our discussion above. The two regimes are intended to capture groups that differ in their ability to smooth consumption, with the probit model identifying the characteristics associated with that greater willingness or ability to smooth consumption. That equation might reflect preferences or a difference in the ability to smooth consumption. The latent variable may, in part, reflect the attitude (and pricing) of banks in extending credit to the household including the credit score of the individual as a function of the household's demographic and financial characteristics. Hu and Schiantarelli (1998) employ a similar estimator in a study of liquidity constraints and company investment.

One strategy for identification is to impose the restriction $\alpha_b = 0$ in the Group B Euler equation. Alternatively, one may estimate the system unconstrained and make inference about the two regimes by examining the difference in $\widehat{\alpha}_a$ and $\widehat{\alpha}_b$. We focus on this approach but have verified that our results are robust to imposing the $\alpha_b = 0$ restriction. The equations in (5) and (6) are estimated jointly by maximizing the log-likelihood given by[12]

$$\text{Log}\, L = \sum_{NT} \ln\left[\frac{1}{\sigma_{v_{i,t+1}}}\phi\left(\frac{v_{i,t+1} \mid X'_{i,t+1}\delta + \epsilon_{i,t+1} > 0}{\sigma_{v_{i,t+1}}}\right)\Phi(\delta X_{i,t+1} + \epsilon_{i,t+1} > 0)\right]$$
$$+ \left[\frac{1}{\sigma_{\varepsilon_{i,t+1}}}\phi\left(\frac{\varepsilon_{i,t+1} \mid X'_{i,t+1}\delta + \epsilon_{i,t+1} \le 0}{\sigma_{\varepsilon_{i,t+1}}}\right)\Phi(\delta X_{i,t+1} + \epsilon_{i,t+1} \le 0)\right],$$

where $\phi(.)$ denotes the normal probability density function, $\sigma_z = \text{var}(z)$ and

$$\Phi(\delta X_{i,t+1} + \epsilon_{i,t+1} > 0) = \Phi\left(\frac{X'_{i,t+1}\delta + \frac{\rho_{v_{i,t+1},\epsilon_{i,t+1}} \times v_{i,t+1}}{\sigma_{v_{i,t+1}}}}{\sqrt{1 - \rho^2_{v_{i,+1t},\epsilon_{i,t+1}}}}\right)$$

$$\Phi(\delta X_{i,t+1} + \epsilon_{i,t+1} \leq 0) = \Phi\left(\frac{X'_{i,t+1}\delta + \frac{\rho_{\varepsilon_{i,t+1},\epsilon_{i,t+1}} \times \varepsilon_{i,t+1}}{\sigma_{\varepsilon_{i,t+1}}}}{\sqrt{1 - \rho^2_{\varepsilon_{i,t+1},\epsilon_{i,t+1}}}}\right),$$

$\rho_{\upsilon_{i,t+1},\epsilon_{i,t+1}}$ and $\rho_{\varepsilon_{i,t+1},\epsilon_{i,t+1}}$ denote the correlation coefficients between the errors of the probit selection equation, $\epsilon_{i,t+1}$, and the error terms of the two Euler equations. In this general form, this model is the endogenous switching model described in Maddala (1986). If it is assumed that $\rho_{\upsilon_{i,t+1},\epsilon_{i,t+1}} = \rho_{\varepsilon_{i,t+1},\epsilon_{i,t+1}} = 0$ then this becomes the exogenous switching model used by Garcia et al. (1997).[13] We employ the general endogenous switching model as our baseline specifications but also have considered the restricted model.[14,15]

There are considerable advantages to the switching regression approach over the more common sample-splitting approach, typified by Zeldes (1989). First, it is unlikely that one variable used for sample splitting, such as liquid assets relative to income, will be sufficient to capture the range of influences that will influence one's propensity to consumption smooth. Misclassification of households into the wrong regime will reduce the power of the tests to discriminate between alternative regimes. Second, this approach generates further results that will be of interest in their own right. This includes generating an estimate of the proportion of households that do not consumption smooth. Third, it acknowledges that there is uncertainty in the classification system, a point highlighted by Jappelli et al. (1998).[16]

3.2. The Data

This study employs data from the British Household Panel Survey for the years 1992 to 2002. The BHPS consists of an annual, panel-based survey of approximately 5,500 households in Britain, which began in 1991. The dataset provides detailed information on employment, education, income, and demographic characteristics of households but also contains some information on consumption and the household balance sheet in terms of mortgage debt, a (self-reported) estimated value of the home, and interest receipts.[17] Further details are provided in the appendix.

Summary statistics for the main variables of interest are presented in Table 1. Average annual real consumption growth is 0.010 (i.e., 1%) and is subject to a large standard error (0.200) with substantial variation across households, although part of that will reflect measurement error. Average (real) income growth over the period is 0.039 (3.9%) and also varies greatly across households. The average loan-to-value ratio is 0.342 indicating that households typically have quite large amounts of equity in their home, although that includes households with no home equity and no debt. Likewise, on average, a household has 1.6 times its annual income in net housing equity and less than its annual income in outstanding debt. Average capital gains on housing are quite high, at 21% of annual income, and with substantial variation across households.

TABLE 1. Summary statistics

	Mnemonic	Mean	St. dev.
Consumption growth	$\Delta \ln c$	0.010	0.200
Income growth	$\Delta \ln y$	0.039	0.424
Weekly income (£, 1995 prices)	y	577.83	325.78
Positive income growth	$\Delta \ln \hat{y}^{+}_{it+1}$	0.057	0.077
Negative income growth	$\Delta \ln \hat{y}^{-}_{it+1}$	−0.018	0.062
Age		42.21	11.19
Adults		2.051	0.795
Married		0.719	
White		0.969	
Owner-occupier		0.773	
Degree-educated		0.171	
A-level qualifications		0.319	
Housing			
Loan-to-value	ltv	0.342	0.353
Housing equity to annual income	HW/Y	1.591	2.253
Capital gain to income	$(\Delta HW)/Y$	0.212	0.695
Mortgage debt-to income	D/Y	0.914	1.056
Observations	n	26,542	

Note: Table reports sample means and standard deviations where relevant.

During the sample period, the U.K. housing market experienced quite significant swings in activity. In the early 1990s, the market was somewhat depressed with negative nominal house price inflation and a protracted period of recovery followed, up to the mid-1990s. In the late 1990s and early 2000s, the market was supported by reductions in unemployment to a low and stable level alongside reductions in nominal and real interest rates. By the end of the sample period, national house price inflation exceeded 20%.

3.3. Estimation Results

We discuss the results first in terms of the evidence on excess sensitivity to income and then in terms of the probability of being in the two different groups of households. The four specifications reported in Table 2 consider three different definitions of the income term for the excess sensitivity test and an alternative definition of the liquid assets term. We then consider the role of housing.

3.3.1. Excess sensitivity. In terms of the excess sensitivity tests, our two key findings are the following. First, there is evidence of excess sensitivity in only one of the two regimes. This suggests that regime consists of a group who fail to consumption smooth, but outside of that group, households consumption smooth very effectively in the sense that they do not display excess sensitivity. Second, this finding is robust to considering income in differences or in levels.

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TABLE 2. Endogenous switching regression models

$\Delta \ln c_{it+1}$	Group A households			
$\ln y_{it}$	−0.013 (0.005)	−0.013 (0.005)		
$\ln y_{it-1}$			−0.019 (0.007)	
$\Delta \ln y_{it}$				0.022 (0.010)
$\ln(age)_{it+1}$	−0.061 (0.016)	−0.056 (0.016)	−0.035 (0.019)	−0.024 (0.019)
$\Delta adults_{it+1}$	0.360 (0.009)	0.363 (0.009)	0.378 (0.011)	0.384 (0.011)
$\Delta children_{it+1}$	0.105 (0.007)	0.106 (0.007)	0.108 (0.009)	0.109 (0.009)
Labor supply controls	yes	yes	yes	yes
Health controls	yes	yes	yes	yes
Year effects	yes	yes	yes	yes
	Group B households			
$\ln y_{it}$	0.000 (0.003)	0.000 (0.003)		
$\ln y_{it-1}$			0.001 (0.003)	
$\Delta \ln y_{it}$				−0.002 (0.004)
$\ln(age)_{it+1}$	−0.069 (0.008)	−0.069 (0.008)	−0.072 (0.008)	−0.072 (0.008)
$\Delta adults_{it+1}$	0.093 (0.003)	0.094 (0.003)	0.093 (0.004)	0.093 (0.004)
$\Delta children_{it+1}$	−0.040 (0.004)	−0.040 (0.004)	−0.045 (0.004)	−0.044 (0.004)
Labor supply controls	yes	yes	yes	yes
Health controls	yes	yes	yes	yes
Year effects	yes	yes	yes	yes

TABLE 2. (Continued.)

Marginal effects	Probability equation			
$\Delta \ln y_{it}$	−0.003 (0.017)	0.007 (0.017)	0.006 (0.020)	0.010 (0.020)
Y^W/Y	−0.085 (0.044)			
Any liquid assets ($y^W > 0$)		−0.065 (0.0207)	−0.095 (0.035)	−0.101 (0.035)
ln(age)	−0.244 (0.036)	−0.248 (0.036)	−0.220 (0.047)	−0.219 (0.047)
Married	−0.230 (0.021)	−0.223 (0.021)	−0.237 (0.026)	−0.233 (0.026)
Non-white	0.085 (0.046)	0.088 (0.047)	0.106 (0.058)	0.102 (0.058)
Male	0.058 (0.023)	0.057 (0.023)	0.034 (0.028)	0.027 (0.028)
Degree-educated	0.036 (0.021)	0.046 (0.021)	0.076 (0.026)	0.087 (0.026)
A-levels	−0.068 (0.023)	−0.062 (0.023)	−0.047 (0.028)	−0.040 (0.028)
Owner-occupier	−0.024 (0.020)	−0.015 (0.021)	0.007 (0.026)	0.006 (0.026)
Log-likelihood	7609.663	7611.142	5621.234	5770.527
% predicted probabillity ⩾ 0.5	21.0	22.1	20.1	19.9
% consumption	14.0	14.0	12.9	12.6
% income	14.2	14.2	13.0	12.7
ρ_1	0.249 (0.079)	0.202 (0.077)	0.016 (0.082)	−0.088 (0.080)
ρ_2	−0.016 (0.114)	−0.030 (0.113)	−0.025 (0.119)	0.048 (0.116)
Observations	20,799	20,799	15,383	15,383

Notes: Maximum likelihood estimates for switching regression models with unknown regimes. Standard errors in parentheses. The marginal effects refer to the change in the predicted probability of being in Group A for a unit change in the regressors, evaluated at the means. ρ_1 (ρ_2) is the correlation between the error term of the probit equation and that of the Group A (B) consumption Euler equation.

In column 1 the level of income, dated $t-1$, is considered in the Euler equation. In the first group—which we refer to as the excess sensitivity group—the coefficient (standard error) is −0.013 (0.005), whereas in the second, consumption smoothing, group the income term is insignificant with a coefficient (standard error) of 0.000 (0.003). The presence of credit constraints or buffer stock saving implies that consumption growth should be higher than otherwise. In the excess sensitivity group consumption growth is negatively related to lagged income as an increase in income improves a household's ability to smooth consumption across periods thereby lowering their consumption growth [see also Zeldes (1989) for further discussion]. The other demographic terms show plausible signs.

3.3.2. Propensity for excess sensitivity. The bottom panel of the table shows estimates for the propensity of the household to be in the excess sensitivity group. These are marginal effects giving the effect on the probability of being in Group A for a unit change in the explanatory variable (or a discrete change for the dummy variables). Our estimates indicate that the probability of excess sensitivity is higher for those with fewer liquid assets relative to their income, for the young, for the unmarried, for those from ethnic minorities and for those that possess a higher education (degree) qualification.

The propensity for excess sensitivity is estimated to be unrelated to income growth. There are two important points here. First, it is future expected income growth that should raise the probability of excess sensitivity, either because such households are more likely to want to borrow or because this effectively raises the degree of impatience [Carroll (2001b)]. Second, an effect of this kind is how we interpret the positive role for a degree qualification. The specification in column 3 for instance, suggests that having a degree raises the probability of excess sensitivity by 0.08. We therefore interpret the effect of a higher education qualification to be through its impact on the income profile and thereby on the demand for credit.[18] In contrast, further education qualifications (specifically, A levels in the United Kingdom) are negatively related to the probability of excess sensitivity, relative to a household head with neither of these as his/her highest academic qualification.

Column 1 considers an asset income term relative to household income; it is on the margin of significance and suggests that larger amounts of asset income, and liquid assets, relative to current income lower the probability of excess sensitivity. Because asset income is likely to be measured with significant error, we also consider a dummy variable for any positive asset income ($y^W > 0$), which is more highly significant. It suggests that having asset income lowers the probability of excess sensitivity by 0.07 (column 2) to 0.10 (columns 3 and 4). In a model of liquidity constraints this can be interpreted as the fact that having liquid assets lowers the likelihood of facing such a liquidity constraint; in a buffer stock saving model, this follows automatically from the concavity of the consumption function, being concave in the level of "cash-on-hand" or liquid assets plus current income.

Moving from someone aged 25 to someone aged 50 is associated with a reduction in the predicted probability of being in the excess sensitivity group by around

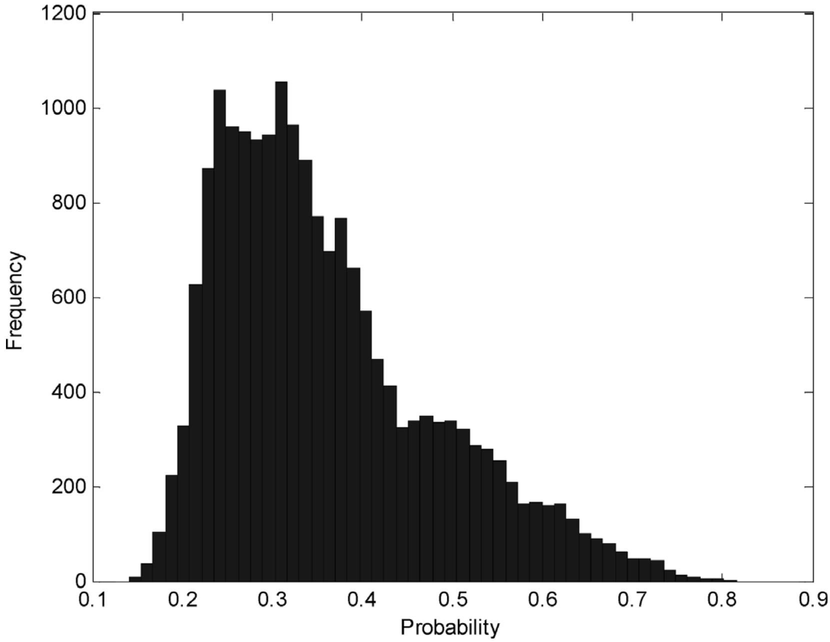

FIGURE 1. Distribution of predicted probabilites of being in Group A.

0.25, controlling for the other characteristics. There are again different ways of interpreting this depending on the favored explanation for excess sensitivity. Under liquidity constraints, it reflects the fact that at younger ages, with a rising earnings profile in age, there is a greater demand for bringing consumption forward and, hence, a greater likelihood of having one's consumption influenced by the presence of the credit constraint. Under buffer stock saving, it reflects the fact that the young remain in the process of accumulating their buffer stock to weather emergencies.

The race variable, whether the household head is white or not, is also significant. The probability of excess sensitivity increases by around 0.10 for nonwhite households. One interpretation is that those from ethnic minorities face discrimination in credit markets. But there are other interpretations and it may reflect differences in the income process. There is no strong evidence, in the results in Table 2, that home ownership matters. We explore the role of housing and debt later.

We use two main criteria to indicate the extent of excess sensitivity in the United Kingdom. On one definition, we use the proportion of households with a predicted probability of being in Group A of at least 0.5, which applies to around 20% of U.K. households. These households account for around 14% of aggregate consumption and a similar proportion of income. Another, arguably better, criterion simply takes the mean predicted probability. That mean probability is close to 0.4 suggesting that almost 40% of households display excess sensitivity. The distribution of predicted probabilities of being in Group A is shown in Figure 1.

In columns 1 and 2 the estimate of $\rho_{v_{i,t+1},\epsilon_{i,t+1}}$ (labeled ρ_1) is significant while that of $\rho_{\varepsilon_{i,t+1},\epsilon_{i,t+1}}$ (ρ_2) is not. This suggests that the endogenous switching model is to be preferred over that the exogenous switching model, although in columns 3 and 4, ρ_1 is not significant. We also consider the exogenous switching model results as a robustness check. The results from the Euler equation were qualitatively very similar to the endogenous switching model and so, for brevity, they are not reported.

3.3.3. Housing equity, debt, and consumption smoothing. The coincidence of housing and consumption booms in the United Kindom and elsewhere has motivated much research on the links between the housing market and consumption. Part of this link is likely to reflect both variables being driven by other factors, in particular, income expectations [King (1990)]. Among the most likely causal explanations for a housing market-consumption link is for reasons of housing acting as collateral. A shock to house prices and increase in home equity may improve the terms on which credit can be obtained, facilitating consumption smoothing. But to date there is little evidence on whether this channel operates in practice.

Alongside the debate concerning housing equity and consumption has been a debate on debt. Mortgage debt has grown considerably in the United Kingdom over the past decade. It seems natural to ask, how is debt related to a household's ability to smooth consumption?

We shed light on both questions through the inclusion of financial ratios in the probability equation, reported in Table 3. We allow roles for the loan-to-value, housing equity-to-income and debt-to-income ratios, considered as both quadratic terms and with dummies for different threshold effects in these variables. Additionally, we consider whether capital gains on housing enter directly into the Euler equation and how this differs between the excess sensitivity group and the group that does not display excess sensitivity. In the model of Iacoviello (2004), an increase in housing equity should lead constrained households to bring forward consumption (lowering the rate of consumption growth from then on), whereas for the unconstrained group it should have no effect.

We find evidence that housing equity and debt matter for the likelihood that a household displays excess sensitivity. Consider housing equity first (Table 3). The linear loan-to-value ratio term, *LTV*, is negatively signed, whereas the quadratic term is positively signed; both are statistically significant. The likelihood of excess sensitivity is declining in the loan-to-value ratio up to a value around 0.50 from which point that probability is increasing. For those households with low to moderate amounts of equity in the home, that is, between zero and 50% of the home value, increases in equity relative to debt are associated with a lower probability of displaying excess sensitivity.

In column, 2 the debt variable, D/Y, also displays a nonlinear relationship with the probability of excess sensitivity. Low levels of debt are likely to, in part, reflect lack of access to credit or the costlier terms on which such credit is offered. More interesting is the finding that beyond a certain point, estimated at

TABLE 3. Endogenous switching regression models with housing equity and debt

$\Delta \ln c_{it+1}$			Group A households		
$\ln y_{it}$	−0.011 (0.005)	−0.010 (0.005)	−0.011 (0.005)	−0.024 (0.006)	
$\Delta \ln y_{it+1}$					0.026 (0.008)
$\Delta HW_{it}/Y_{it}$				−0.014 (0.006)	
$\Delta HW_{it+1}/Y_{it}$					0.024 (0.005)
$\ln(age)_{it+1}$	−0.048 (0.016)	−0.041 (0.015)	−0.046 (0.016)	−0.105 (0.020)	−0.051 (0.017)
$\Delta adults_{it+1}$	0.366 (0.009)	0.368 (0.009)	0.367 (0.009)	0.330 (0.010)	0.352 (0.011)
$\Delta children_{it+1}$	0.107 (0.007)	0.108 (0.007)	0.107 (0.007)	0.078 (0.010)	0.087 (0.011)
Labor supply controls	yes	yes	yes	yes	yes
Health controls	yes	yes	yes	yes	yes
Year effects	yes	yes	yes	yes	yes
			Group B households		
$\ln y_{it}$	0.000 (0.003)	0.000 (0.003)	0.000 (0.003)	0.004 (0.003)	
$\Delta \ln y_{it+1}$					0.010 (0.004)
$\Delta HW_{it}/Y_{it}$				0.006 (0.003)	
$\Delta HW_{it+1}/Y_{it}$					−0.001 (0.002)
$\ln(age)_{it+1}$	−0.070 (0.007)	−0.070 (0.007)	−0.070 (0.007)	−0.056 (0.008)	−0.063 (0.007)
$\Delta adults_{it+1}$	0.094 (0.003)	0.094 (0.003)	0.094 (0.003)	0.108 (0.004)	0.105 (0.004)
$\Delta children_{it+1}$	−0.039 (0.004)	−0.039 (0.004)	−0.039 (0.004)	−0.024 (0.005)	−0.026 (0.004)
Labor supply controls	yes	yes	yes	yes	yes
Health controls	yes	yes	yes	yes	yes
Year effects	yes	yes	yes	yes	yes

TABLE 3. (Continued.)

Marginal Effects	Probability equation				
$\Delta \ln y_{it}$	0.007 (0.017)	0.023 (0.018)	0.013 (0.018)	−0.015 (0.015)	0.014 (0.019)
$(Y^W > 0)$	−0.070 (0.028)	−0.076 (0.028)	−0.071 (0.028)	−0.003 (0.019)	−0.032 (0.029)
ln(*age*)	−0.254 (0.039)	−0.269 (0.038)	−0.237 (0.043)	−0.187 (0.036)	−0.183 (0.050)
Married	−0.222 (0.021)	−0.220 (0.022)	−0.224 (0.022)	−0.148 (0.016)	−0.197 (0.023)
Non-white	0.088 (0.048)	0.087 (0.049)	0.092 (0.048)	0.055 (0.033)	0.072 (0.050)
Male	0.054 (0.023)	0.049 (0.023)	0.052 (0.024)	0.060 (0.018)	0.032 (0.025)
Degree-educated	0.060 (0.022)	0.071 (0.022)	0.061 (0.022)	−0.001 (0.015)	0.068 (0.023)
A-levels	−0.056 (0.024)	−0.049 (0.024)	−0.055 (0.024)	−0.078 (0.019)	−0.051 (0.025)
LTV	−0.212 (0.062)				
LTV-squared	0.222 (0.063)				
D/Y		−0.055 (0.018)			
(D/Y)-squared		0.016 (0.011)			
$(HW/Y) < 0$			0.091 (0.061)	0.028 (0.042)	0.146 (0.066)
$(HW/Y) = 0$			base	base	base
$0 < (HW/Y) \leqslant 0.5$			0.011 (0.029)	−0.005 (0.021)	0.016 (0.031)
$0.5 < (HW/Y) \leqslant 1$			−0.026 (0.027)	−0.017 (0.020)	−0.007 (0.028)
$1 < (HW/Y) \leqslant 2$			−0.041 (0.025)	−0.040 (0.018)	−0.037 (0.026)
$2 < (HW/Y) \leqslant 5$			−0.020 (0.025)	−0.022 (0.018)	−0.016 (0.026)
$5 < (HW/Y)$			0.026 (0.035)	−0.008 (0.024)	0.020 (0.035)
Log-likelihood	7617.654	7615.864	7615.876	7252.741	7259.428
% pred. prob. $\geqslant 0.5$	23.3	23.4	23.2	9.4	14.8
% total consumption	14.2	14.3	14.2	4.8	8.5
% total income	14.3	14.3	14.3	4.9	8.6
ρ_1	0.125 (0.074)	0.053 (0.072)	0.231 (0.067)	0.856 (0.035)	0.095 (0.087)
ρ_2	−0.019 (0.106)	−0.020 (0.106)	−0.221 (0.098)	−0.369 (0.127)	−0.043 (0.114)
Observations	18,614	18,614	18,614	18,614	18,614

around twice annual income, further increases in debt become associated with a rising probability of being in the excess sensitivity group. That might reflect an increased likelihood of facing a credit constraint—including a self-imposed credit constraint associated with a reluctance to take on more debt. This suggests that there are limits, either on the demand- or supply-side of the credit market, to the ability of debt to facilitate consumption smoothing.

When considering the role for housing equity relative to income (HW/Y), the nonlinearity is picked up better by considering dummy variables for different levels of housing equity.[19] There might be special interest in a role for negative equity with such households having higher probabilities of being credit constrained, although only 2.2% of household-year observations fall into this category.

In columns 3 to 5, there is some evidence of higher levels of housing equity lowering the probability of excess sensitivity, particularly compared to the group of households with negative home equity. The specifications differ in their treatment of the consumption Euler equation described later. In column 3, the term for negative equity ($HW/Y < 0$) is almost significant, relative to the base group of no housing equity. Having larger positive amounts of home equity significantly lowers the probability of being in the excess sensitivity group relative to having negative equity: the coefficient on the dummy for home equity between one and two times annual household income is significantly different from that on the dummy for negative equity at the 5% level [$\chi^2(1) = 5.02$; p-value $= 0.024$]. At higher levels of home equity, its role becomes insignificant. Why housing equity should not be related to the probability for consumption smoothing for those with especially high levels of equity is not clear. A preliminary analysis of those households (i.e., with $HW/Y > 5$) suggests that these tend to be older households with relatively low levels of income. It may be that these households have a strong bequest motive for their housing, making them reluctant to use the equity to smooth consumption, and the fixed transactions costs in accessing that equity may be higher relative to their (lower) income level. In column 4, a significant role for intermediate levels of home equity to be associated with a lower likelihood of excess sensitivity emerges, and in column 5 a statistically significant role for negative home equity in raising the likelihood of excess sensitivity (relative to the base group of no home equity) emerges more clearly.

In column 4, we extend our earlier Euler equations by adding a role for the change in housing equity relative to income in a model otherwise identical to that in Table 2, column 2. The capital gain to income ratio term $\Delta HW_{it}/Y_{it}$ is significantly negative for the Group A ("excess sensitivity") households for whom the term attracts a "t-ratio" of 2.4, and is at the margin of significance—but positively signed—for the Group B households. This suggests that, in a similar way to income, capital gains on housing may support consumption—for households that would otherwise be credit constrained—allowing the household to bring forward spending, which lowers the rate of consumption growth from that year to the next. This mechanism may operate by relaxing a borrowing limit [e.g., Kiyotaki and Moore (1997)] or by relaxing the terms on which equity can be

TABLE 4. Asymmetries in the consumption response to income growth

	[1]	[2]
	Group A households	
$\Delta \ln \hat{y}_{it+1}$	0.537 (0.090)	
$\Delta \ln \hat{y}^{+}_{it+1}$		0.620 (0.087)
$\Delta \ln \hat{y}^{-}_{it+1}$		0.381 (0.108)
	Group B households	
$\Delta \ln \hat{y}_{it+1}$	0.125 (0.038)	
$\Delta \ln \hat{y}^{+}_{it+1}$		0.070 (0.039)
$\Delta \ln \hat{y}^{-}_{it+1}$		0.207 (0.043)
Log likelihood	7633.293	7639.662
% constrained	21.6	19.0
% consumption	13.6	11.3
% income	13.6	11.4
Observations	20,799	20,799

Notes: Maximum likelihood estimates for switching regression models. Standard errors in parentheses. Specifications also include the full set of controls and probit equation shown in Table 3.

borrowed [e.g., Aoki et al. (2004)]. In column 5, we alter the timing of the housing capital gains and income growth terms. Here, we show that capital gains on housing raise consumption growth contemporaneously as does income growth, for the excess sensitivity or constrained group of households but not for the Group B set of households. This again confirms our previous intuition.

The results in columns 4 and 5, which include the housing equity terms, are generally associated with a lower percentage of households having an elevated (above 0.5) predicted probability of being in the excess sensitivity group of households. However, the mean predicted probability is less sensitive to the inclusion of the housing capital gains terms. At close to 0.3, that mean predicted probability still suggests that around 30% of households are classified as demonstrating excess sensitivity.

We have also estimated the Euler equations in our switching regression framework and included a role for asymmetric responses to predictable income growth. Table 4, column 1, reports a model that includes the symmetric change in predicted income based on demographic characteristics of the household [see Benito and Mumtaz (2006) for further details]. If the permanent income hypothesis and rational expectations hold, then predicted income should be insignificant for both types of consumers. In column 2, we investigate asymmetries in responses to positive and negative predicted income growth.

Consumption models based on liquidity constraints predict a stronger (positive) response of consumption growth to positive predicted income growth than to negative income growth since liquidity constraints only impede a household's ability to borrow against future expected income growth and not to save ahead

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of future expected income reductions. That would also be expected in a buffer-stock saving model as such behavior reflects a "self-imposed" liquidity constraint. Therefore, we would expect $\Delta \ln \widehat{y}^{+}_{i,t+1}$ to have a larger effect than $\Delta \ln \widehat{y}^{-}_{i,t+1}$ and especially so in the Group A households. We find that the effect of predictable income growth is more positive for the group that displays greater excess sensitivity, with a coefficient over four times as large as for the Group B households. The point estimates in column 2 suggest that the Group A households react more strongly to $\Delta \ln \widehat{y}^{+}_{it}$ than $\Delta \ln \widehat{y}^{-}_{it}$, consistent with the liquidity constraints or buffer stock saving explanation for excess sensitivity. Formally, the coefficients are significantly different from one another at the 5 per cent level [$\chi^2(1) = 5.11$; p-value $= 0.024$]. Estimates for Group B households are instead consistent with loss aversion. For those households, the impact of positive predicted income growth is smaller than the effect of negative predictable income growth and the null of equality of coefficients can be rejected [$\chi^2(1) = 9.52$; p-value $= 0.002$].

4. CONCLUSIONS

This paper has examined the consumption behavior of households in the United Kingdom. We have examined the role of housing and the incidence of excess sensitivity of consumer spending, using data from the British Household Panel Survey (BHPS) for the years 1992 to 2002. In distinguishing between different groups of households using household-level data, we have also provided evidence on the determinants of a household's likelihood of displaying excess sensitivity.

We have found evidence of excess sensitivity for one set of households but absent in a second group. We find that the young, those without liquid assets, those from ethnic minorities and the degree educated are significantly more likely to display excess sensitivity. The source of this excess sensitivity is unclear but a plausible explanation is that it reflects the combined effects of liquidity constraints and precautionary saving behavior, with precautionary saving effectively giving rise to a "self-imposed" credit constraint making households reluctant to borrow [Carroll (2001b)].

We estimate that around 20%–40% of U.K. households fall into the excess sensitivity group. Our other major contribution has been to explore the role of housing equity in facilitating consumption smoothing. We find that negative home equity increases the likelihood of displaying excess sensitivity. Additionally, for the excess sensitivity group of households, we find that housing capital gains enter directly in the Euler equation. That is consistent with a significant collateral channel for housing. Housing capital gains may increase borrowing limits or allow borrowing on more favorable terms, thereby allowing households to bring forward spending.

NOTES

1. Hall (1978) assumed that utility was quadratic and that the rate of interest was equal to the discount rate and derived the random walk result that Δc_{t+1} is white noise.

2. The extent of substitution possibilities between housing and consumption will also matter. An increase in the relative price of housing would lead households to attempt to substitute away from

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housing toward (nonhousing) consumption goods. But the link would depend on what caused house prices to rise. If house prices rise because of a preference shift (an increase in the marginal utility of housing services), then this would imply an increase in house prices and a reduction in (nonhousing) consumption growth.

3. Several studies also include an interest rate term in (4). In household-level studies, because interest rates are essentially constant across the population this is subsumed into a set of time effects. Using variation in marginal tax rates as a source of variation in the posttax interest rate is unlikely to provide a reliable estimate of the elasticity of intertemporal substitution (the coefficient on the interest rate term).

4. See Flavin (1981), who termed the finding "excess sensitivity," and Campbell and Mankiw (1989), for studies using aggregate data. Attanasio and Weber (1993) highlighted the potential importance of aggregation bias in such aggregate studies.

5. Their results suggested a negative relation between consumption growth and lagged income growth. That applied to a minority of households that together accounted for around 20% of consumption in the United States.

6. Note that this is a measure of credit rationing rather than a liquidity constraint more generally where credit may be available but at a higher interest rate; it is also a backward-looking indicator.

7. Two studies that did not find general evidence of liquidity constraints using household-level data are Blundell, Browning, and Meghir (1994) and Meghir and Weber (1996). The former emphasized the importance of controlling for changes in household demographics and labor market status. The latter found evidence for liquidity constraints among young households.

8. Campbell and Cocco (2007) investigate house price effects on consumption using U.K. household-level data. They do not distinguish between different groups of households according to their likelihood of displaying excess sensitivity.

9. Carroll, Dynan, and Krane (2003) find evidence of precautionary saving in response to unemployment risk when the wealth measure includes housing equity, but not when it is restricted to financial assets.

10. Altonji and Siow (1987) found expected income growth to be insignificant when their sample was split between households expecting income to grow and those expecting their income to decline. Also looking for evidence of asymmetries, Garcia et al. (1997) found evidence to support the liquidity constraints interpretation, but Shea (1995) favored the loss aversion model of consumer behavior.

11. The time effects will include a role for the policy interest rate for instance.

12. In our applications, this is carried out using the BFGS algorithm in Gauss^{TM}.

13. They argue that this assumption of uncorrelated errors is suitable when examining consumption given that, under the permanent income hypothesis and rational expectations, $v_{i,t+1}$ and $\varepsilon_{i,t+1}$ should be uncorrelated with the sample selection error $(\epsilon_{i,t+1})$.

14. We have also investigated the small sample properties of our estimator through Monte Carlo experiments. These results are available from the authors on request and confirm that the estimator performs well in samples significantly smaller than the sample size we employ.

15. Our model does not allow for dynamics in the probability of being constrained. Lee (1997) has proposed a simulated likelihood approximation for this case, but the computational demands of the approximation are prohibitive given our sample sizes.

16. Although more general than many previous studies, this approach shares with others the assumption that a single coefficient on the income term applies to all households in the excess sensitivity group.

17. See Benito (2006) for a study of consumption that uses these data.

18. See Lopes (2003) for a model of consumption, borrowing, and default, which highlights these characteristics.

19. For brevity, we do not report the results, which considered this variable as a quadratic.

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APPENDIX

The typical measure of consumption in household level panel datasets (such as the BHPS or PSID) is food consumption. Use of food consumption data requires an assumption of separability in the utility function between food and other consumption. This is unlikely to hold. But the use of food consumption as the measure of consumption applies to the studies by Hall and Mishkin (1982), Zeldes (1989), Jappelli et al. (1998), among others.

Food is the most general measure of consumption available in the BHPS. However, we address the issue of employing a broader measure by using a second household-level dataset, the Family Expenditure Survey (FES) which we use to relate total, nonhousing, to food expenditure and a set of other demographic characteristics; we then impute a value for total expenditure by each household into the BHPS. This procedure follows Skinner (1987) and has recently been applied in U.S. studies of consumption behavior by Parker (1999) and Palumbo (1999). The following regression is estimated on FES data:

$$\ln c_{it}^{total} = \alpha_1 \ln c_{it}^{food} + \alpha_2 \ln c_{it}^{(food)2} + \alpha_3 \ln c_{it}^{(food)3} + X_{it}^{'}\beta + \varepsilon_{it}, \qquad \textbf{(A.1)}$$

where "i" indexes households, $i = 1, 2 \ldots N$ and t years, 1991, 1992. . . 2001. $c^{(total)}$ is weekly total expenditure excluding that on housing, $c^{(food)}$ is household weekly food expenditure and X is a vector of household-level demographic variables given by the number of adults and children in the household, age of the household-head and his/her education level.

Estimating this function by least squares for FES data for 1991 to 2001 generates coefficients relating total expenditure to food consumption and these demographic variables. Given the same variables in the BHPS we can apply estimates of Equation A.1 to these variables and thereby impute a value for total expenditure for each household in the BHPS over the period 1992 to 2002. More recently, alternative methods for imputing consumption data from food consumption have been developed by Blundell, Pistaferri, and Preston (2004), which we have not employed. Attempts to do so found encountered difficulties in obtaining a negative price elasticity in the food expenditure equation, which may partly be a result of the very limited disaggregation available in a U.K. food price index.