Working Paper no. 306

Consumption excess sensitivity, liquidity constraints and the collateral role of housing

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August 2006

Bank of England

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The views expressed in this paper are those of the authors, and not necessarily those of the Bank of England. We thank Peter Andrews, Charlie Bean, Emilio Fernandez-Corugedo, John Duca, Neal Hatch, seminar participants at the Bank of England, European Central Bank and European University Institute Conference on Finance and Consumption and three anonymous referees. The data employed were originally collected by the ESRC Research Centre on Micro-Social Change at the University of Essex. Neither the original collectors of the data nor the Data Archive bear any responsibility for the analyses presented here. This paper was finalised on 10 May 2006.

The Bank of England's working paper series is externally refereed.

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Publications Group, Bank of England, Threadneedle Street, London, EC2R 8AH; telephone +44 (0)20 7601 4030, fax +44 (0)20 7601 3298, email mapublications@bankofengland.co.uk.

ISSN 1749-9135 (on-line)

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Abstract

Using a switching regression technique we provide unique evidence on three questions concerning the consumption behaviour of UK households. First, what percentage of households display excess sensitivity to income? Second, what affects the likelihood of being in that group? Third, is there a collateral channel from house prices to consumption? We find 20%–40% of households display excess sensitivity. These households may be liquidity constrained or saving for other precautionary reasons. This is found to be more likely for those without liquid assets, with negative home equity, the young, unmarried, non-white and the degree-educated.

According to the 'collateral channel', house prices influence consumption by allowing households that would otherwise be liquidity constrained to borrow on more attractive terms. A key implication of that view is that capital gains on housing should influence the consumption of the liquidity constrained/precautionary saving households, but not other households. We test that implication for the first time and find direct evidence in support.

Key words: Collateral; liquidity constraint; precautionary saving.

JEL classification: D12, C35.

Summary

Consumer expenditure is the dominant component of aggregate demand, and as such, understanding consumption plays a central role in understanding the behaviour of the macroeconomy. That requires a good understanding of how households form their consumption plans. The most influential way of thinking about how households do that is through the life-cycle model. That is based on the idea that households are forward looking and wish to avoid changes in the satisfaction they get from consumption during their lives. In that way, households smooth their consumption.

It has long been recognised that some households may not smooth their consumption to the full extent implied by the life-cycle model. The first aim of this paper is to estimate what percentage of households in the United Kingdom do not smooth their consumption in such a manner. Among other things, that is important for understanding how households will adjust their spending in reaction to shocks that affect their income.

In recent years there has been increasing interest in the role of housing and its relationship with consumption. On several occasions in the past, consumption and house prices have moved together. But Monetary Policy Committee discussions have noted that the reduced-form relationship between consumption and house prices has recently appeared weaker than in earlier periods.

There are various channels through which house prices can influence consumption, notably the so-called collateral channel, and common determinants of both housing demand and consumption. One view has it that house prices are an asset price for an essential commodity, shelter, and that they 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 favourable terms and supports consumption. That role may be particularly strong, or only exist at all, for those that might otherwise have been constrained by the availability of credit. Among other things, this collateral channel could amplify the effects of monetary policy on the economy. However, there is little evidence on whether housing equity fulfils this role and how it affects households' consumption plans. A further aim of this paper is to use microdata to confront the implication of the collateral hypothesis that housing capital gains should affect those

that are liquidity constrained differently from those that are not liquidity constrained.

If households smooth consumption as the life-cycle model implies, then current consumption plans should not react to past news about income: that should already be incorporated into households' consumption plans. In this paper, we explicitly model the likelihood that a household's behaviour falls into one of two 'regimes' according to whether the household displays 'excess sensitivity' to recent income news or not (ie, whether it fails to smooth consumption). We find that around 20%-40% of households display excess sensitivity. These households are liquidity constrained or saving for other precautionary reasons. The former are households who would like to borrow to smooth consumption but cannot, or face a relatively high interest rate which puts them off borrowing. The latter are those who are reluctant to borrow because of the risks of large amounts of debt when future income or expenses are uncertain. They can be said to have a 'self-imposed' liquidity constraint and instead want to accumulate their buffer of assets. We find that households are more likely to fall into either group if they are without liquid assets, have negative home equity, are young, unmarried, non-white or are degree-educated.

Regarding the collateral channel, in addition to the effect of negative home equity in influencing the likelihood of being liquidity constrained, we also find evidence for the effect referred to above, that housing capital gains affect the consumption of those that are more likely to be liquidity constrained. That is direct evidence in support of the existence of a collateral channel.

1 Introduction

How well do households smooth consumption over their life cycle? What determines the likelihood that a household fails to consumption smooth? And, what percentage of households does that apply to? Does a departure from consumption smoothing reflect the existence of credit market imperfections? These long-standing questions, as they apply in the United Kingdom, are among those we address in this paper.

In recent years there has been increasing interest in the role of housing and its relationship with consumption. One view of house prices is that they are an asset price for an essential commodity, shelter, and that they 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 which allows credit to be obtained on more favourable terms and supports consumption. That role may be particularly strong, or only exist at all, 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 will also affect current consumption plans. Among other things, this collateral channel could amplify the effects of monetary policy on the economy (Iacoviello (2005); Aoki *et al* (2004)). However, there is little evidence on whether housing equity fulfils this role as collateral and how it affects households' consumption plans. Confronting the collateral hypothesis with microdata for the first time is a further aim of this paper.

Our paper makes the following contributions. First, we revisit the issue of excess sensitivity of consumption plans to income, but for a sample of UK households. While most previous studies have been for the United States, the use of household-level data also responds to the suggestion that aggregation biases may have corrupted previous tests of excess sensitivity (Attanasio and Weber (1993)). Second, and more substantively, we model explicitly the likelihood that a household's behaviour falls into one of two 'regimes' which are, *ex ante*, unknown. Our results are such that we can 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 microdata the role of housing in facilitating consumption smoothing and the existence of the collateral channel. Most notably, that involves looking at the effect of housing equity on the likelihood of excess sensitivity as well as through a direct effect on consumption – where the latter effect on consumption distinguishes between constrained and unconstrained households.

The remainder of the paper is organised 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

The basic Euler equation gives the equilibrium condition for maximising lifetime utility subject to the intertemporal budget constraint. Under standard assumptions associated with the permanent income hypothesis and rational expectations, including the absence of liquidity constraints and time separability, this can be stated as:

$$(1+r_t)\beta E_t\left(\frac{u'(c_{t+1})}{u'(c_t)}\right)=1 \qquad \textbf{(1)}$$

where r is the interest rate, β is the discount factor and $u'(c_t)$ is the marginal utility from consumption, c, in period t. E_t is the expectations operator, conditional on information at t. 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. Assuming utility takes the constant relative risk aversion form, $u(c)=\frac{c^{1-\rho}}{1-\rho}$ where $\rho>0$ and denotes the coefficient of relative risk aversion, the following Euler equation can be derived as a first-order approximation (see, eg, Carroll (2001a)):

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

where δ is the discount rate (ie, $\beta=1/(1+\delta)$) and ϵ_{t+1} is iid and uncorrelated with any variable known at t. Equation **(2)** shows that the coefficient on the interest rate term in a consumption growth equation should, in principle, give an estimate of the intertemporal elasticity of substitution, σ, as $\sigma=\rho^{-1}$. Crucially, current or lagged income (and income growth) are absent from equation **(2)**. All past and predictable information is incorporated in current consumption so that no lagged information can provide additional explanatory power in accounting for variations in future consumption. Tests of excess sensitivity have proceeded by estimating the following equation.

$$\Delta \ln c_{t+1} = \alpha \ln y_t + \varepsilon_{t+1} \quad \textbf{(3)}$$

where y is household income. A number of other control variables might be added to equation **(3)** but the key hypothesis is $H_0 : \alpha = 0$ under the permanent income model and rational expectations. In many studies (eg, Hall (1978); Zeldes (1989); Jappelli *et al* (1998)) the (log) level of income is used. Attanasio and Weber (1993) use the growth in income.[(1)] 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 emphasised as the most likely source of any excess sensitivity. Carroll and Kimball (2005) and Carroll (2001b) emphasise the observational equivalence between a model of liquidity constraints (given income uncertainty) and a standard model of precautionary saving owing to 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 the possibility that a liquidity constraint may bind in the future restricts the household's ability to respond to any shock and this raises the expected value of holding precautionary assets.

A role for housing is explored by Iacoviello (2004) by distinguishing between constrained and unconstrained households with the Euler equation **(2)** holding for unconstrained households, for whom $\alpha = 0$.[(2)] The Euler equation for a second group is constrained by a borrowing constraint that limits borrowing capacity by the household's home equity. The consumption of these constrained households, as well as being sensitive to household income, should also be influenced by housing equity. An increase in housing equity for these households allows them to borrow more and bring forward consumption.

2.2 Empirical evidence

Following Hall's (1978) estimates of an aggregate Euler equation for the United States – which found no evidence that consumption growth was correlated with lagged levels of income –

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(1) Several studies also include an interest rate term in **(3)**. In household-level studies, since 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 r is unlikely to provide reliable estimates of σ.

(2) Of course this involves adding a housing services term into the household utility function and a second optimality condition for the demand for housing. Iacoviello's (2004) model does not allow for income uncertainty and so does not give rise to precautionary saving.

subsequent studies generally contested that conclusion, but with some notable exceptions.[3] Hall and Mishkin (1982) found evidence of excess sensitivity using household-level US data.[4] 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 which impeded their ability to smooth consumption.

In the context of studying such liquidity constraints, some studies have employed an indicator for whether the household has been denied credit or believes they would be denied credit.[5] 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.[6] Jappelli (1990) estimated the likelihood for having been denied credit to be higher for the young, the less wealthy and non-whites. Garcia *et al* (1997) modelled consumption as well as a probability of being constrained using a switching regression technique and found a similar pattern of results.

Two studies that did not find general evidence of liquidity constraints using household-level data are Blundell *et al* (1994) and Meghir and Weber (1996). The former found that controlling for changes in household demographics and labour market status removes the sensitivity of consumption growth to income. Meghir and Weber (1996) also found little evidence for liquidity constraints, except among young households.

The role of housing in these studies has been largely unexplored. That is despite the fact that the link between house prices and consumption has been the subject of considerable debate. Exceptionally, Hurst and Stafford (2004) examined home equity release. They found that households with a low level of liquid assets that experienced a negative income shock (ie, suffered unemployment) were more likely to refinance, which is consistent with consumption smoothing.

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(3) 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.
(4) 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.
(5) Note that this is a measure of credit rationing, rather than the broader notion of a liquidity constraint, where credit may be available but at a higher interest rate. It is also backward looking.
(6) Zeldes’s (1989) study essentially assumed that this propensity can be adequately proxied solely by whether the household had liquid assets of at least two months’ income.

They suggested that the use of home equity as a buffer has been overlooked; this is surprising, given the importance of housing in the household balance sheet. It is true, however, that it is generally more expensive to extract home equity than withdraw liquid savings. We assess whether homeownership and equity are positively related to consumption-smoothing behaviour (less excess sensitivity) as the collateral hypothesis predicts.

Another useful study for our purposes is by Iacoviello (2004) which also focused on the collateral role of housing. 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 housing equity, but housing equity should not influence the consumption of the unconstrained households. When an aggregate Euler for the United States is estimated, there is a role for house prices. 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 directly below.

House price rises may influence consumption because, in giving rise to a larger amount of housing equity, this makes borrowing cheaper. Strictly, this role may be given either a credit constraint or a buffer stock interpretation. Housing equity lessens the credit constraint directly by raising the value of the collateral. It also lessens the precautionary saving motive since the household expects that it can raise funds against the housing equity if it ever faces a significant adverse shock in the future (Skinner (1993); Angelini and Simmons (2005)). We are not aware of any studies that have looked for a role for housing to influence the consumption of households in general in this way.[7] The large number of studies that look at direct effects of house prices on consumption, includes a recent study by Attanasio *et al* (2005). The paper focuses on contrasting the implications of the view that households might perceive capital gains as real wealth gains with the view that the consumption response reflects changed perceptions of income or productivity. Their results generally favour the latter interpretation. Their approach does not distinguish between groups that are credit constrained (or display excess sensitivity) and a group that does not, in a way implied by the collateral channel. They find however, that house prices have a larger effect on the consumption of the young. Since credit constraints are more likely to bind on the young that is indirect evidence that capital gains are more important for those that are more likely to be

(7) Carroll *et al* (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.

credit constrained.[8]

Policymakers 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 (eg, Nickell (2003)). 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 non-linear, even non-monotonic.

2.3 Explanations for excess sensitivity

The literature has typically 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 what characteristics are associated with that propensity.

There are other models which might generate excess sensitivity. Following Garcia *et al* (1997) we attempt to shed some light on which of these models appear to get 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

(8) Campbell and Cocco (2005) however find differently: that house prices are associated with stronger consumption effects on older households. The FES data used by Attanasio *et al* (2005) and Campbell and Cocco (2005) do not include house price values at the household-level but instead use regional-level house price indices.

to anticipated positive income growth than to negative income growth. In contrast, 'rule of thumb' behaviour would seem to suggest a similar response to anticipated rises and falls in income. A further possibility is a specific form of habits known as 'loss aversion' where individuals are especially averse to revising their consumption plans downwards (Tversky and Kahneman (1991)). In this case, if a household anticipates a downturn in its income, rather than adjust consumption downwards 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.(9)

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.

$$\begin{aligned} \Delta \ln c_{i,t+1} &= a_c + \alpha_a \ln y_{i,t} + Z'_{i,t+1}\gamma + \varsigma_t + \upsilon_{i,t+1} \text{ if } \Phi\left(X'_{i,t+1}\delta + \epsilon_{i,t+1} > 0\right) \quad \text{Group A} \quad \textbf{(4)} \\ \Delta \ln c_{i,t+1} &= a_{uc} + \alpha_b \ln y_{i,t} + Z'_{i,t+1}\lambda + \chi_t + \varepsilon_{i,t+1} \text{ if } \Phi\left(X'_{i,t+1}\delta + \epsilon_{i,t+1} \leq 0\right) \quad \text{Group B} \end{aligned}$$

where i indexes households i=1,2...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.(10) A key issue concerns the identification of the Group A and Group B households. This is determined according

(9) 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) favoured the loss aversion model of consumer behaviour.

(10) The time effects will include a role for the policy interest rate, for instance.

to the probit model that allocates a household to one group or the other, given by:

$$\Pr(X'_{i,t+1}\delta + \epsilon_{i,t+1} > 0) = \Phi\left(X'_{i,t+1}\delta\right) \tag{5}$$

where, as in **(4)**, $\Phi(.)$ is the normal cumulative density function, while 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 but the interpretation is discussed further with the results.

We also highlight the roles of home equity and mortgage debt in determining this propensity. Since the main means by which households smooth consumption is by borrowing and saving accordingly, that probability can be interpreted as reflecting both lender and household (borrower) behaviour. An interpretation of credit constraints would interpret it as a combination of demand and supply-side influences in the credit market. For instance, since young households are more likely to want to borrow against a rising income profile, if there are credit market imperfections then these will be more likely to influence the consumption-smoothing ability of such younger households. Consistent with Carroll (2001b), the probability equation can also be viewed as reflecting the varying intensity of the precautionary saving motive according to household characteristics.

One strategy for identification is to impose the restrictions $\alpha_a \neq 0$ and $\alpha_b = 0$ in the two Euler equations. 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 experiment with both approaches beginning with the latter. The equations in **(4)** and **(5)** are estimated jointly by maximising the log-likelihood given by:[(11)]

$$\begin{aligned} LogL &= \sum_{NT} \ln\left[\frac{1}{\sigma_{\upsilon_{i,t+1}}}\phi\left(\frac{\upsilon_{i,t+1}|\, X'_{i,t+1}\delta + \epsilon_{i,t+1} > 0}{\sigma_{\upsilon_{i,t+1}}}\right)\Phi\left(\delta X_{i,t+1} + \epsilon_{i,t+1} > 0\right)\right] + \\ &\left[\frac{1}{\sigma_{\varepsilon_{i,t+1}}}\phi\left(\frac{\varepsilon_{i,t+1}|\, X'_{i,t+1}\delta + \epsilon_{i,t+1} \leq 0}{\sigma_{\varepsilon_{i,t+1}}}\right)\Phi\left(\delta X_{i,t+1} + \epsilon_{i,t+1} \leq 0\right)\right] \end{aligned}$$

(11) In our applications, this is carried out using the BFGS algorithm in Gauss™.

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

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

$\rho_{\upsilon_{i,t+1},\epsilon_{i,t+1}}$ 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).(12) Below, we employ the general endogenous switching model as our baseline specification, but also consider the restricted model.

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).

3.1.2 On asymmetries

If excess sensitivity reflects borrowing constraints or a precautionary saving motive then it suggests the ability of the household to borrow ahead of predicted rising income is impeded, but

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

not to save ahead of falling income. This implies an asymmetry in the response to predicted income growth which is absent from a habits and rule-of-thumb model. This consideration is implemented by estimating the following equation:

$$\Delta \ln c_{it+1} = \alpha + \delta_1 \Delta \ln \widehat{y}^{+}_{it+1} + \delta_2 \Delta \ln \widehat{y}^{-}_{it+1} + Z'_{it+1}\phi + \gamma_t + \omega_{it+1} \quad \textbf{(6)}$$

where the estimating equation now distinguishes between positive ($\Delta \ln \widehat{y}^{+}_{it+1}$) and negative ($\Delta ln \widehat{y}^{-}_{it+1}$) predicted income growth. This approach is again adopted employing the switching regression method. This allows us to consider whether there is an asymmetry in the form of a stronger sensitivity to positive anticipated income growth for the group identified as displaying greater excess sensitivity. Estimation of equation **(6)** requires values for predicted income growth. This is obtained as the predicted values from the following supplementary regression for income growth.(13)

$$\Delta \ln y_{it+1} = \alpha + Qual'_i\alpha_1 + Occ'_{it}\alpha_2 + \alpha_3 age_{it} + \alpha_4 age^2_{it} + (Occ\ X\ age)'_{it}\alpha_5 + (Qual\ Xage)_{it}\alpha_6 + B'_{it}\alpha_7 + \xi_{it} \quad \textbf{(7)}$$

The set of regressors generally refers to characteristics of the head of the household. $Qual$ is a vector of six educational qualification dummies, Occ is a vector of nine occupational dummies, which are included both linearly and interacted with the age term in order to allow for different age profiles in income growth by educational attainment and by occupation. B is a vector of personal characteristics, that is dummy variables for whether the household head is male, white and married or cohabiting. ξ_{it} is the error term.

3.2 The data

This study employs microdata on UK households 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, that began in 1991. The data provide 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 outstanding mortgage debt. The data on consumption are imputed using the approach of Skinner (1987) given the relationship between food (actually reported in the BHPS) and total (less housing) expenditures in the Family

(13) The use of a generated regressor in this way is likely to bias downwards the standard errors in our results. As in Garcia *et al* (1997) we make no allowance for this.

Expenditure Survey.[14] Further details are provided in the data appendix.

Summary statistics for the main variables of interest are presented in Table 1. Average annual real consumption growth is 0.010 (ie, 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.

During the sample period, the UK housing market experienced quite significant swings in house price inflation. 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 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.

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

(14) See Benito (2006) for a study of consumption that use the food consumption data and data on durables purchases available in the BHPS.

finding is robust to the two definitions of income, whether in differences or in levels and at different lags.

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) while 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 and in the excess sensitivity group consumption growth is negatively related to lagged income as households are better able to smooth consumption across periods (see also Zeldes (1989) for further discussion). The negative coefficient on lagged income and the positive coefficient for lagged income growth in the excess sensitivity group of households are consistent with earlier findings (eg, Zeldes (1989) and Attanasio and Weber (1993), respectively).

3.3.2 Propensity for excess sensitivity

The bottom panel of the table shows estimates for the propensity of the households 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 degree qualification.

The propensity for excess sensitivity is estimated to be unrelated to income growth. In principle, 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)). The positive effect of a degree qualification, which may raise future expected income growth, might be explained by this mechanism.[15] We interpret the effect of a higher education qualification to be through its impact on the income profile and thereby on the demand for credit. In contrast, further education qualifications (specifically, A-levels) are negatively related to the probability of excess sensitivity, relative to a household head with neither of these as his/her highest academic qualification.

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

Column 1 considers an asset income term relative to household income; it is on the margin of significance at the 5% level and suggests that larger amounts of asset income, and liquid assets, relative to current income lower the probability of excess sensitivity. Since 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). This follows from concavity of the consumption function (being concave in the level of 'cash-on-hand' or current labour income plus liquid assets) which arises under liquidity constraints or precautionary saving behaviour. In a model of liquidity constraints this would reflect the fact that having liquid assets lowers the likelihood of facing the constraint; in a precautionary saving model, the concavity of the consumption function is caused by households with lower levels of assets depressing their consumption to a greater extent. The interactions between liquidity constraints and precautionary saving behaviour are examined in detail by Carroll and Kimball (2005). They emphasise the similarity in predictions of the two types of model.

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 of around 0.25, controlling for the other characteristics. There are again different ways of interpreting this depending on the favoured 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 desire to bring 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 non-white households. Some previous studies of US credit markets have found evidence that non-whites face tighter debt limits, that they are more likely to be credit constrained and that this has consequences for their rate of homeownership (Duca and Rosenthal (1992, 1993)). But there are other interpretations of the significant race differential, such as different income profiles, and by itself it cannot be plausibly interpreted as evidence of discrimination in credit markets. There is no strong evidence, in the results in Table 2, that homeownership matters. We explore the role of housing and debt further below.

Using the proportion of households whose predicted probability of being in the excess sensitivity group exceeds a 0.5 cut-off point, our estimates indicate that 20% of UK households display excess sensitivity. These households account for around 14% of aggregate consumption and a similar proportion of income. That compares to estimates for the United States, by Jappelli (1990) who found that around 20% of households are credit constrained, by Jappelli *et al* (1998) whose main estimates indicated that between 6% and 24% of households were credit constrained, and by Garcia *et al* (1997) that a higher percentage, around 40% of households, were in the excess sensitivity group. The distribution of predicted probabilities of being in the Group A sample in our results is shown in Figure A. An alternative criterion for the percentage that are liquidity constrained is simply the mean predicted probability. On that definition close to 40% of households are liquidity constrained.

In columns 1 and 2 the estimate of $\rho_{\upsilon_{i,t+1},\epsilon_{i,t+1}}$ (labelled 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 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.[16]

3.3.3 Housing equity, debt and consumption smoothing

The coincidence of housing and consumption booms in the United Kingdom and elsewhere has motivated much research on the links between the housing market and consumption. Much of this correlation at the aggregate level 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 rise in house prices and therefore 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. 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. During the sample period 7% of the households in the sample withdrew home equity.

(16) We also re-estimated models using food consumption as our measure of consumption. The results were very similar.

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?[17]

We shed light on both issues by including 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 house prices should lead constrained households to bring forward consumption while for the unconstrained group it should have no effect through this collateral channel.

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 while 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 beyond which it increases. At low levels of debt relative to equity, higher levels of debt are associated with improved consumption smoothing and a lower likelihood of excess sensitivity. In terms of home equity, for those households with low to moderate amounts of equity in the home (between zero and 50%), increases in equity relative to debt are associated with a lower probability of displaying excess sensitivity.

When considering the role for housing equity relative to income (HW/Y), the non-linearity is picked up better by considering different dummy variables for different levels of housing equity.[18] 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. There is again some evidence of higher levels of housing equity lowering the probability of excess sensitivity, although this effect is absent for especially high levels of equity. 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

(17) Mortgage debt may be related to consumption because the household has withdrawn housing equity (see Angelini and Simmons (2005) for a model of this kind).
(18) For brevity we do not report the results which considered this variable as a quadratic.

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 ($\chi^2(1) = 5.02; p - value = 0.024$).[19] At higher levels of home equity its role becomes insignificant. Why housing equity should not be related to the probability of consumption smoothing for those with especially high levels of equity is not clear. A preliminary analysis of those households (ie with $HW/Y > 5$) suggests 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.

The debt variable, D/Y, also displays a non-linear relationship with the probability of excess sensitivity.[20] 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 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.

In column 4, we extend our Euler equations by adding a role for the change in housing equity relative to income in a model otherwise identical to that in Table 3 column 2. This specification is restricted to those households that have not moved home in the past year. The capital gain to income ratio term $(\Delta HW_{it+1})/Y_{it}$ is significant for the Group A ('excess sensitivity') households for whom the term attracts a 't-ratio' of 2.7, and is insignificantly different from zero for the Group B households. This suggests that capital gains on housing, providing housing equity that can then be borrowed against on more favourable terms, are associated with supporting consumption for households that would otherwise be 'credit constrained'. The point estimate suggests that for that group of households, capital gains on housing equal to annual income would raise the growth rate of consumption by 2.0 percentage points, greater than the average rate of real

(19) Our finding that housing equity or collateral lowers the likelihood of being in the excess sensitivity group is related to a finding of Lustig and Van Nieuwerburgh (2004) on the role of housing collateral across US regions. They find that in regions where housing collateral is high, the correlation between the region's consumption growth and income growth is lower.
(20) A quadratic term picks this up better than separate dummy variables.

consumption growth. But it has no effect on the consumption of households that are more effective in smoothing their consumption and do not display excess sensitivity.

Monetary Policy Committee discussions have noted that the reduced-form relationship between consumption and house prices has recently appeared weaker than in earlier periods.(21) There are various channels through which house prices can influence consumption, notably the collateral channel, and common determinants of both housing demand and consumption. The weakening in the overall relationship could reflect a weakening in the collateral channel but could alternatively reflect a change in the influence of other factors, such as income expectations.

3.3.4 Asymmetric effects

In Table 4 we estimate the Euler equations in our switching regression framework and include a role for asymmetric responses to predictable income growth. Column 1 reports a model that includes the symmetric change in predicted income based on demographic characteristics of the household as in **(7)**. If the permanent income hypothesis holds, then under rational expectations 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 (based on **(6)**).

Consumption models with a liquidity constraint predict a stronger (positive) response of consumption growth to positive predicted income growth than to negative income growth since it affects a household's ability to borrow against future expected income growth but not to save ahead of future expected income reductions. That would also be expected in a buffer stock saving model as such behaviour 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 significantly more strongly ($\chi^2(1) = 5.11$; $p - value = 0.024$) 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. Estimates for Group B households are instead consistent with loss aversion. For those households, the impact of positive predicted income growth is significantly larger than the effect of negative

(21) See for example *Inflation Report*, November 2004, page 12.

predictable income growth ($\chi^2(1) = 9.52$; $p - value = 0.002$).

4 Conclusions

This paper has examined the consumption behaviour of households in the United Kingdom. Using data from the British Household Panel Survey (BHPS) for the years 1992 to 2002, household-level Euler equations have been estimated to investigate whether there is excess sensitivity of consumption to income relative to the permanent income model under rational expectations. In distinguishing between different groups of households we have also provided evidence on the determinants of a household's likelihood of displaying excess sensitivity and explored the role of housing.

The study has found evidence of excess sensitivity of consumption to income for one set of households but none for a second, larger, group of households. 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 behaviour. We estimate that 20%–40% of UK households fall into the excess sensitivity group.

Our other major contribution has been to explore the roles of housing equity and debt in facilitating consumption smoothing. We find that negative home equity increases the likelihood of displaying excess sensitivity. Additionally, a role for capital gains on housing enters directly into the Euler equation for consumption of the excess sensitivity group of households – households that might otherwise be credit constrained – but is absent from the second, larger group of households that do not demonstrate excess sensitivity. Our results suggest housing fulfils two roles and these govern its links with consumption. First, housing equity acts as a buffer. Having home equity improves a household's ability to smooth consumption since it has an option of withdrawing the equity and supporting its future consumption should the need arise. Second, housing acts as collateral, improving the terms on which credit may be obtained for those that would otherwise be liquidity constrained.

Monetary Policy Committee discussions have noted that the reduced-form relationship between consumption and house prices has recently appeared weaker than in earlier periods.[22] There are various channels through which house prices can influence consumption, notably the collateral channel, and common determinants of both housing demand and consumption. The weakening in the overall relationship could reflect a weakening in the collateral channel but could alternatively reflect a change in the influence of other factors, such as income expectations.

(22) See for example *Inflation Report*, November 2004, page 12.

Data appendix

One issue which has arisen in household-level studies of consumption is that the typical measure of consumption 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 data set, the Family Expenditure Survey (FES) which we use to relate total, non-housing, 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 US studies of consumption behaviour by Parker (1999) and Palumbo (1999). The following regression is estimated on FES data

$$\ln c_{it}^{total} = \alpha_1 \ln c_{it}^{food} + \alpha_2 \ln c_{it}^{(food)2} + \alpha_3 \ln c_{it}^{(food)3} + X_{it}^{'}\beta + \varepsilon_{it} \qquad \textbf{(8)}$$

where 'i' indexes households, i=1,2… 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 **(8)** to these variables and thereby impute a value for total expenditure for each household in the BHPS over the period 1992 to 2002.

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 annual income	$(\Delta HW)/Y$	0.212	0.695
Mortgage debt to annual income	D/Y	0.914	1.056
Observations	n	26,542	

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

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)		
lny_{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)
Household 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)
Household controls	yes	yes	yes	yes
Year effects	yes	yes	yes	yes
$Marginal\ effects$	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 (0.021)	-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 probability $\geqslant 0.5$	21.0	22.1	20.1	19.9
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. Household controls are changes in the number of adults, children, full-time and part-time workers, dummies for changes in subjective health status. 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.

Table 3: Endogenous switching regression models with housing and debt

$\Delta \ln c_{it+1}$	Group A households			
$\ln y_{it}$	-0.011 (0.005)	-0.011 (0.005)	-0.010 (0.005)	
$\Delta \ln y_{it}$				0.018 (0.011)
$\Delta HW_{it+1}/Y_{it}$				0.020 (0.007)
$ln(age)_{it+1}$	-0.048 (0.016)	-0.046 (0.016)	-0.041 (0.015)	-0.031 (0.021)
Household 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)	0.000 (0.003)	
$\Delta \ln y_{it}$				-0.003 (0.004)
$\Delta HW_{it+1}/Y_{it}$				-0.002 (0.003)
$ln(age)_{it+1}$	-0.070 (0.007)	-0.070 (0.007)	-0.070 (0.007)	-0.065 (0.008)
Household controls	yes	yes	yes	yes
Year effects	yes	yes	yes	yes
Marginal effects	Probability equation			
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)		0.133 (0.077)
(HW/Y) $= 0$		base		base
$0 <$ (HW/Y) $\leqslant 0.5$		0.011 (0.029)		0.068 (0.038)
$0.5 <$ (HW/Y) $\leqslant 1$		-0.026 (0.027)		0.013 (0.035)
$1 <$ (HW/Y) $\leqslant 2$		-0.041 (0.025)		-0.021 (0.031)
$2 <$ (HW/Y) $\leqslant 5$		-0.020 (0.025)		-0.022 (0.031)
$5 <$ (HW/Y)		0.026 (0.035)		0.032 (0.040)
Log-likelihood	7617.654	7615.876	7615.864	5376.809
% predicted probability $\geqslant 0.5$	23.3	23.2	23.4	10.3
ρ_1	0.125 (0.074)	0.231 (0.067)	0.053 (0.072)	-0.163 (0.090)
ρ_2	-0.019 (0.106)	-0.221 (0.098)	-0.020 (0.106)	0.040 (0.118)
Observations	18,614	18,614	18,614	12,194

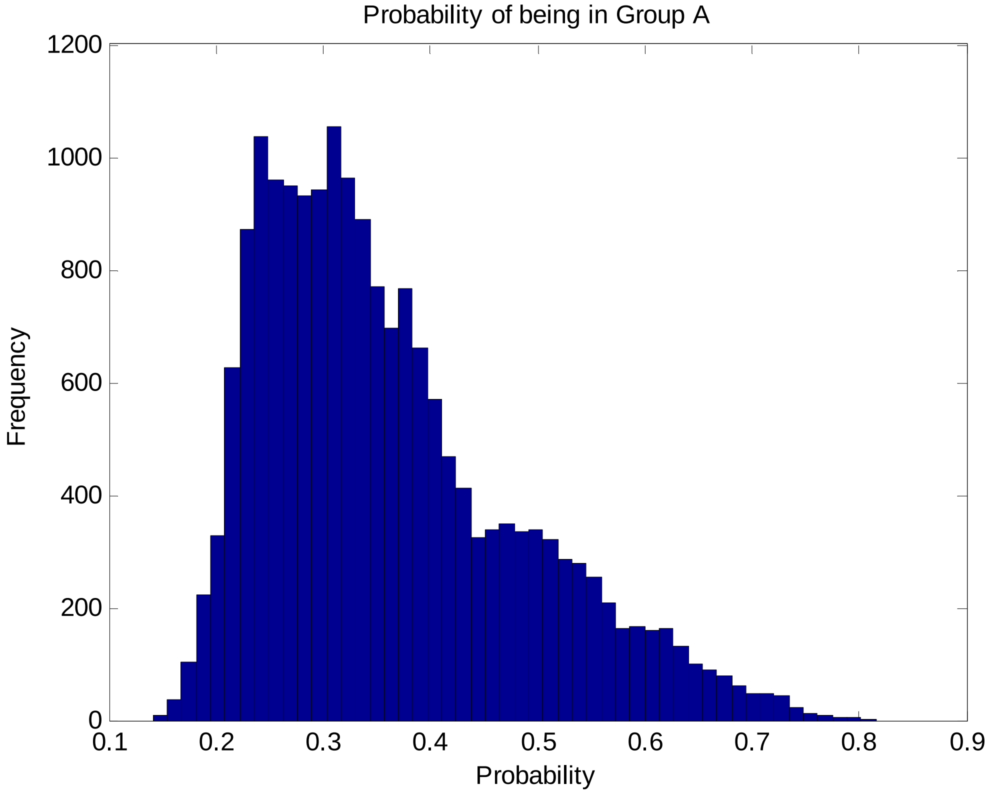
Notes: As for Table 2. Probability equation also includes a constant term, household income growth, a dummy for any interest-bearing liquid assets, log age, married, non-white, male and education dummies (2).

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
% credit-constrained	21.6	19.0
% total consumption	13.6	11.3
% total 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.

Figure A: Distribution of predicted probabilities of being in Group A



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