Household Decisions, Credit Markets and the Macroeconomy: Implications for the Design of Central Bank Models

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1. Introduction and non-technical summary of the paper

Many of the econometric models used by central banks, and the mind-set they represent, have contributed to policy failings in anticipating and dealing with the global economic crisis, and also to earlier policy errors in coping with past economic expansions. This theme was taken up by Don Kohn, Vice-Chairman of the Federal Reserve, in a November 2008 speech:

"The challenge is to improve our understanding of the linkages between the financial sector and real activity. The recent experience indicates that we did not fully appreciate how financial innovation interacted with the channels of credit to affect real economic activity--both as credit and activity expanded and as they have contracted. In this regard, the macroeconomic models that have been used by central banks to inform their monetary policy decisions are clearly inadequate.

These models incorporate few, if any, complex relationships among financial institutions or the financial-accelerator effects and other credit interactions that are now causing stresses in financial markets to spill over to the real economy. Rather, these models abstract from institutional arrangements and focus on a few simple asset-arbitrage relationships, leaving them incapable of explaining recent developments in both credit volumes and risk premiums. Economists at central banks and in academia will need to devote much effort to overcoming these deficiencies in coming years".

Charles Goodhart made similar points at the Bank of England Monetary Policy Round-table in September 2008, as has Buiter (2009) with even greater ferocity. Colander et al. (2009), in the 'Dahlem report' argue that the profession is guilty of 'systemic failure' in not addressing the issues raised by Kohn and of neglecting even the possibility of financial crises, let alone warning of the dangers as risk factors mounted. One of the eminent proponents of DSGE models with New Keynesian frictions, Jordi Gali admitted at the European Area Business Cycle Network conference in November 2008 that the New Keynesian-DSGE models had little to say about the current crisis.

Underlying conceptual reasons for the failure of central bank models of the DSGE type include their typical assumptions about representative agents, perfect information, zero transactions costs, and of efficient markets. For most of these models, with the notable exception of Bernanke et al (1999), and others who also incorporate a financial accelerator for firms, e.g. Christiano et al (2003), Christiano et al (2009), it is as if the information economics revolution, for which George Akerlof, Michael Spence and Joe Stiglitz shared the Nobel prize in 2001, had not occurred. The combination of assumptions, when coupled with the trivialisation of uncertainty in these supposedly stochastic models, and the linearization techniques used in their solution, render money, credit and asset prices largely irrelevant.[1] The calibration/estimation methods currently used to apply these models to the data typically ignore inconvenient truths, as we shall see.

This paper provides empirical evidence and a discussion of the literature to expand on these themes, with a focus on consumption, credit and asset prices. As consumer expenditure accounts for around 70 percent of GDP in mature industrial economies, its fluctuations are of central importance. The literature on the financial accelerator, see Bernanke et al. (1999), has been mainly about the corporate sector and with a simple view of financial frictions. However, the financial accelerator operating via the household sector and the banking system has been more important in the recent crisis. Section 2 revisits a 1990 debate with Mervyn King and Marco Pagano on the causes of the UK consumption boom of the 1980s as seen in the collapse of the household saving rate (Muellbauer and Murphy, 1990; Debelle, 2004). This boom, along with its Scandivanian counterparts, was followed by a bust, leading to major banking crises in Norway, Sweden and Finland. The UK came close to a financial crisis, being forced out of the European Exchange Rate Mechanism in 1992, while the Bank of England launched a behind the scenes 'life-raft' to save some major financial institutions. There are interesting parallels between these earlier crises and the current global crisis.

Despite the bust that followed the 1980s consumption boom, many economists, including Attanasio and Weber (1994) and Attanasio et al. (2009), have persisted in

[1] Some exceptions will be discussed in Section 5.

arguing that the main cause of the rise in the ratio of UK consumption to income in the 1980s was an exogenous shift in income growth expectations rather than the credit market liberalisation and its interactions with asset prices emphasised by Muellbauer and Murphy (1990). I show using a mix of non-parametric and parametric methods that, for any reasonable discount rates for discounting future income, neither perfect foresight models of future income growth nor plausible econometric models for income growth expectations with data coherence could account for the rise in the ratio of consumption to non-property income in the later 1980s. Nor can they, by themselves, explain fluctuations in the UK consumption-to-income ratio in the last 40 years. This contradicts simple rational expectations DSGE models that omit relevant financial frictions. By contrast, explanations that emphasise asset values, credit supply shifts, the relaxation of down-payment constraints and their interactions with housing collateral and other variables such as interest rates, the unemployment rate as well as income growth expectations, convincingly explain the behaviour of the UK consumption-to-income ratio (see summarised research in Muellbauer (2007)).

As far as income growth expectations are concerned, to explain variations in the UK consumption to income ratio, the evidence is that one needs to assume *either* that households have far shorter horizons than typically assumed in DSGE models, *or* attribute a far higher weight to current as opposed to permanent income than is consistent with the pure permanent income theory. This evidence is much more consistent with a buffer stock saving interpretation of behaviour, pioneered by Deaton (1991, 1992), and Carroll (1992, 1997, 2001). The important literature on buffer stock saving and the precautionary motive more generally, see for example Kimball (1990), Hubbard et al. (1995) and Gourinchas and Parker (2002), seems to have been bypassed in most DSGE models.

This research extends the Ando-Modigliani solved-out consumption function to incorporate credit channel features. The main conclusions of this modernised consumption function as applied to the UK are robust to alternative discount rates and alternative information sets used to model income growth expectations. Unlike standard DSGE models, this model has an important role for income uncertainty (proxied by the change in the unemployment rate), for credit market conditions, for wealth effects and potentially for cash-flow effects of changes in nominal interest rates. The marginal propensity to spend out of net liquid assets is higher than out of illiquid financial assets, while the housing collateral effect is found to be zero before the period of credit market liberalization, but with a marginal propensity to spend eventually exceeding that out of illiquid financial assets. This finding supports a housing collateral effect on consumption, as opposed to a classical wealth effect. The finding that liquid assets are around four to five times as "spendable" in the UK as stock market wealth, and two to three times as spendable as housing collateral, throws important light on the controversial role of broad money in macroeconomics.[2] But since household debt is effectively negative liquid assets, our estimates also highlight the vulnerability of consumer expenditure to household indebtedness when negative shocks to asset prices, credit supply and income occur, as in the current crisis.

The model also attributes a larger weight to income growth expectations as credit conditions expand and a smaller weight to the cash flow impact of rises in nominal interest rates on debt, an important part of monetary transmission in economies where floating rate household debt dominates, as in the UK or South Africa. An equation of this kind provides important short- and medium-term insights into business cycle fluctuations, the role of monetary policy and credit shocks and how these are likely to differ between economies with different institutions. But, of course, it is only when it is embedded in a system of equations including portfolio allocation, asset prices and income determination, that the system-wide impact of shocks can be analysed, as in a central bank policy model. What drives house prices is discussed further below.

Section 3 turns to the centre-piece of virtually all DSGE models, the consumption Euler equation for the "representative" consumer. The hugely influential paper by Hall (1978)[3] explained the martingale property of consumption implied by the rational expectations permanent income theory. This says that next period's consumption growth should be unpredictable given this period's information. An inconvenient truth ignored by most of the DSGE literature is that contrary to the theory, next period's consumption growth is strongly linked to predictable income growth, the 'excess sensitivity' finding established by Campbell and Mankiw (1989,

[2] The comfort provided to monetarists is limited, however, since our empirical evidence also emphasises asset prices and shifts in credit supply.
[3] Hall was my supervisor in Berkeley at the end of the heady 1960s.

1991) for major OECD countries. I show that using income forecasting models for the UK, US and Japan with plausible economic content (for example, introducing roles for monetary and fiscal policy variables, and including a Ricardian element for the latter), that excess sensitivity is strongly confirmed. The UK evidence suggests that excess sensitivity is as strong, or stronger, in the period of easier credit after 1980 than it was before. Thus, the failure of the simple rational expectations hypothesis is *at least as* important as are credit constraints in accounting for excess sensitivity.

Far preferable to the unrealistic rational expectations assumption, therefore, is the sticky information or 'inattentive agent' approach of Reis (2006, 2009), Mankiw and Reis (2007), Carroll (2003) and Carroll et al (2006). In this view, only a fraction of agents update their information sets every quarter so that shocks take time to feed through into decisions of households. The rejection of the Euler equation favours a broader view of household behaviour and of the constraints faced by households implied by the modernised Ando-Modigliani style consumption function discussed in Section 2. In this broader view, households are still aware of basic facts about budget constraints, so that wealth, uncertainty, expected income, interest rates all affect behaviour but do so in a way which allows the data to speak in a less constrained manner.

Section 4 examines the research by Attanasio et al. (2009), referred to above, that analyses micro data from the Family Expenditure Survey from 1977 to 2002. These authors suggest that rising UK consumption relative to income in the 1980s had little to do with housing and other wealth and credit effects. They argue that the expected correlations of consumption with house prices by age (and tenure) that would be implied by the presence of housing wealth effects are contradicted by the data. Using the consumption residuals for young, middle aged and old households generated by Attanasio et al., I show in Section 4 that these are entirely consistent with the predictions of consumption differences by age, implied by our research, for the response of consumption to changes in interest rates, unemployment rates, income and housing collateral. The evidence strongly supports a housing collateral—rather than a simple housing wealth—interpretation of "wealth effects". It also supports a direct credit channel or cash-flow role for interest rates, and a role for precautionary saving. The evidence is also consistent with the existence of substantial measurement error in consumption data at the micro level, throwing doubt on the wide-spread belief that micro data always have far greater information content than macro data.

Section 5 considers a recent ‘fix’ of the DSGE approach by Iacoviello (2005) and Iacoviello and Neri (2008), which introduces a housing market with a simple financial friction, into the DSGE framework. In Section 5, I discuss nine significant weaknesses in the ability of this model to match both reality and behavioural issues raised by other research on consumer behaviour and housing markets. For example, the model cannot generate positive and volatile mortgage equity withdrawal as seen in the US and the UK. It misses important life-cycle features, including saving for a housing down-payment, ignores the overwhelming evidence against efficient housing markets and, because there is no banking sector and no default possibility, cannot generate this shock-amplifying element of the financial accelerator. Recent literature by Favilukis et al. (2009), Kiyotaki et al. (2008), Rios-Rull and Sanchez (2008) and others has expanded the framework in a number of directions, but large holes remain.

In the light of the empirical findings summarised above and further discussions of the literature, the concluding Section 6 considers the formulation of central bank policy models that could be useful for short to medium term policy analysis, taking account of some of the factors that Kohn suggests they have ignored. In the US, the UK and some other economies, house prices are an important part of the financial accelerator and so it is crucial to understand drivers stemming from household decisions and the credit market. Indeed, with a housing stock which is inflexible in the short run, an equation for the household demand for housing with a credit channel can be inverted to derive a house price equation, see Hendry (1984), Meen (2001), Muellbauer and Murphy (1997), Cameron et al. (2006) and Duca et al. (2009).

House price expectations play a crucial role in explaining house price dynamics in such an equation. There is strong evidence of extrapolative expectations (where people believe that recent increases in house prices will continue) or momentum trading, as in Abraham and Hendershott (1996) and many other empirical studies. With such expectations, a sequence of positive shocks which drive up house prices, for example from increases in credit availability or lower interest rates, then increase optimism about further price rises. Together with an important and intrinsic non-linearity (or "frenzy effect") impinging on house prices, this amplifies the original shocks, leading to overshooting of house prices. In the US there was exactly such a series of positive shocks. In Duca et al. (2009), we provide evidence that the rise in loan-to-value ratios for first time buyers in the US between 1998 and 2005, together with other positive economic factors, can explain the US house price boom of the period. The combination of extrapolative house price expectations and the non-linear or frenzy effect contributed to the exaggerated rise in US house prices. The credit crunch that followed was then exacerbated by the reversal of these expectations, implying overshooting on the down-side.

The survey evidence and theory model of Piazzesi and Schneider (2009) is consistent with our time series evidence. They examine survey data from the Michigan Survey, and find a 25-year peak in 2005 in the percentage of households with views consistent with momentum trading. Using a search model, they also argue that the existence of a relative small number of momentum traders can have large effects on house prices. The replacement of the assumption of a representative agent with rational expectations with a more realistic assumption, therefore, could be extremely helpful in capturing this important piece of the financial accelerator. As Rios-Rull and Sanchez (2008) admit, it is difficult to explain the volatility of house prices, and the persistence and the correlation of housing transactions with house prices, in a general equilibrium, representative agent rational expectations model.

Central Bank policy models need to incorporate the feedbacks from the rest of the economy to the financial system and from it back to the real economy.[4] The Bank of England's developing RAMSI model[5] is making some progress in this direction. Such approaches need to be incorporated in a model that fully encompasses the financial accelerator as well as the more conventional macroeconomic linkages. I

[4] However, the nature of the relevant feedbacks will be different in different economies. For example, the housing collateral channel for households is effectively irrelevant for Germany, though the residential investment channel is not. With the New Zealand banking sector largely foreign owned, domestic feedbacks via the banking system will be small, though a banking crisis in Australia would have serious implications.

[5] The Risk Assessment Model for Systemic Institutions (RAMSI) is an empirical model for risks to bank balance sheets, with impacts from the real economy, asset prices and credit spreads, and a limited set of feedbacks.

argue that such a model needs to encompass the intrinsic non-linearities arising out of the economics of key behavioural relationships affecting consumption, asset prices, residential construction and loan defaults. These are largely additional to the non-linearities highlighted by Von Peter (2009).

The size of the required model needs to be larger than that of the recent empirical DSGE models (e.g. Smets and Wouters (2003), Christiano et al. (2005) or Iacoviello and Neri (2008)). Nevertheless, even with around 30 behavioural equations, a minimal practical policy model will be far smaller than the large macro-econometric models of the 1970s and 80s which attracted the criticisms of Lucas (1976) and of Sims (1980). With careful treatment of structural shifts, less blinkered use of economic theory and modern model selection techniques, see Hendry and Krolzig (2005) and Castle, Doornik and Hendry (2008), far more progress is possible than many macroeconomists believe, particularly in small open economies. Such a policy model is needed by practitioners while economists continue their quest to develop an ideal micro-founded model with agent heterogeneity, credit and financial frictions and limited information. Evidence-based macroeconomic research of the kind I propose should, moreover, feed into better micro-simulation models.

2. The 1980s UK consumption boom revisited.

2.1. The debate on the fall in the 1980s saving ratio.

Between 1980 and 1988, the household saving ratio fell from over 12 percent to around 5 percent. The obverse, the ratio of consumer expenditure to income rose correspondingly. Figure 1 shows the log ratio of consumer expenditure to non-property income, rising sharply in the 1980s. The key elements of the 1990 debate, already referred to, about this phenomenon can be summarised in the following extracts:

"*Our empirical evidence on the determination of house prices suggests an important extrapolative component in expectations, giving rise to bouts of speculative frenzy. With the sharp rise in house prices, residential property became more than half of* *personal sector wealth. Financial liberalization allowed households to cash it in as consumer expenditure financed by borrowing. In our view, in contrast to that of at least one of our discussants, liberalization of housing finance had important effects on personal wealth, consumption and hence the trade deficit*" (Muellbauer and Murphy, 1990, p.349-350)

" *Overall, the impact of a change in house prices on non-housing consumption is likely to be small."* King, 1990, p. 384[6].

Until recently, the view that consumption is not much influenced by the housing market and that house prices mainly reflect income growth expectations has remained the official view of the Bank of England.[7] King and Pagano emphasised, on perfectly reasonable *a priori* grounds, the role of income expectations in influencing consumption, in contrast to the Muellbauer and Murphy view above, as follows:

"*Since wealth is endogenous it is possible to imagine alternative sources of the shock to consumption and investment in the late 1980s. For example, if in that period there was a change in beliefs about the future growth rate of incomes, then even with a small change in the anticipated growth rate the optimal response of households to this in the context of liberalized financial markets would be a step jump upwards in the level of consumption.*" King, 1990, p.385.

"The truly exogenous shock would be the revision of permanent disposable income; financial liberalization would be not a cause but a mere precondition for revised expectations to translate fully into consumption changes; and the surge of house

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6 The passage preceding King's conclusion is as follows: "*When house prices rise there is an equal rise in the price of housing services. Consumers gain from the rise in house prices only to the extent that they can reduce their future consumption of housing services. Doubtless there are some families in this position who would be able to use the capital gain on housing to increase their consumption of non-housing goods and service. Equally, there will be some (probably younger) households who would feel that they should reduce their consumption of non housing items in order to save to acquire a house in the future. Most households would probably feel little gain from a rise in house prices."* A simple formulation of the economic theory behind King's argument can be found in Muellbauer and Lattimore (1995) and Muellbauer (2007).

7 The November 2008 Inflation Report and Hellebrandt et al. (2009) give hints of a shifting view.

prices would become a symptom, rather than the cause of the consumption boom.” Pagano, 1990, p.388.

These are perfectly reasonable arguments. The question arises as to whether they are supported by the evidence. In the next sections, several different ways of measuring expectations are examined, including perfect foresight and applied rational expectations, using forecasting models for future income.

2.2. Measuring income growth expectations and their impact on consumption.

The ratio of consumption to non-property income rose by a considerable 6 percent between 1984 and 1988. How much of this rise could plausibly be attributed to a shift in the expected growth rate of income, as emphasised by King and Pagano? In Muellbauer and Murphy (1990), we constructed a proxy for expected income growth based on an end of year Gallup survey of consumers’ expectations, and found this had only a *marginal* impact on consumption.

An alternative approach is to take the perfect foresight view and measure whether the proportional deviation between permanent and current non-property income can explain such a rise in the consumption to income ratio. To apply this approach, one needs a discount rate to weight future incomes. This rate could be larger than a ‘safe’ market real interest rate, since standard models of behaviour under uncertainty suggest adding a risk premium to the market interest rate, see Kimball (1990), Muellbauer and Lattimore (1995). Indeed, Friedman (1957, 1963) suggested that a discount rate as high as 30 percent per annum, with an effective horizon of only around 3 years, was appropriate. Other authors support substantial discount rates. Carroll (2001) has put forward buffer stock models of consumption with calibrated income processes which justify such high discount rates. Hayashi (1985) finds US evidence suggesting a discount rate of around 12 percent per annum (though the standard error around his estimate is substantial).

I therefore consider a range of quarterly discount rates from 1.25 percent to 10 percent, covering an annual range from 5 percent to around 40 percent, and over a ten year horizon. The exercise ends in 2007, in order to exclude the recent, surely unanticipated downturn; and I impute the average growth rate from 1963 to 2007 to the expected growth rate from 2007 onwards.

The next step is to define *yperm* to be permanent real per capita non-property income, with the log ratio to current income, *y*, defined as

$$\log(yperm_t \ / \ y_t) = E_t(\textstyle\sum_1^k \delta^{s-1} \log y_{t+s} \ / \ \sum_1^k \delta^{s-1}) - \log y_t \qquad (2.1)$$

Thus, *log yperm* is the discounted future value of log income. While this is not exactly the same as the log of the discounted future value of the level of income, it is a very good approximation. The horizon k is assumed to be 40 quarters and the discount factor, δ, is equal to (1 – discount rate). Consider the smallest of the discount rates in the range above, or 0.0125 per quarter. In the last 50 years or so, the log of real UK per capita non-property income has moved around what looks like a linear trend. With a low discount rate, permanent income averages income over a long period, removing most business cycle fluctuations. Unsurprisingly, with this discount rate, *log (yperm/y)* can be closely approximated by the deviation between a fitted linear trend and *log y*. This is shown in Figure 2, where *log (yperm/y)* is plotted against a fitted value obtained by regressing *log (yperm/y)* on a constant, linear trend and *log y*. In Figure 3a the log of the consumption to income ratio, log *c/y*, is plotted against the same measure of *log (yperm/y),* over the period 1963 to 2000. Positive correlations over parts of the period are visible to the naked eye. Since consumption is well-known to be smoother (i.e. more trend-like) than income, the log ratio, or *(log c – log y)* should have a positive correlation with the fitted trend less *log y*, given the common *log y* element.

While the recovery of consumption relative to income from 1980 to 1984 might be partly explicable in terms of the recovery of *log y* towards its trend path, the rise in *log c/y* from 1984/1985 to 1988/1989 cannot be thus explained. This is because *log (yperm/y)* is actually declining over these years. Indeed, the decline is the more pronounced the smaller the discount rate. This is shown in Figures 3b to 3d. Thus, the perfect foresight view is incapable of explaining the rise in consumption relative to income form 1984/5 to 1988/9. Further, the closer is the discount rate to the low rates used in typical DSGE models the worse is the discrepancy between the data and the perfect foresight view.

This dissonance is a problem not just for the second half of the 1980s, but holds over the last 40 years of data. Regressions of *log c/y* on the four versions of *log (yperm/y)* for 1967 to 2005 all suffer from severe residual autocorrelation, with Durbin-Watson statistics far lower than the R-squared statistics, so qualifying for the 'nonsense regression' epithet (Yule, 1926). Habit formation justifies partial adjustment of consumption to its drivers (Muellbauer, 1988) and eliminates the residual autocorrelation. Thus, I regress $\Delta log\ c_t$ on a constant and on $log\ y_t / c_{t-1}$ and log $(yperm/y)_t$, permitting a long-run relationship between *log (c/y)* and *log (yperm/y)*. The results for discount rates of 1.25 percent and 10 percent per quarter are shown in the first column of Tables 1a-1b. They show no evidence of any significant long-run relationship.[8] The results for discount rates of 2.5 percent and 5 percent per quarter also show no relationship, with estimated coefficients intermediary between those shown.[9]

2.3. Life-cycle models and a modern extension for the credit channel

The evidence just examined means that fluctuations of consumption relative to income must be driven by other factors. Standard life cycle models of the Ando and Modigliani (1963) kind suggest that part of the answer lies in wealth effects. Widely-used consumption functions of this type, for example the FRB-US consumption function (Brayton and Tinsley, 1996), employ net worth, i.e. total assets, including housing wealth, minus debt, as the wealth measure. The natural log linearization of the simple life cycle model with habits[10] implies adding A_{t-1}/y_t to the regressions discussed above, where *A* is net worth:

$$\Delta \ln c_t \approx \beta\left(\alpha_0 + \alpha E_t \log yperm_t / y_t + \gamma_1 A_{t-1}/y_t + \ln y_t - \ln c_{t-1}\right) + \varepsilon_t \qquad (2.2)$$

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[8] Dummies for tax anticipation effects and major strikes are included in all runs displayed in Tables 1a-b, though are not reported. Their inclusion improves the fit, but otherwise has no bearing on these results.
[9] The results are available on request.
[10] See Muellbauer and Lattimore (1995), p.277, and further discussion in Section 6.

This implies partial adjustment of the log of consumption to a long-run target defined by the first four terms in the bracket of equation (2.2). The strict version of the hypothesis implies that the weight on *log (yperm/y)* should be equal to (1-the discount rate), using the discount rate used to construct *log yperm*. This is testable. The results are shown in column 2 of Tables 1a and 1b. In both cases, *A/y* and *log (yperm/y)* are both now significant (and this applies also for discount rates of 2.5 percent and 5 percent per quarter).

On the face of it, this offers evidence against DSGE models with strict informational assumptions and no financial frictions[11]. For in such models, asset prices play no intrinsic role: they are merely a reflection of expected future returns and hence of future income growth. As Tovar (2008) notes, the usual log linearisation around a steady state in such models makes it difficult to address asset price issues, such as the size of the equity premium.[12] Thus, portfolio choice amongst different assets is hard to imbed in first generation DSGE models. However, recent work by Nistico (2007), Castelnuovo and Nistico (2008) and Airaudo et al. (2006) introduces a stock market wealth effect for consumers, which arises because of a finite horizon assumption. As wealth holders die, they are replaced by new households without wealth. As a result, aggregate consumption is not entirely immune from wealth fluctuations.[13] Still not

The concept of net worth used in the Ando-Modigliani model and in the FRB-US consumption model aggregates all assets minus debt into a single figure. Net worth includes housing wealth, so that this imputes the *same* wealth effect to housing as to

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[11]See Bernanke, Gertler and Gilchrist (1999) for one type of friction, a one-period agency cost for firms that is empirically applied in Christiano et al (2003), Christensen and Dib (2008) and Christiano et al (2009). Christiano et al (2003), p.1160, admit that the two financial shocks in their model explain the data poorly: negative shocks reduce investment but counterfactually stimulate consumption. Clearly, this class of models has failed to capture the credit and asset price channel for households. Iacoviello (2005) introduces another type of financial friction for households, discussed below in Section 5.

[12] He notes: "*log-linearization around a steady state is not applicable to asset pricing, because by construction it eliminates all risk premiums in the model …therefore higher-order approximations are required*".

[13] The argument is similar to the explanation by Gali (1990) and Clarida (1991) to explain one small aspect of 'excess sensitivity' by aggregation with finite lives. The intuition is that the death of households and the entry of new households serves to break the inter-temporal link from rational individual decisions between consumption in adjacent periods for a small component of consumption. This effect is necessarily small since, in any one year, the number of entering and exiting households is small relative to the population.

all other types of wealth. However, as King (1990) correctly remarked, the wealth effect from housing implied by the life-cycle theory is suspect (see footnote 2 above), and hence, so must be the theory's net worth concept. However, if there is a credit channel, systematic rises in consumption can result from increases in the collateral values of houses (Muellbauer and Murphy, 1990). Moreover, as pointed out by Aron and Muellbauer (2000), the presence of down-payment constraints faced by first time buyers, introduces another link between house prices and consumption. Shifts in the access to credit will affect the size of these linkages. Thus, when access to credit is restricted, a rise in house prices, given the down-payment constraint, can actually result in a *fall* in aggregate consumption, particularly if home equity loans are hard to access. There is evidence for such a fall for Italy (Kennedy and Andersen (1994), Boone et al. (2001) and Slacalek (2006)), and for Japan (Muellbauer and Murata, 2009).

These arguments imply a potentially important interaction effect between the access to credit and the effect of housing wealth on consumption, in addition to the level effect from credit availability on the aggregate consumption to income ratio. There is therefore an argument for *separating* housing wealth from financial wealth, and for interacting housing wealth with a credit conditions index (that captures the changing liberality of credit extension and is discussed further below) in consumption regressions.

There is also a liquidity argument for *not* aggregating liquid with illiquid financial assets, formalised in a calibrated transactions cost model by Otsuka (2006). As Otsuka demonstrates, the buffer stock role of liquid assets, gives them a higher marginal propensity to spend (MPC) than for illiquid assets. Thus, the combination of the liquidity and the housing arguments suggest a three-fold disaggregation of wealth into liquid assets minus debt, illiquid financial assets, and housing wealth.

The original consumption function of Ando and Modigliani (1963) took no explicit account of income uncertainty, the precautionary motive for saving, and of time varying interest rates. A more comprehensive model needs to take these factors into account. One simple proxy for income uncertainty is the change in the unemployment rate. Real interest rates affect consumers because of they influence inter-temporal substitution choices and the user cost effects for goods with some durability. However, changes in nominal rates may also have cash flow effects on households with floating rate debt, and the UK is a prime example of an economy where consumers face such interest rate shocks. However, the incidence of such constraints shifts with credit availability and with the size of debt relative to income. Increased access to credit should lower the impact of such cash flow constraints. This suggests an interaction effect between a credit conditions index and the change in nominal borrowing rates weighted by the debt to income ratio.

Finally, Pagano (1990) drew attention to another potential credit interaction effect in the following passage: "*financial liberalization would be not a cause but a mere precondition for revised expectations to translate fully into consumption changes*". As access to credit improves, so the role of income growth expectations should increase because households can then borrow to consume ahead of the expected income rise.

The above considerations and the three potential credit interaction effects have been combined in an empirical model for UK consumption in Aron et al. (2008) and expanded to include estimates for the US and Japan in Aron et al. (2009). The model is shown in equation (2.3),

$$\Delta \ln c_t \approx \beta \begin{pmatrix} \alpha_{0t} + \alpha_{1t} r_t + \alpha_{2t} \Delta ur_t + \alpha_{3t} E_t \log yperm_t \,/\, y_t \\ +\gamma_1 \, NLA_{t-1}/y_t + \gamma_2 \, IFA_{t-1}/y_t + \gamma_{3t} \, HA_{t-1}/y_t \\ +\ln y_t - \ln c_{t-1} \end{pmatrix} + \beta_{1t} \Delta \ln y_t + \beta_{2t} \Delta nr_t \left(DB_{t-1}/y_t \right) + \varepsilon_t \qquad (2.3)$$

Here r is the real interest rate, ur is the unemployment rate, *NLA/y* is the ratio of liquid assets minus debt to non-property income, *IFA/y* is the ratio of illiquid financial assets to non-property income, and *HA/y* is the ratio of housing wealth to non-property income; $\Delta nr_t \left(DB_{t-1}/y_t \right)$ measures the cash flow impact on borrowers of changes in nominal rates, where *nr* is the nominal interest rate on debt, *DB*; the speed of adjustment is β; and the γ parameters measure the marginal propensities to consume (MPCs) for each of the three types of assets. The term in the log change of income can be rationalized by aggregating over credit constrained and unconstrained households, (Muellbauer and Lattimore, 1995, p.279-280). This equation reduces to equation (2.2) with an appropriate set of testable restrictions[14].

There is time variation in some of the parameters of equation (2.3) induced by shifts in credit availability. The credit channel enters the consumption function through the different MPCs for net liquid assets and for housing; through the cash flow effect for borrowers; and by allowing for possible parameter shifts stemming from credit market liberalization. As noted above, credit market liberalization should raise the intercept α_0, implying a higher level of $\log(c/y)$; shift the real interest rate coefficient α_1 in a negative direction; raise α_3 by increasing the impact of expected income growth; and increase the MPC for housing collateral, γ_3. It should also lower the current income growth effect, β_1, and the cash flow impact of the change in the nominal rate, β_2. In work on the UK, Aron et al. (2008 handle these shifts by writing each of these time-varying parameters as a linear function of an index of credit supply conditions, *CCI*[15]. The *CCI* enters the model both as an intercept shift and in interaction with several economic variables.

2.4. *Empirical results for consumption with permanent income under perfect foresight.*

In Aron et al. (2008), we use the fitted value of *log (yperm/y)* from a forecasting model to measure income growth expectations. This section demonstrates that similar results can be found using the perfect foresight treatment of permanent income. This section also measures the *maximum* contribution *log (yperm/y)* can make to explaining fluctuations in the log ratio of consumption to income under the perfect foresight assumption.

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[14] These restrictions are as follows: $\alpha_{1t} = \alpha_{2t} = 0,\ \gamma_1 = \gamma_2 = \gamma_{3t},\ \beta_{1t} = \beta_{2t} = 0, \alpha_{3t} = \alpha$.

[15] Fernandez-Corugedo and Muellbauer (2006) constructed a credit conditions index for the UK as a common factor in a system of equations for ten credit indicators. Detailed institutional knowledge and a rich set of controls for economic and demographic variables permits it interpretation as a shift of credit supply conditions.

To summarise Aron et al. (2008) using UK data: in the empirical version of equation (2.3) we found that four-quarter changes in the unemployment rate and in nominal interest rates best captured the effects of changes of these variables on consumption. There is no evidence for shifts in the coefficient on the unemployment rate, but significant shifts occur in the interest rate effects, especially nominal, in the expected direction. There is a significant positive intercept effect on the CCI implying a higher ratio of consumption to income with easier credit, and evidence for the interaction of CCI with expected income growth. Most notably, there is a zero housing collateral effect on consumption when CCI is zero. However, at peak credit availability, the housing collateral effect is highly significant, implying a larger MPC to spend out of housing wealth than out of illiquid assets. Estimating this model in equation (2.3) under the perfect foresight calculation of *log (yperm/y)* gives comparable results to Aron et al. (2008), shown in column 3 of Table 1a-b, confirming the above empirical findings of that paper.

The credit conditions index is normalised at 1 at its maximum. Hence the sum of coefficients on *log (yperm/y)* and its interaction with CCI [16], yield the total weight on permanent income relative to current income in the long-run solution for consumption. The total estimated weight ranges from around 0.5 when the discount rate is 1.25 percent per quarter to the maximum of 0.73 when the discount rate is 10 percent per quarter. For the latter, the weight is 0.23 when CCI is zero and 0.73 when CCI =1. The implication is that when CCI=1, consumers put around 27 percent weight on current income and 73 percent weight on future permanent income measured from next quarter, when the quarterly discount rate is 10 percent. The restriction that the *maximum* coefficient on *log (yperm/y)* is (1 – discount rate) can be accepted (with chi-square=1.2). However, note that the rejection of this restriction becomes more and more severe as the discount rate is lowered towards levels used in DSGE models.

Imposing the upper bound on the coefficient on *log (yperm/y)* of (1 – discount rate) = 0.9, we can then calculate the maximum long run contribution of income growth expectations represented by *log (yperm/y)* to the variation in log (c/y). This is shown

[16] All interaction effects with CCI in this paper are with variables minus their sample mean. Failure to do this would make it hard to interpret the level effect of CCI on consumption.

in Figure 4 which plots *log c/y* against *0.22 log (yperm/y) + 0.68 (CCI)[log (yperm/y)- mean]*. Figure 4 makes plain that it is impossible to explain the rise in the ratio of consumption to income from 1984/5 to 1988/9 in terms of improved income growth expectations measured by the perfect foresight measure, though some of the rise from 1980/81 to 1984/5 can be thus explained. Simply, *log c/y* rises, while *log yperm/y* falls.

It is important to note that the most prominent role we can attribute to income growth expectations rests on assumptions about the rate at which households discount future income which are far, far higher than assumed in DSGE models. If we revert to discount rates typically assumed of around 1.25 percent per quarter, the maximum weight on *log (yperm/y)* consistent with the data at the peak of credit availability is around 0.5. Though as Figures 3a-d show, the fluctuation in *log (yperm/y)* is then greater, the lower weight implies that the fitted contribution is not very different from that shown in Figure 4. In other words, the finding that perfect foresight income growth expectations cannot explain the rise in the consumption to income ratio from 1984/5 to 1988/9 is robust to the choice of the discount rate.

2.5. Relaxing the perfect foresight treatment of expectations

Perfect foresight is, of course, an extreme assumption. It is possible that during the second half of the 1980s, rational households might have been a little over-optimistic relative to the out-turn of actual income growth. Thus, it would be preferable to instrument *log (yperm/y)* when estimating the empirical influence of *log (yperm/y)* on log consumption. Effectively, the perfect foresight assumption is then replaced by an empirical version of rational expectations, imputing to households the forecasting ability of an econometrician. Thus, econometric models are used to forecast *log (yperm/y)* and the fitted values taken as instruments. After considering the rational expectations approach, I also examine a recursive forecasting model that builds in a simple learning mechanism. As we shall see, these relaxations of perfect foresight help a little in reconciling income growth expectations with the rise in the consumption to income ratio from 1984/5 to 1988/9, but not much.

To construct appropriate instruments each of the four measures of income growth expectations is regressed on a range of information sets from 1959 to 2003. This constructs estimates of predictable income growth. Ending in 2003 helps overcome possible sensitivity to the assumption made in defining yperm that growth beyond 2007 continued at the historical average. Some basic sign restrictions are imposed from the theory and automatic model selection (Autometrics, Doornik 2007) is used to obtain parsimonious models. For example, the priors are that real interest rates and changes in nominal rates should have negative effects on future income growth, while prices of housing and of equities should have positive effects (as indeed assumed by King and Pagano). Failure to satisfy the sign restrictions associated with any variable leads to that variable being dropped from the general unrestricted model (or GUM).

A range of information sets is examined. Apart from a linear trend and the level of *log y*, the regressors in the first of these general unrestricted models (called GUM1) are entirely in differenced form, and include short and long interest rates, the unemployment rate, and logs of consumption, real private sector credit, real oil prices, the real exchange rate, real prices of equity and of housing. Given credit market liberalisation beginning at the end of 1979, see Fernandez-Corugedo and Muellbauer (2006), a possible shift in the influence of house prices is allowed for by interacting the annual log change in real house prices with a credit dummy (this takes the value zero up to 1980Q4 and increasing linearly to the value 1 by 1981Q4, then remaining at 1). This assumes that households have some perception of the change in credit conditions, without imputing to them knowledge of the complete history of CCI.

The next general unrestricted model, GUM2, uses an information set with the levels of the regressors included also for the unemployment rate, log real oil prices, the log real exchange rate, and log real equity and house prices. A possible shift in the influence of house prices with credit liberalisation is captured by the moving average[17] of log real house prices is interacted with the lagged credit dummy. Interestingly, the level of real house prices would have a negative coefficient if

[17] These level effects are parameterised both by four-quarter moving averages and their four-quarter lags to permit long lags to operate, as well as by conventional levels variables. In the event, Autometrics usually chooses the moving average form of these variables.

retained[18], but the post 1980 interaction effect is strongly significant and positive. This is consistent with the effect of credit liberalisation boosting consumption, and therefore economic activity and income growth in the 1980s.

The final general unrestricted model, GUM3, takes an even more general formulation. The decline of trade union power in the UK is plausibly associated with the fall in the share of non-property income in GDP. We therefore include trade union density. Another influence on non-property income is likely to be the rate of personal income tax. We measure this by taking the ratio of disposable non-property income to pre-tax personal income. Finally, we take into account the undoubted shift in fiscal policy from 1980 associated with the Thatcher government. From 1980, far more weight was placed on the government budget constraint so that recent government deficits would be followed by higher taxation and/or lower government spending. It seems likely that this Ricardian effect would have counterbalanced at least part of any Keynesian demand boosting impact of fiscal policy. We interact a post-1980 dummy capturing the accession of Thatcher with the government surplus to GDP ratio.

Though the resulting formulation looks very general indeed, the combination of sign restrictions and model selection results in parsimonious models which retain a number of these features in a plausible manner. The fitted values from the parsimonious models from each of these three information sets were taken as instruments for *log (yperm/y)* and the equations estimated by instrumental variables (IV). A small selection of results is reported in Table 2.

The results are notably similar to Table 1, though generally speaking, the sum of the estimated coefficients on *log (yperm/y)* and its interaction with CCI are a little lower, by 0.01 to 0.03, while the housing collateral and illiquid financial wealth effects on consumption are a little lower also[19]. The important conclusion is that

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[18] A partial explanation could be the accident that the early 1970s UK house price and income boom was followed by the first oil shock and severe recession. However, the negative effect before 1980 of house prices on future growth remains, though in more muted form, even after controlling for a significant negative real oil price effect and dummies for 1974.

[19] This is very likely connected with the role of asset prices in the income forecasting equations. Clearly, if one controls for the expectations effects of asset prices, the estimated wealth or collateral effects on consumption should be lower. Thus, forecasting equations with

instrumentation does not raise the estimated contribution of *log (yperm/y)* and that the results are fairly robust to the use of the different instruments sets described above.

In terms of trying to find an expectations interpretation of the rise in consumption relative to income from 1984/5 to 1988/9, the rational expectations approach, using econometric model based forecasts of future income growth, does a little less badly than perfect foresight. The forecasts of *log (yperm/y)* imputed to households by this fitting exercise are a little above the actual, later realised values between 1984/5 and 1988/9. This reduces by a small amount the gap between the rise in *log (c/y)* and what is implied by *log (yperm/y)*. As Figure 5 demonstrates, this is the case with *log yperm* defined using a 10 percent per quarter discount rate and the most comprehensive of the information sets. Fitted values from the narrower information sets show a similar tendency. The peak of the forecast error is around 1 percent in 1986, averaging around 0.5 percent over 1985 to 1988. This is small relative to the gap of around 7 percent which opened up between *log (c/y)* and the part of it explicable by *log (yperm/y)* between 1984/5 and 1988/9.

An obvious objection to this evidence might be that this fitting exercise is not "real time" forecasting. To get closer to real time forecasting, we can estimate and forecast recursively, from 1984 to 1989, and compute the deviations between the recursive forecasts and the actual later realised values. This marginally pushes up the forecast errors over 1985-1988, meaning that the forecasts were more optimistic than the outcomes. But even without the problem of data revisions, this is still not true real time forecasting. Note that the recursively fitted value for *log (yperm/y)* at t uses later realised data unavailable at t to estimate the parameters available at t. To get round this, I estimate a relationship between *log (yperm/y)* and a constant, trend, *log y* and $\Delta_4 \log y_{t+4}$. This is fairly stable over time and I choose the estimated relationship for 1959 to 1981. Then, I recursively forecast $\Delta_4 \log y_{t+4}$ from information available at t, but using parameter estimates from t-4, based on data on $\Delta_4 \log y_{t},$ and t-4 dated information on the regressors. Thus a two-step recursive forecast of $\log (yperm/y)_t$ can be obtained from the forecast values of $\Delta_4 \log y_{t+4}$ and the fitted relationship

larger asset price effects tend to result in marginally lower estimated MPCs out of those assets in the consumption equation.

between the two. This gets close to replicating what a practical econometrician forecasting in real time might have been able to achieve in the 1980s

This pushes the maximum deviation between the recursive forecast of *log (yperm/y)* and its later realised value to around 2 percent in 1986, and around 1 percent on average over 1985-88. Effectively, this replaces the standard rational expectations treatment where agents are assumed to know the true forecasting model and have access to full sample estimates of the parameters, by a real time learning process, recursive forecasting (abstracting from data revisions). Deriving income growth expectations from this learning model does less badly than rational expectations, which as we saw above, in turn does less badly than perfect foresight in accounting for the rise in consumption relative to income in the 1984/5 to 1988/9 period.

Thus, one can argue that, abstracting from data revisions, households in the period, making the best use of available data, might have erred in an overoptimistic direction by overestimating *log (yperm/y)* by 1 to 2 percent. This closes the 7 percent gap between *log (c/y)* and what *log (yperm/y)* can explain by a little. But the bottom line is the same: the rise in the consumption to income ratio form 1984/5 to 1988/9 cannot be explained by a shift in income growth expectations.

This small help for the hypothesis that a shift in income growth expectations accounts for the rise in the consumption to income ratio from 1984/5 to 1988/9 can only be of very limited comfort, however, to those economists willing to accept the usual assumptions made by DSGE modellers. It is important to note that these estimates rest on a very high discount rate and hence assume households have far shorter horizons for assessing future income than would be acceptable in standard DSGE models. With a discount rate of 1.25 or even 2.5 percent per quarter, estimated "over-optimism" is lower than for a discount rate of 10 percent per quarter. This follows from the observation that, see Figure 2, *log (yperm/y)* for a discount rate of 1.25 is virtually a fitted linear trend minus log y. Then full sample and recursive estimates will be almost the same and recent good economic performance has far less influence on estimates of *log (yperm/y)* than is true for high discount rates.

One possible defence of the conventional DSGE position is that the effect of *log (yperm/y)* on consumption is underestimated because the included controls are positively correlated with *log (yperm/y)*. Unfortunately, this position is contradicted by the evidence: we have already seen that *with no controls* there is no evidence of *any* relationship between *log (c/y)* and *log (yperm/y).*

It is important to realise that finding a significant impact of *log (yperm/y)* in the extended consumption model could, in part, reflect the impact of positive exogenous shocks to credit supply. Since these raise consumption, and consumption is around 70 percent of GDP, it seems likely that household incomes will be raised in the short run. To the extent that consumers understand this mechanism, or at least the data correlations it generates, income expectations should respond to positive credit shocks perceived by households. Finding a significant role for income growth expectations in the data thus does *not* necessarily imply that there was an exogenous shift in income growth expectations.

The question then is what lay behind the rise in the consumption/income ratio between 1984/5 and 1988/9. Our model suggests four main proximate factors: increased credit access, the interaction of credit conditions and higher housing collateral, higher stock market wealth and the fall in the unemployment rate. However, there was an important offset: increasing household debt lowered net liquid assets relative to income, and with an MPC far higher than that for illiquid financial wealth or gross housing wealth, this dampened the rise in consumption/income, see Figures 6a and b, which plots the fitted long-run contributions explaining variations in the log consumption to income ratio.

The true believer can resort to the claim that macro data are either 'uninformative' or inaccurate. The existence of the stable, co-integrated[20] relationships presented in Tables 1 and 2 which hold for 1967 to 2005, or for sub-samples such as 1967 to 1995, 1976 to 2001, 1980 to 2005, is evidence of the information content in UK macro data.

[20] See Aron et. al. (2008) for co-integration evidence, suggesting that single equation estimates produce long-run solutions close to the single co-integration vector identified by the co-integration exercise. Instrumenting current income has hardly any bearing on the estimates, which is not surprising given the super-consistency property of co-integrated relationships.

In any case, even a casual examination of graphs of UK data on asset prices, interest rates, unemployment rates and growth rates will confirm the very large macro shocks experienced by this small open economy. These have overwhelmed the undoubted heterogeneity of consumption behaviour at the micro level to allow identification of important macro effects. Sometimes these have had external origins, sometimes the result of policy shifts such as Mrs. Thatcher's, and sometimes the result of financial innovation. Though some economists would deny that a conditional relationship such as equation (2.3) could be 'structural', its stability and interpretability qualify it as a useful equation in a larger system including equations for portfolio choice, asset pricing and income determination.

As for accuracy, national accounts data are, of course, subject to revision. However, the national accountants do their best to reconcile the production, expenditure, income and flow of funds accounts to produce coherent estimates. The consumption boom of the 1980s was associated with a very substantial deterioration of the trade balance and a subsequent serious bout of inflation. It is impossible to believe it did not occur. The questions of whether UK micro data give a very different view of the consumption boom of the 1980s, and of the influence of credit and house prices, are the subject of Section 4.

3. The failure of the consumption Euler equation.

DSGE models rest on the consumption Euler equation, the most important of the simple asset-arbitrage relationships mentioned in the quote from Kohn in the introduction. This section confirms that the data strongly reject this hypothesis. In his celebrated 1978 paper, Hall showed that under preferences which are additive over time in consumption, a linear inter-temporal budget constraint and rational expectations, consumption (or log consumption) followed a martingale so that changes in consumption or log consumption were unforecastable given information from the previous period. This generated a large empirical literature, following an early contribution by Flavin (1981), and the authoritative rejection of the hypothesis by Campbell and Mankiw (1989, 1991) on data for the main OECD economies. Campbell and Mankiw showed that there was "excess sensitivity" of consumption growth to forecastable growth in income. This section reports on empirical work for the UK, Japan and the US, that supports the findings of Campbell and Mankiw (1989, 1991).

To be more specific, the log form of the Euler equation is implied by a life-cycle utility function additive in each period's consumption and a constant intertemporal elasticity of substitution. Then the period utility function is $u(c) = c^{-\rho}$ or log c if $\rho \to 0$. The first order condition for optimization, or Euler equation, for a consumer facing a linear budget constraint is

$$c_t^{-1/\sigma} = E_t\{(1+r_t)/(1+\delta)\}c_{t+1}^{-1/\sigma} \tag{3.1}$$

where the intertemporal elasticity of substitution $\sigma=1/(1+\rho),\rho>-1$, r is the real interest rate and δ is the subjective discount rate.

Hansen and Singleton (1983) showed that, under the assumption of log normal distributions for consumption and the real interest rate r,

$$\Delta \log c_{t+1} = \sigma \log(1+r_t) + \sigma(\text{uncertainty measure})_t + \text{constant} + \varepsilon_{t+1} \tag{3.2}$$

Under rational expectations, ε_{t+1} is a stochastic error unpredictable from information at time t. Since random measurement errors in consumption (or transitory consumption) and time aggregation can be shown to induce a first order moving average process in the residuals, Campbell and Mankiw and other researchers use instruments dated t-2.

Table 3 shows similar results for the UK. Following Campbell and Mankiw, I estimate by instrumental variables the regression of $\Delta log\ c_t$ on a constant and on $\Delta log\ y_t$, generating efficient instruments from parsimonious forecasting equations for the log change in income, using t-2 dated information. The same three information sets are used as discussed in the previous section. The results are similar for all three, so only those for the most comprehensive information set are reported.

If we assume that uncertainty and the real interest rate are approximately constant, then the simplest test of excess sensitivity, is shown in columns 1 and 2 of Table 3. The coefficient on $\Delta log\ y_t$ is usually around 0.4 for aggregate consumption, shown in column 1, and around 0.3 for consumption of non-durables and services, shown in remaining columns. It is always highly significant and is not sensitive to the t-2 dated information set used to obtain the fitted value of $\Delta log\ y_{t.}$ The estimated coefficient appears to be roughly stable over different samples, though is even higher for post 1980 data, when the access to credit improved. These findings appear to contradict the role of credit constraints as the main explanation of the excess sensitivity finding. If true, the excess sensitivity coefficient should decline with easier access to credit. This suggests that the failure of the simple rational expectations assumption may instead be the main cause of failure of the main prediction of the consumption Euler equation.

The inclusion of the dummies used for the regressions in Table 1 has little impact on the excess sensitivity estimate, marginally raising the t-ratio on the coefficient. Column 3 shows a specification where the real interest rate, measured by the tax-adjusted real mortgage interest rate, dated t-1, is introduced, instrumented by its lags dated t-2 and t-3. The coefficient proves to be small and insignificant, while the excess sensitivity coefficient is little affected by its inclusion.

Column 4 shows a specification where $\Delta log\ c_{t-1}$ is included, and is instrumented by lags of itself and of $log\ (c/y)_{t-2}$. Such a specification is derived from a simple model of habit adjustment, see Muellbauer (1988). It has been popular as it potentially could account both for excess sensitivity and for the equity premium puzzle, see Constantinides (1990) and Campbell (2000). However, column 5 casts doubt on the habits explanation for excess sensitivity: when $\Delta log\ y_t$ is included also, the coefficient on $\Delta log\ c_{t-1}$ becomes insignificant while excess sensitivity remains highly significant. Research on the Japanese economy reaches similar conclusions. Muellbauer and Murata (2009) show that for annual data on Japan from 1961 to 2006, and using t-2 instruments: a hugely significant excess sensitivity coefficient results, but with little evidence consistent with habits.

For the US, the empirical findings are similar too. For quarterly data from 1963 to 2008, the excess sensitivity coefficient is estimated at around 0.65 for total consumer expenditure and a little lower for consumption of non-durables and services, with t-ratios in excess of 7. Again, the coefficient on lagged consumption growth is insignificantly different from zero, when instrumented income growth is included.

These findings reinforce the findings of Campbell and Mankiw (1989, 1991). The use of somewhat more informative instruments, including predictable effects on income of monetary policy, fiscal policy with a Ricardian element, and asset prices, gives even stronger rejections of the consumption Euler equation for aggregate data. This "inconvenient truth" greatly weakens the case for standard, representative agent, rational expectations DSGE models. It supports the use of the kind of data-coherent solved out consumption function discussed in Section 2, and which is consistent with a broader view of consumer behaviour, less reliant on extreme informational requirements and full rationality.

4. The interpretation of UK micro-evidence.

As noted in the introduction, Attanasio et al. (2009), ABHL for short, examine cross-section micro data from the Family Expenditure Survey for 1975 to 2001, to investigate the relationship between UK house prices and non-housing consumption. They use information on regional house prices to measure the impact of house price levels and changes on consumption by households distinguished by age, tenure and region of residence. They expect to find larger effects on older households and on owner-occupiers if the housing wealth hypothesis holds. They start with the idea that the log of consumption should be a linear function of log life-cycle wealth and also depend on age and demographic structure. Cohort dummies are used and information on education to proxy log life-cycle wealth. The residuals from regressing log consumption on age, demographic structure, cohort dummies and education are constructed. ABHL examine the correlation of these residuals with log real house prices for the region of residence interacted with age dummies. These are for young households where the head is aged 21-34, middle-aged households with the head aged 35-59, and for older households. Contrary to the housing wealth hypothesis, ABHL find that older households do *not* have larger correlations of the consumption residuals with house prices (or indeed with the log changes in real house prices). They conclude that it is income expectations, rather than housing wealth, that drive consumption.

The average residuals by age group are shown in Figure 7, taken from their paper. Indeed, they show a stronger rise in the residuals for the young with the 1980s rise in house prices, and a stronger fall in the early 1990s, as house prices fell. The interpretation of these findings is, however, problematic. The first question arising concerns the accuracy of the FES data used. There are problems with the FES response rate, which was as high as 72 percent in 1992, but was as low as 59 percent in 2001. Younger, more affluent, less stable households tend to be under-represented, and there are well-known biases in reported spending on alcohol, tobacco, and meals away from home. Figure 8 plots annual consumption growth from the FES with comparable national accounts data. This suggests that 1987 and 1988 were years in which the FES was particularly biased, though overall there is a reasonable correlation with the national accounts data. Unfortunately, the income data in the FES are of rather worse quality than the consumption data: the two together imply that 1988 had the highest personal sector saving rate of the 1980s, while the national accounts data imply that 1988 had the lowest saving rate of the 1980s (Banks and Johnson 1997).

As was made plain in the earlier discussion, the 1980s debate in the UK concerned the collapse of the household saving ratio. That is, it was about the rise in consumption *relative to income*, and not about the growth of consumption in isolation. Unfortunately the omission of this key control, i.e. income, makes it very difficult to draw robust conclusions from ABHL’s exercise, and from the earlier study by Attanasio and Weber (1994). Our work suggests changes in interest rates, the unemployment rate, other asset prices, and shifts in access to credit, all affected consumption. The omission of these controls together with the income control, all of them likely to be correlated with house prices, makes it impossible to say anything about causal links between house prices and consumption.

The relevance of these points can be demonstrated by analysing the relationship between the three consumption residuals by age from ABHL shown in Figure 7, and the aggregate data driving our aggregate consumption function. Given annual data on these residuals[21] for 1978 to 2001, and hence far few observations than for our quarterly aggregate consumption model for 1967 to 2005, a stripped-down version of our quarterly consumption function equation (2.3) is required. Since the estimated quarterly speed of adjustment reported in Section 2 is around 0.35, most of the adjustment is complete in one year and we therefore ignore the adjustment lag. The estimated real interest rate effect is relatively weak in the quarterly model, and so can be omitted from a stripped-down model. The weighted cash flow effects of interest rate changes are collapsed into the annual change in the log of the nominal mortgage interest rate, abmr. And the interaction effect of permanent income with credit conditions is omitted, partly because of fewer data points and partly because few years belonging to the tight credit regime are in the sample. To translate quarterly data into annual data, we take the four-quarter moving average of the quarterly data, and extract the moving average corresponding to the calendar year. The stripped-down version of our model for aggregate data is then as follows:

$$MA4\log c_t \approx \begin{pmatrix} \alpha_0 + \alpha_{0C} MA4CCI_t + \alpha_2 MA4\Delta_4 ur_t + \alpha_3 MA4E_t \log yperm_t / y_t \\ +\gamma_1 MA4NLA_{t-1}/y_t + \gamma_2 MA4IFA_{t-1}/y_t + \gamma_{3C} MA4CCI_t (MA4HA_{t-1}/y_t - MEAN) \\ +MA4\ln y_t + \beta_2 MA4\Delta_4 \log abmr_t + \varepsilon_t \end{pmatrix}$$

(4.1)

The economic reasoning behind our aggregate consumption function has predictions for the heterogeneity of estimated coefficients with age. Though we do not observe the relevant income, portfolio and unemployment data by age, we can make predictions about the correlation of consumption by age with the aggregate data we do have. Thus, the young (aged 21-34) should be most affected by changes in the unemployment rate interpreted as an income uncertainty indicator: they have less secure labour market attachment than middle aged (35-59) workers and the security of their prospective earnings is more likely to be undermined by a rise in the

21 I am grateful to Andrew Leicester for making these data available.

unemployment rate. For those aged 60 or more, the security of prospective incomes should be hardly influenced at all by a rise in the aggregate unemployment rate.

The young and especially the middle aged have bigger mortgages than the old, so their cash flows should be more affected by changes in mortgage rate. The consumption of all age groups but likely most of all the young, who were more likely previously to have been credit constrained, should be affected by aggregate credit market liberalisation. The housing collateral effect measured by the interaction of the credit conditions index and the housing wealth to income ratio might be expected to result in the largest marginal propensity to spend out of housing wealth for the young. However, some of this effect will be offset by the tendency for the young to own less housing than the middle aged, so this will offset some of this effect, leaving it unclear whether to expect a larger or smaller response compared to the middle aged. On a wealth interpretation, the largest response of consumption to aggregate housing wealth/income would be for older households who own the most housing, whereas the collateral interpretation would lead one to expect a lower response for the old than for the middle aged. However, the effect is not necessarily zero as increased access to home equity loans and reverse mortgages could also affect the ability of older households to access housing wealth.

From ABHL we do not have consumption by age but non-housing consumption residuals for the young, middle aged and old after age, after the effects of cohort and other household characteristics have been removed. My strategy is to regress the three sets of consumption residuals on the variables shown in equation (4.1) augmented by a time trend. The trend compensates for the removal of mean and trends in ABHL's construction of the residuals. I do not force the coefficient on current log income to be unity, since the correlation of the incomes for each age group with aggregate non-property income is not necessarily unity. I also show results which allow for measurement error in the micro data by including, RESDIFF = FES consumption growth rate- ONS consumption growth rate, derived from the data in Figure 8.

With annual data constructed as above, it is important to remove key endogeneity biases by appropriate use of instruments. Thus, I instrument current log income, log permanent income relative to current income and the three asset-to-income ratios. At quarterly frequency all the instruments are lagged four quarters, and then annualised, to ensure that no current annual information is used for these variables. For the three asset to income ratios, I simply use end of previous year asset to income ratios. The two income variables are instrumented by fitted values using four quarter lagged data.

The results are shown in Table 4 and are almost entirely consistent with the predictions based on our model, though the coefficients on illiquid financial wealth/income were close to zero or negative for all ages. This variable was omitted therefore. The coefficient on current income is greater than unity for all age groups, most of all for the young, given the greater cyclicality of the income of the young. One reason for coefficients larger than unity is that ABHL's consumption residuals have removed effects of some variables such as education, likely to be correlated with income. A coefficient on log current income greater than 1 compensates for this.[22] The unemployment effect declines with age, and is not significant for the old. The cash flow effect of interest rate changes is large for the young and the middle aged and not significant for the old. The effect of the credit conditions index declines with age, suggesting, reasonably enough, that the relaxation of credit constraints matters most for the young. Income growth expectations are not very accurately estimated, but generally have positive effects. The housing collateral effect is larger for the two younger groups and negative for the old. At least in this respect, I can agree with ABHL: there is little evidence for a classical housing wealth effect. The measurement error proxy is not relevant for older households, but is relevant for the two younger age groups. This is consistent with the known under-representation of younger and more mobile households in the FES. But omitting the measurement error proxy does not affect the other main conclusions.

Given the removal of some long-run information on households in the process of construction of the consumption residuals and the exclusion of housing expenditure from the definition of consumption, one should not expect the coefficients on the two included asset-to-income ratios necessarily to be very close to those shown in Table 2 for aggregate quarterly consumption data. Those for housing collateral/income

[22] The possibility of an overfitted instrument for log income can be excluded: an alternative instrument based on one year lagged log income and last year's change, trend and a constant gives very similar estimates.

interacted with the credit conditions index are in the right ball park. Those for net liquid assets/income are rather larger than the quarterly estimates. This variable is trend-like with a negative slope, and may be picking up some long-term effects not quite captured by the linear trend.

A number of important conclusions result from this exercise. Most obviously, current income does matter for consumption, and much more than expected income growth. Macro data for the UK have large information content, and while there are important differences in behaviour by age, there are many common features in aggregate consumption. The UK population shares of the different age groups evolve very slowly, so that a relationship estimated on UK aggregate data can be stable for long periods, even with some heterogeneity in behaviour with age. Finally, though micro data are subject to significant measurement error, ABHL's data confirm the robustness of the findings of our UK consumption research, which highlights the role of shifting access to credit, its interaction with housing collateral, of cash flow effects from changes in nominal interest rates and the important influence of changes in the unemployment rate, interpreted as a proxy for income uncertainty.

5. DSGE models with housing.

Iacoviello and Neri (2008) and Iacoviello (2005) introduce a housing sector into a DSGE model, with a financial friction. This model has proved influential – the European Commission, for example, are using a similar model for the Eurozone. Calza, Monacelli and Stracca (2008) have extended the model further by adding fixed rate as well as variable rate mortgages. The model has two sectors, one sector produces consumption, business investment and intermediate goods (using capital and labour), while the other sector produces new homes (using capital, labour, land and intermediate goods). There are two types of households. Patient households work, consume, buy homes, rent capital and land to firms, and lend to impatient households. Impatient (and hence assumed to be credit-constrained) households work, consume, buy homes, and borrow against the value of their home.

There is different trend technological progress across sectors, and sticky prices in the non-housing sector (with Calvo-style price rigidity and indexation). Technology and preferences are subject to random shocks. Wages are sticky in both sectors. Real frictions include habits in consumption, imperfect labour mobility, adjustment costs for capital, and variable capital utilization, which all help generate persistence in the real variables. The central bank runs monetary policy. Given the separability of housing and consumption in the utility function, the consumption Euler equation takes its usual form.

The model works like a Real Business Cycle (RBC) model with sticky prices (though not for housing), and some real frictions. Housing collateral then generates wealth effects on aggregate consumption from fluctuations in house prices.

In this model, the economy is closed and there is no financial sector. In lending to the impatient households, the patient households apply a maximum loan-to-value ratio. This is the financial friction in the model. Impatient households are assumed always to be borrowing the maximum allowable. The budget constraint says that consumption + housing purchase = labour income + expansion of mortgage debt i.e. consumption = labour income + mortgage equity withdrawal (MEW). But if the maximum loan-to-value ratio is significantly less than 1 (calibrated at 0.85 by the authors), then housing purchases even for the impatient households alone almost always exceed the rise in their debt (unless extraordinary house price appreciation is expected). Given that the patient households, who are a majority of the population, are savers, the aggregate MEW will always be negative. Yet this is entirely inconsistent with data for the US, UK, Australia and many other economies. Swings in the ratio of MEW to income for quarterly data in these economies have been of the order of 15 percent between the maximum and minimum – a hugely important part of financial flows in the national accounts. It should be obvious that a closed economy without a banking system could never generate such swings. The model therefore fails this simple first reality test, despite being calibrated on US data.

Other weaknesses of these extended DSGE models, not in order of importance, include the following:

1. As a result of the omission of a financial sector, these models miss the amplification mechanisms so relevant for financial crises e.g. see Bernanke (1983), Brunnermeier (2008), Shin (2008) and Von Peter (2009).
2. Credit rationing, driven by consumers' exogenous taste differences and an unexplained loan-to-value ratio limit, lacks micro foundations in asymmetric information and the shifts over time in credit technology.
3. A fixed fraction of credit constrained households is assumed. This omits the impact on the desire to borrow of time-varying expectations of income, capital appreciation and uncertainty.[23]
4. The model also ignores the life-cycle: young households need to borrow, but their need to save first for their initial housing deposit is omitted from the model. Their saving should depend on both the loan-to-value ratio constraint and level of real house prices. There is no role for saving by the young in these models.
5. Precautionary and buffer stock saving is also absent, as in most DSGE models.
6. There are no defaults on loans and therefore there is no default risk. Thus, mortgage foreclosures, now at record levels in the US, are outside the scope of such models.
7. Housing preference shocks play an implausibly large role in explaining real house prices and housing investment.
8. There is no role for extrapolative expectations of house price appreciation or other housing market inefficiencies, which ignores the large literature on housing market inefficiency. Extrapolative expectations are one major amplification channel for the financial accelerator discussed further below.

Recent literature by Favilukis et al. (2009), Kiyotaki et al. (2008), Rios-Rull and Sanchez (2008) and others has expanded the framework in a number of directions. Rios-Rull and Sanchez (2008) argue that under rational expectations, the multi-sectoral DSGE models, even with housing added, will find it very difficult to generate the persistence and volatility of house prices, residential investment and transactions

[23] Indeed, in the screening model of Stiglitz and Weiss (part IV, 1981), the credit standard below which applicants do not qualify for loans depends on key macro drivers such as real interest rates and the economic outlook.

volumes actually observed in the data. They argue that other assumptions about the generation of expectations are needed, particularly for house price expectations.

Instead, Favilukis et al. (2009) emphasise shifts in risk premia. They remove the closed economy restriction, and introduce a major role for the (assumed exogenous) rise in loan-to-value ratios for US first-time home buyers (as documented in Duca et al., 2009), and also for a reduction in transactions costs for housing. These changes, they argue, sharply lowered risk premia in both housing and equity markets. Heterogenous households face limited risk-sharing opportunities as a result of incomplete financial markets, so risk premia must play a key role. Their model can generate substantial variability in national house price-rent ratios, both because they fluctuate endogenously with the state of the economy and because they rise in response to a relaxation of credit constraints and decline in housing transaction costs. They find that in a calibrated model, the relaxation of the loan-to-value ratio constraint, plus lower transactions costs and an infusion of foreign capital (calibrated to match the increase in foreign ownership of U.S. Treasuries from 2000-2007) can explain much of the rise in US house prices relative to rents in this period. It leads to a short-run boom in aggregate consumption but a crowding out of investment, softened by the inflow of foreign capital.

In many ways, their findings agree with our own analysis of the US house price boom in Duca et al. (2009), and the consumption implications modelled in Aron et al. (2009). However, our research places more emphasis on overshooting due to extrapolative expectations (or momentum trading), on an intrinsic non-linearity discussed below and is consistent with a more general role for the relaxation of credit constraints, as opposed to the restriction that they only affect risk premia.

6. Modelling implications.

Central banks are usually wise enough to follow a "suite of models" principle, employing special models for specific purposes, such as forecasting inflation. However, as the quote from Don Kohn in the introduction indicates, many central banks have relied on models which "*omit financial-accelerator effects and other* *credit interactions that are now causing stresses in financial markets to spill over to the real economy"*. He argues that *"These models abstract from institutional arrangements and focus on a few simple asset-arbitrage relationships"*. It is clear then that most New Keynesian-DSGE models have little to say about the current crisis. What are the alternatives?

One way forward could be to adapt older type income-expenditure models, of which the FRB-US model is a good example, with the advantage of a systematic treatment of expectations.[24] However, in this model, the specification of credit channel transmission in consumption, house prices and investment equations needs to be improved, with a greater focus on structural change and on non-linearities, see below. Corporate spreads could play a role in investment equations, see Gilchrist et al (2009) for evidence on their macroeconomic effects, but clearly need to be endogenised. The treatment of the financial sector needs to be better articulated, so that loan defaults feed back into bank balance sheets and credit spreads, as in the Bank of England's RAMSI.

6.1 Some mechanisms for shock amplification

The large empirical literature on defaults necessarily implies non-linear or asymmetric responses to asset prices, e.g. Aron and Muellbauer (2009) on UK mortgage defaults. While the non-linear impact of asset prices on defaults and hence the balance sheets of the financial sector is one major source of shock amplification, important amplification of shocks also occurs via the household sector. I shall now discuss four distinct channels, each largely concerning house prices.

To understand these amplification mechanisms, consider the demand for housing services, proxied by the housing stock per head, or *hs*:

$$\log hs_t = a_0 + a_1 \log y_t + a_2 \log z_t - a_3 \log(rhp_t)(uch_t) \qquad (6.1)$$

[24] I am grateful to Lucas Papademos for noting that the ECB retained its older income-expenditure model which it runs alongside a newer DSGE model. The Bank of England scrapped its old model entirely when, in 2005, it switched to BEQM, which has a DSGE model at its core.

Here *y* is real income per head; *z* refers to other demand shifters which could include demography and income growth expectations; *rhp* is the real price of housing; and *uch* is a 'user cost of housing' term discussed below. This is a log-linear version of the standard neoclassical model of the demand for durable goods, see Cramer (1957).

With the housing stock given in the short run, one can invert equation (6.1) to obtain the long-run solution for the log of real house prices:

$$\log rhp_t = [a_0 + a_1 \log y_t + a_2 \log z_t - \log hs_t] / a_3 - \log uch_t \qquad (6.2)$$

An adjustment process of the price to its long-run value generates short-run dynamics around equation (6.2).

The user cost term is of great importance for understanding the potential of the housing market to amplify and transmit shocks. A simple expression for the user cost term is

$$uch = (ra + m + th - E\Delta \log rhp) \qquad (6.3)$$

where *rhp* is the real price of houses; *ra* is the tax adjusted real interest rate; *m* is the rate of expenditure on maintenance and repair etc.; *th* is the net rate of tax on housing plus transactions costs and a risk premium; and $E\Delta \log rhp$ is the expected rate of appreciation of real house prices. The main drivers of the user cost are the mortgage rate and the expected rate of inflation of house prices. Given lumpy transactions costs, the horizon for expectations is likely to exceed one quarter.

The first of the four amplification channels concerns expectations. As noted in section 5, there is much evidence for an extrapolative element in expectations or momentum trading, as in Piazzesi and Schneider (2008), Abraham and Hendershott (1996) and Muellbauer and Murphy (1997). Such an element in expectations can be an important source of shock propagation and amplification: a sequence of positive shocks, e.g. the sub-prime explosion and low interest rates in the last decade, can then drive up appreciation, generating more demand and further appreciation. This was an important element in the overshooting of US house prices in the new millennium, see Duca et al. (2009).

The user cost expression (6.3) implies a second potentially important source of non-linearity, a kind of house price "frenzy" effect. The model set out above implies that *log uch* should have a coefficient of -1 in long run solution. This is not the result of taking a log-linear approximation to the housing demand function, but it comes from the multiplicative manner in which *uch* and the real price of housing combine in the neoclassical theory of the demand for durables.[25] Since the log of zero is minus infinity and the log function amplifies movements when *uch* falls to low levels, with extrapolative expectations, *uch* could even be negative during a house price boom, unless the transactions costs and risk premia are large enough. Thus, the theory itself suggests that in a boom an *amplification* of optimism is likely, inducing a speculative "frenzy" in some market participants.

Shiller has long emphasized the psychological element in the behaviour of investors in asset markets (and more recently in Shiller (2007) and Akerlof and Shiller (2009)). Unfortunately, 'psychology' is not easily amenable to quantification and this approach can neglect important economic drivers, such as interest rates and access to credit. Our approach to the empirical modelling of house prices gives some scope for psychological insights, but it also brings hard econometric evidence to bear.

A third potential amplification mechanism can operate in house price down-turns via fear of default or of heavy losses. One might expect fear of default to be more important in countries such as the UK, where mortgage default has far more severe implications for households than would, for example, be the case in the US. In our UK house price research, we find such effects appear both in house price and regional migration models, Cameron et al. (2006a, 2006b).[26]

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[25] Indeed in Jorgenson's classic exposition of user cost for producer durables, user cost is defined as the product of *uch* and the price of the durable good.

[26] To define a rate of return in housing, say *RRH* (approximately minus user cost), we define an indicator function, $RRHN = 0$ if $RRH>0$; and $RRHN=RRH$ if $RRH<0$. This picks out periods of bad returns. It is typical to find that *RRHN* in the previous three to four years is significant for the UK, suggesting a long memory of bad times.

There is fourth non-linearity, which may be less pronounced, but it applies to the *largest* component of GDP, namely consumption. To be precise, this non-linearity arises as a violation of the log-linearity stemming from linear standard inter-temporal budget constraints and the usual assumptions about inter-temporal preferences. The implied life-cycle consumption functions have marginal propensities to consume out of assets which are independent of the level of asset ownership. Thus, consumption cannot have a log-linear relationship with asset prices. Instead, the elasticity of consumption with respect to asset prices rises with the *share* of the value of assets in life-cycle wealth, amplifying the consumption elasticity as asset prices rise.

These four amplification channels for the effects of house prices on consumption have important policy implications. They make a case for property taxes linked to current market value as an important automatic stabiliser to reduce the probability of financial instability and to stabilise the business cycle, see Muellbauer (2005) for further details of the argument. They also highlight the importance of the housing market and its interactions with US or UK style credit markets in amplifying the business cycle and generating risks to financial stability. Macro-prudential regulatory policies need to take account of these housing and mortgage related macro risk factors.[27]

6.2. Booms and busts in residential construction.

While Leamer (2007) may have been overstating the case slightly when he wrote "Housing ***is*** the business cycle", the collapse of residential construction has contributed greatly to the fall in output in the US, Spain and Ireland. Understanding better the mechanisms driving booms and busts in construction should certainly improve monetary policy[28]. We reviewed the literature on residential supply in Muellbauer and Murphy (2008). There is now widespread agreement that zoning or land use planning restrictions play an important role in the determination both of

[27] Residential mortgages had low risk weightings in Basel I and II capital adequacy rules because their asset backing lowers micro-risk. However, macro-risk and the potential amplifying role of mortgage and housing markets were insufficiently taken into account in designing these rules.

[28] The FRB-US model did not do well in this regard, under-predicting both the boom and the subsequent collapse. In this model, residential construction is largely driven by bond yields.

house prices and of construction volumes – otherwise it would be hard to understand the failure of UK house building to respond to house prices since 1997. But the dynamics of construction have long remained a puzzle.

Mayer and Somerville (2000) argue that residential construction responds not to the level of real house prices but to the rate of appreciation, and this could be part of the reason for the great instability of estimates of the supply elasticity. Their first argument is that residential construction is a stationary variable while real house prices are non-stationary, and hence, co-integration fails. Their second argument, stripped to its essentials, is that house values are basically land values plus the value of the bricks, mortar etc. erected by builders on the land. Capital gains in land are approximately capital gains in housing minus the rise in other construction costs. Hence, expected capital gains in land (or housing) will be important drivers of residential construction volumes. The user cost concept combines both expected capital gains and interest rates to which residential construction is widely believed to be sensitive.

In a simple model for the log change in housing capital per head (approximately the ratio of investment to the capital stock) in the US, we find that the main driver is the same log user cost term (with t=8) which drives our house price equation. Figure 9 shows the fitted contribution of the log user cost term to the log change in the residential capital stock per head. The data reject the linear user cost specification. This is a striking finding, with the promise of an integrated explanation of *both* house price and construction dynamics, incorporating the same two shock amplification mechanisms discussed above. It remains to be seen whether similar models will apply for Ireland and Spain: if they do, they could play an important role in modeling business cycle dynamics in these economies.

6.3. Econometric methodology.

This kind of modelling of sectoral relationships can uncover interesting economic insights, but is somewhat against prevailing fashions in macroeconomics. These fashions were largely set by two papers. The first was the Lucas (1976) critique of macro-econometric models, which highlighted the problems caused by structural breaks due to policy shifts and pointed to a pervasive role for expectations. The second was the Sims (1980) paper on 'macroeconomics and reality', in my view a suboptimal response to Lucas's critique. Sims proposed vector autoregressive (VAR) models to overcome the 'incredible restrictions' of typical macro-econometric models, which had neglected the pervasive role of expectations, which make 'everything depend on everything else'. However, though VARs can be useful modelling tools in some circumstances, particularly in the context of the co-integration of non-stationary data, they are just as prone to structural shifts as the models criticised by Lucas. Moreover, they often impose their own 'incredible restrictions': to deal with the curse of dimensionality, the set of relevant variables and chosen lags is of necessity often very restrictive. Kapetanios et al (2007) illustrate this point by calibrating a DSGE model with effectively 26 behavioural equations, which they simulate to generate time-series of artificial data for 5 core variables. They estimate structural VARs with lag lengths of 4 to 7 quarters on these data and ask whether the impulse responses to shocks for the core set of variables can be retrieved from the estimated VARs. The answer is 'no' even with 30,000 (!) observations instead of the more usual 200 or less.[29]

A more constructive response is thus required from econometric modellers, who need to work hard to address structural change – particularly shifts in credit market architecture and in fiscal and monetary policy rules. Also crucial to recognize is that the expectations of households and firms are potentially an important channel linking different variables. So conditioning on expectations, as in our consumption function, should produce more parsimonious structural equations. However, as we discovered, though important, expectations are far from dominating the influences on consumption of other variables such as asset prices, interest rates, shifts in credit supply, current income and changes in the unemployment rate. Indeed without such controls, in the context of UK consumption, it proved impossible to find a coherent empirical role for income expectations. Much research, influenced by the rational expectations revolution, has tended to overstate the role of expectations at the expense of omitting other important factors, and a sensible balance still needs to be struck.

[29] However, with lags up to 50 quarters in the VAR and 30,000 observations, the impulse responses can be inferred quite accurately. This illustrates that the problem is one of practice rather than principle.

In model building, it is often helpful to work with equation sub-systems to handle common structural breaks. I have exploited the basic principle of the multiple indicator-multiple cause (MIMIC) idea of Joreskog and Goldberger (1975) to extract information on credit shifts, used in our consumption research. In Fernandez-Corugedo and Muellbauer (2006), we extract the credit conditions index (CCI) as a common factor from 10 jointly estimated equations for credit indicators, with a complete set of economic controls. This model also contains a risk index as another common factor in all ten equations.[30] The risk index can be thought of as one potential way of quantifying the 'risk-taking channel' of monetary policy transmission of Borio and Zhu (2008), highlighted at the BIS conference by Governor Shirakawa of the Bank of Japan. Borio and Zhu argue that insufficient attention has been paid so far in research on the transmission mechanism to the link between monetary policy and the perception and pricing of risk by economic agents. They argue that: *"changes in the financial system and prudential regulation may have increased the importance of the risk-taking channel and that prevailing macroeconomic paradigms and associated models are not well suited to capturing it, thereby also reducing their effectiveness as guides to monetary policy."* It seems likely that quantification of the risk-taking channel will need to take into account sectoral differences in the nature of risk, so that the risk index relevant for the mortgage market can be different from a risk index relevant for manufacturing, even if there are some common influences. Distinguishing separate roles for access to credit caused by longer term shifts in credit market architecture and risk perceptions, which are likely to be more volatile is useful, though far from trivial.

In current work on US consumption, house prices and debt with John Duca and Anthony Murphy, the MIMIC approach to extracting credit conditions indices has proved illuminating even when, as for most other countries, credit data are less rich than for the UK mortgage market.

One of the potential hazards of current VAR methodology is the use of information criteria e.g. Akaike, to select the maximum lag length in a VAR. This can lead to an across-the-board cut-off of longer lags to the detriment of finding good models. We employ a simple device, "parsimonious longer lags" (PLL) to allow for the possibility

[30] The risk index depends on the change in the unemployment rate, inflation volatility, the downside housing risk measure discussed in footnote 26 and the rate of mortgage repossessions. An interest rate spread would be another plausible candidate for a risk index.

of longer lags, illustrated in forecasting US inflation on monthly data (Aron and Muellbauer, 2008). Separate lags are used for each month up to 3 months, then the 3-month change to capture lags between 3 and 6 months, the 6-month change to capture lags between 6 and 12 months, and the 12 month changes to capture lags older than 12 months. Thus, for example, with a maximum lag of 24 months, 24 monthly lag coefficients are replaced by 6 lag coefficients. We demonstrate that for forecasting US inflation, PLL out-performs standard VAR information criteria.

Finally, in bringing empirical evidence to bear, automatic model selection methods (PCGets, Autometrics), see Hendry and Krolzig (2005) and Castle, Doornik and Hendry (2008), provide a powerful tool for specification search and for testing whether indeed “incredible restrictions” have been imposed.[31]

To conclude, evidence-based macro research needs to replace faith-based models. Theory needs to be applied in a less heavy handed and exclusionary manner, and data should be used to discriminate between theories. Although we have learnt a great deal from good quality micro panel data, there is much information content in macro data that should not be neglected, while the quality of micro data is sometimes questionable. There are, however, large gaps in the macro and micro data of many countries, often for household balance sheets, credit market data such as data on debt by type, interest rates for different types of debt, and surveys of credit conditions (such as the US Federal Reserve’s survey of senior loan officers). The quality of house price indices is poor in many countries and very few household surveys track household expectations of house prices changes, despite their importance. There is increasing recognition of these deficiencies and action has been taken to rectify them. For example, the OECD has given priority to improving comparability of international balance sheet data. Within Europe, a new series of consumer finance

[31] This is an objective and easily reproducible tool, not affected by the subjective choices of the modeller. Any other investigator with the same data and the same specification of the ‘general unrestricted model’ (GUM), will then make the same model selection, given the chosen settings in Autometrics. This software examines a full set of general to simple reduction paths to select a parsimonious form of the GUM to satisfy a set of test criteria. The test criteria include tests for normality, heteroscedasticty, ARCH residuals, residual autocorrelation, parameter stability in the form of a Chow test, and the RESET test. There is also the option of automatically dummying out large outliers.

surveys with a common methodology promise to add to our future understanding of household portfolio behaviour.

Clearly the DSGE models with frictions of the type estimated with Bayesian methods by Smets and Wouters (2003) and Christiano et al. (2005), currently omit far too many of the variables and mechanisms needed to understand the financial accelerator. Until improved DSGE models, or better micro-simulation models to generate macro data, are designed, central banks will require practical models for policy determination. In small open economies with mature finance systems, such minimal scale models would probably require up to around thirty behavioural equations. These models should incorporate many of the features discussed in this paper in order properly to handle asset prices, credit supply shifts, uncertainty and expectations, and to track the transmission of global monetary policy and credit shocks and other external shocks. Differences in institutions, tax systems, policy rules and the structure of industry and of trade will have implications for the choice of the most salient model design.

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Table 1a: Estimates of equation (2.3*) for UK consumption data, 1967Q1 to 2005Q4 under perfect foresight with discount rate of 1.25% per quarter.

		Column 1		***Column 2***		***Column 3***	
Parameter	***Definition***	***coefficient***	***t-ratio***	***coefficient***	***t-ratio***	***coefficient***	***t-ratio***
β	speed of adj	0.014	0.8	0.12	3.7	0.343	10.2
a_0	intercept	0.43	0.9	-0.05	-1.7	-0.020	-1.7
a_{0C}	shift with CCI					0.022	1.8
a_{1C}	real interest rate x CCI	-		-		-0.22	-0.9
a_2	4-q change in unemployment	-		-		-0.0193	-7.9
a_3	log yperm/y	2.35	0.7	0.574	2.9	0.537	4.9
θ	wt. on non CCI part of log	-		-		0.35	2.1

	yperm/y						
γ_1	MPC for net liquid assets	-		0.032 (for net worth)	5.1	0.108	6.5
γ_2	MPC for illiquid financial assets	-		-		0.0241	7.3
γ_{3C}	MPC for housing wealth x CCI	-		-		0.0549	11.7
b_2	4-q change in wt'd nominal int rate	-		-		-0.0093	-4.1
b_{2C}	ditto x CCI	-				0.0075	2.7
Diagnostics							
Std. error of regression		8.3E-03		7.9E-03		5.83E-03	
R-squared		5.0E-01		5.4E-01		7.67E-01	
Adjusted R-squared		4.7E-01		5.2E-01		7.39E-01	
LM het. Test (P-value)		0.70		0.59		0.06	
Durbin-Watson		1.43		1.36		1.98	

Table 1b: Estimates of equation (2.3*) for UK consumption data, 1967Q1 to 2005Q4 under perfect foresight with discount rate of 10% per quarter.

		Column 1		*Column 2*		*Column 3*	
Parameter	***Definition***	***coefficient***	***t-ratio***	***coefficient***	***t-ratio***	***coefficient***	***t-ratio***
β	speed of adj	0.023	1.3	0.148	4.6	0.350	10.9
a_0	intercept	0.365	1.7	-0.015	-0.8	-0.0049	-0.4
a_{0C}	shift with CCI	-		-		0.0344	3.6
a_{1C}	real interest rate x CCI	-		-		-0.43	-1.8
a_2	4-q change in unemployment	-		-		-0.0178	-7.7
a_3	log yperm/y	2.725	1.2	0.795	4.0	0.728	5.7
θ	wt. on non CCI part of log yperm/y	-		-		0.32	2.5
γ_1	MPC for net liquid assets	-		0.029 (for net worth)	6.8	0.094	5.8
γ_2	MPC for illiquid financial assets	-		-		0.0259	8.1
γ_{3C}	MPC for housing wealth x CCI	-		-		0.0471	13.1
b_2	4-q change in wt'd nominal int rate	-		-		-0.0093	-4.2
b_{2C}	ditto x CCI	-		-		0.0082	3.0
Diagnostics							
Std. error of regression		8.2E-03		7.72E-03		5.71E-03	
R-squared		0.51		0.57		0.777	
Adjusted R-squared		4.8E-01		5.4E-01		0.749	
LM het. Test (P-value)		0.46		0.16		0.18	
Durbin-Watson		1.47		1.41		2.03	

The variant of equation (2.3) estimated in the above tables is as follows:

$$\Delta \ln c_t \approx \beta \begin{pmatrix} a_0 + a_{0c}CCI_t + a_{1c}CCI_t r_t + a_2\Delta_4 ur_t \\ +a_3(\theta E_t \log yperm_t / y_t + (1-\theta)(CCI_t)E_t \log yperm_t / y_t) \\ +\gamma_1 NLA_{t-1}/y_t + \gamma_2 IFA_{t-1}/y_t + \gamma_{3c}(CCI_t)(HA_{t-1}/y_t - mean) \\ +\ln y_t - \ln c_{t-1} \end{pmatrix} \quad \textbf{(2.3*)}$$

$$+b_2\Delta_4 nr_t \left(DB_{t-1}/y_t\right) + b_{2c}(CCI_t)\Delta_4 nr_t \left(DB_{t-1}/y_t\right) + \varepsilon_t$$

For details of data sources and definitions, see Aron et al (2008).

Table 2: Estimates of equation (2.3*) for UK consumption data, 1967Q1 to 2005Q4, under instrumented rational expectations with discount rates of 1.25% and 10% per quarter.

		Discount rate 1.25%		*Discount rate 10%*	
Parameter	***Definition***	***coefficient***	***t-ratio***	***coefficient***	***t-ratio***
β	speed of adj	0.340	10.0	0.338	10.5
a_0	intercept	-0.010	-0.8	-0.005	-0.4
a_{0C}	shift with CCI	0.044	4.4	0.036	3.3
a_{1C}	real interest rate x CCI	-0.24	-1.0	-0.41	-1.6
a_2	4-q change in unemployment	-0.0199	-8.1	-0.0184	7.5
a_3	log yperm/y	0.546	4.7	0.727	5.8
θ	wt. on non CCI part of log yperm/y	0.33	2.0	0.31	2.3
γ_1	MPC for net liquid assets	0.110	6.5	0.095	5.7
γ_2	MPC for illiquid financial assets	0.024	7.0	0.026	7.8
γ_{3C}	MPC for housing wealth x CCI	0.055	11.5	0.046	12.4
b_2	4-q change in wt'd nominal int rate	-0.0092	-4.1	-0.0092	-4.0
b_{2C}	ditto x CCI	0.0073	2.7	0.0080	2.9
Diagnostics					
Std. error of regression		0.00587		0.00574	
R-squared		0.764		0.775	
Adjusted R-squared		0.735		0.747	
LM het. Test (P-value)		0.064		0.184	
Durbin-Watson		1.96		2.02	

Table 3: Euler equation estimates with excess sensitivity, 1965Q1 to 2005Q4, using instruments lagged t-2

	Column 1 Total consumption		***Column 2 Non-durables+services***		***Column 3 Non-durables+services***		***Column 4 Non-durables+services***		***Column 5 Non-durables+services***	
Definition	***coefficient***	***t-ratio***	***coefficient***	***t-ratio***	***coefficient***	***t-ratio***	***coefficient***	***t-ratio***	***coefficient***	***t-ratio***
	0.0034	4.3	0.0029	4.0	0.0029	4.0	0.0017	1.5	0.0029	2.4
Income growth	0.44	5.2	00.30	4.0	0.28	3.9	-	-	00.29	1.8
Lagged real interest rate	-	-	-	-	0.016	1.1	-	-	-	-
Lagged consumption growth	-	-	-	-	-	-	0.62	2.9	0.007	0.02
Diagnostics										
Std. error of regression	0.0079		0.0074		0.0073		0.0086		0.0074	
R-squared	0.549		0.247		0.259		0.103		0.247	
Adjusted R-squared	0.532		0.223		0.231		0.074		0.223	
Durbin-Watson	2.05		2.03		2.03		2.83		2.03	

Table 4a: ABHL consumption residuals by age regressed on aggregate drivers of consumption, including measurement error proxy, 1978-2001.

	Young		*Middle-aged*		*Old*	
Definition	***coefficient***	***t-ratio***	***coefficient***	***t-ratio***	***coefficient***	***t-ratio***
intercept	-0.23	-1.5	-0.02	-0.3	-0.14	-0.9
trend	-0.015	-3.7	-0.0086	4.4	-0.0089	-2.2
RESDIFF	0.36	1.7	0.37	3.4	0.02	0.1
log income	3.12	4.0	1.74	4.5	1.91	2.3
CCI	0.08	1.9	0.02	0.9	0.03	0.6
change in log mortgage rate	-0.05	-1.4	-0.065	-3.8	-0.037	-1.0
Change in unemployment rate	-0.020	3.8	-0.005	-2.1	0.002	0.3
log yperm/y	0.36	0.6	0.61	2.0	0.85	1.3
net liquid assets/income	0.80	3.6	0.33	2.9	0.40	1.7
housing wealth/income x CCI	0.021	0.6	0.038	2.3	-0.023	-0.7
Diagnostics						
Std. error of regression	0.016		0.008		0.017	
R-squared	0.937		0.965		0.533	
Adjusted R-squared	0.896		0.943		0.233	
Durbin-Watson	2.9		2.35		2.07	

Table 4b: ABHL consumption residuals by age regressed on aggregate drivers of consumption excluding measurement error proxy, 1978-2001.

	Young		*Middle-aged*		*Old*	
Definition	***coefficient***	***t-ratio***	***coefficient***	***t-ratio***	***coefficient***	***t-ratio***
intercept	-0.36	-2.6	-0.16	-1.9	-0.15	-1.3
trend	-0.013	-2.5	-0.0075	2.4	-0.0092	-2.1
RESDIFF	-	-	-	-	-	-
log income	2.90	3.0	1.64	2.7	1.99	2.3
CCI	0.10	2.4	0.05	1.7	0.03	0.8
change in log mortgage rate	-0.04	-1.1	-0.060	-2.4	-0.037	-1.0
change in unemployment rate	-0.019	-3.1	-0.005	-1.3	0.001	0.3
log yperm/y	-0.07	0.1	0.19	0.5	0.83	1.4
net liquid assets/income	0.93	4.3	0.48	2.9	0.42	2.2
housing wealth/income x CCI	0.043	1.0	0.054	2.0	-0.025	-0.7
Diagnostics						
Std. error of regression	0.019		0.012		0.016	
R-squared	0.905		0.921		0.527	
Adjusted R-squared	0.855		0.879		0.275	
Durbin-Watson	2.9		2.40		1.77	

Figure 1: The log ratio of consumer expenditure to non-property income.

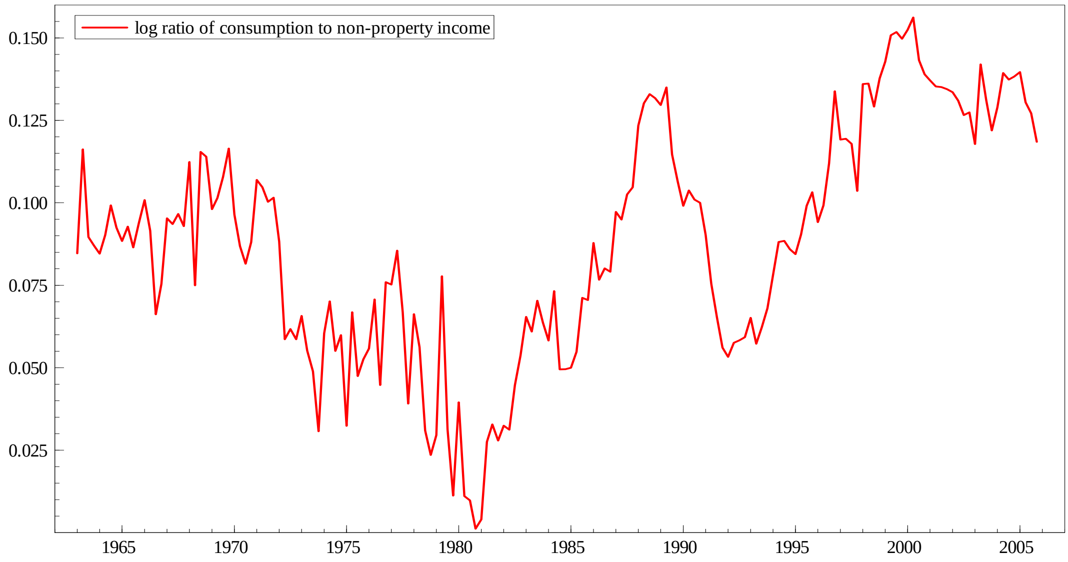

Figure 2: *log (yperm/y)* against the fitted value obtained by regressing *log (yperm/y)* on a constant, linear trend and log y for 1.25% discount rate/quarter.

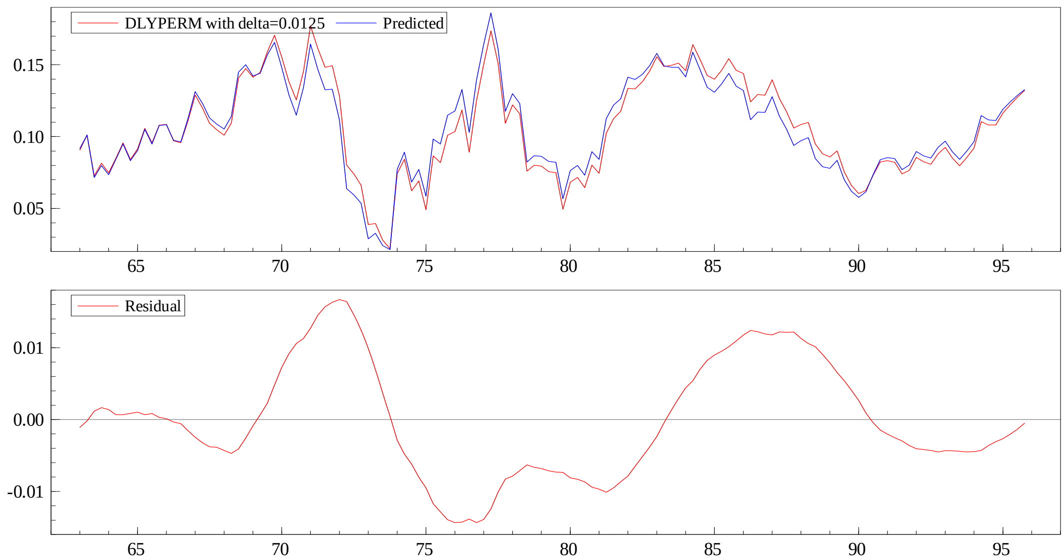

Figure 3a: Plot of *log c/y* against *log (yperm/y)* with 1.25% discount rate/quarter

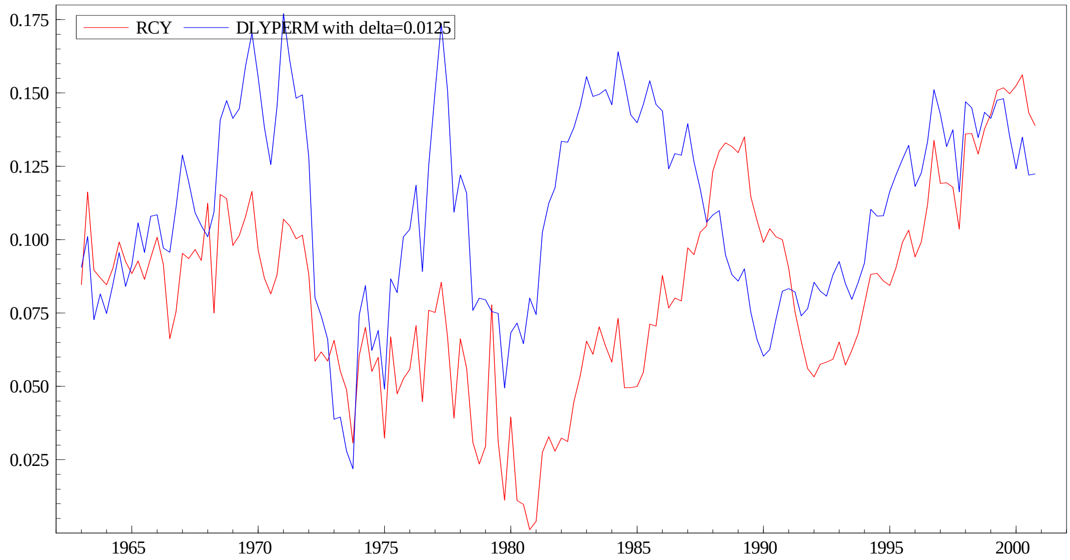

Figure 3b: Plot of *log c/y* against *log (yperm/y)* with 2.5% discount rate/quarter

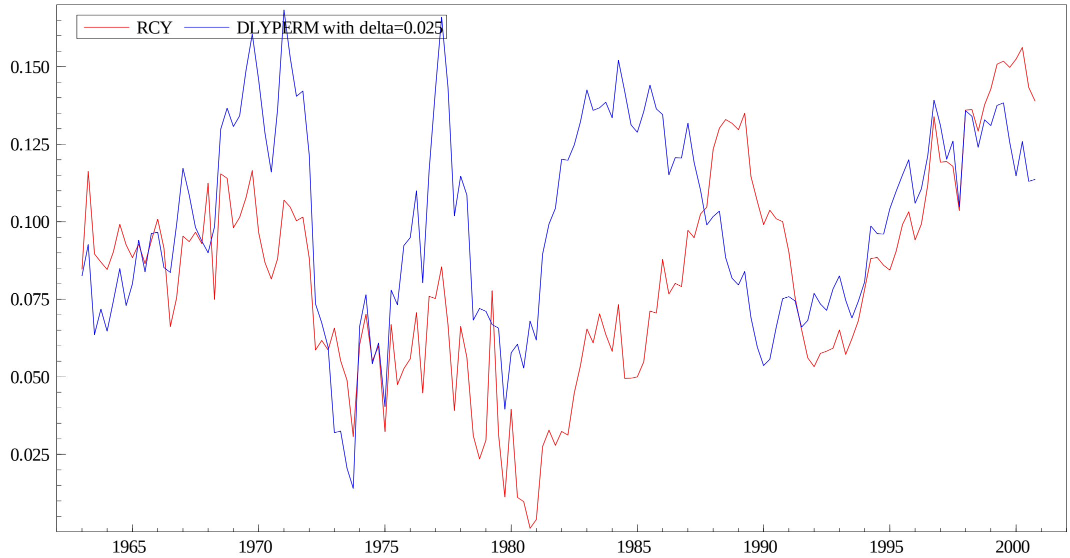

Figure 3c: Plot of *log c/y* against *log (yperm/y)* with 5% discount rate/quarter

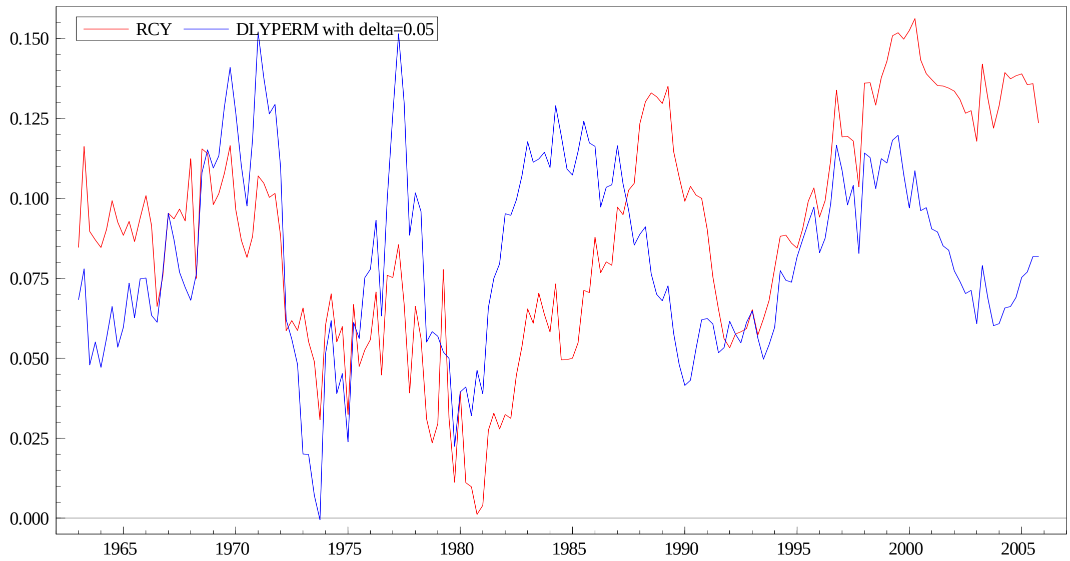

Figure 3d: Plot of *log c/y* against *log (yperm/y)* with 10% discount rate/quarter

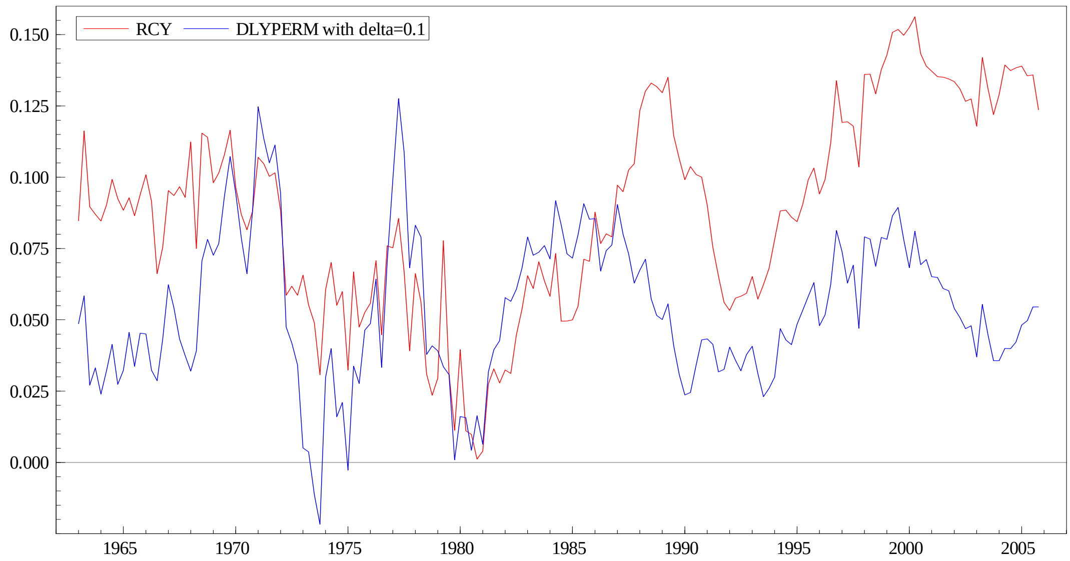

Figure 4: The maximum contribution to log (consumption/income) of log (permanent income/income) under perfect foresight, and its interaction with the credit conditions index.

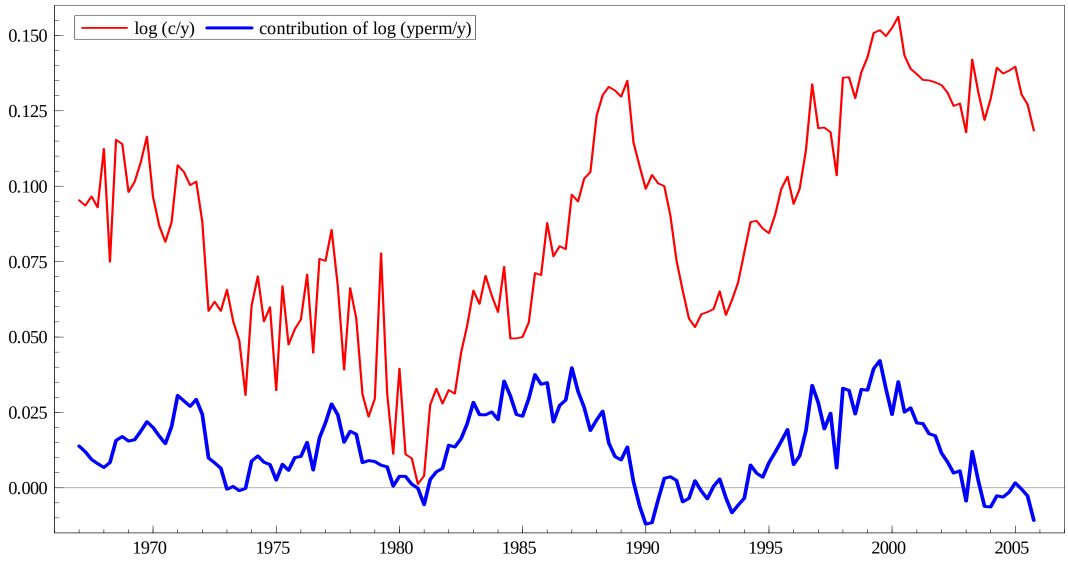

Figure 5: The deviation between fitted *log (yperm/y)* and the actual ex-post value, assuming 10% per quarter discount rate and GUM3 information set.

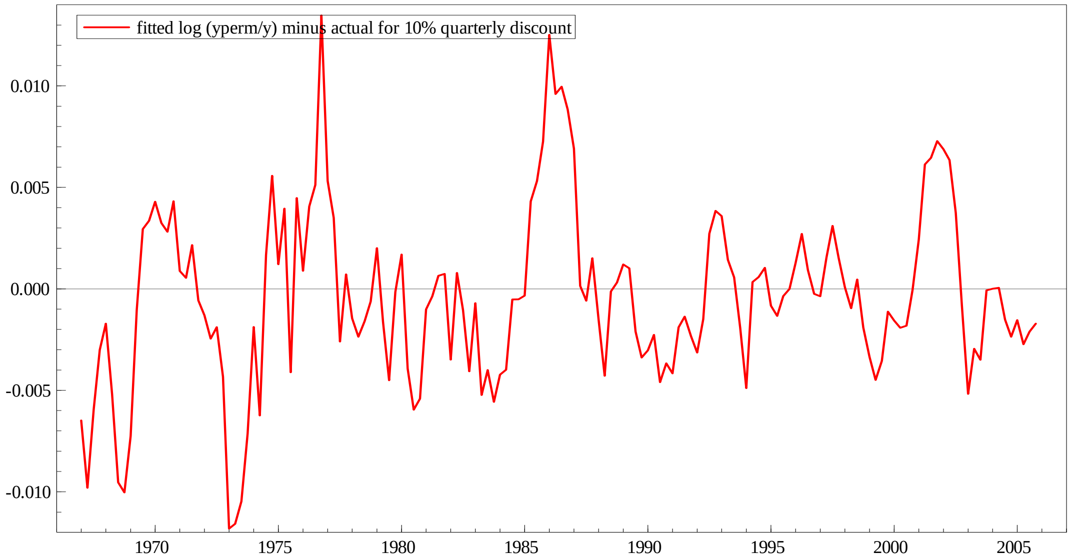

Figure 6a: The fitted long-run contributions to log consumption/income of the credit conditions index and its interaction with housing wealth/income.

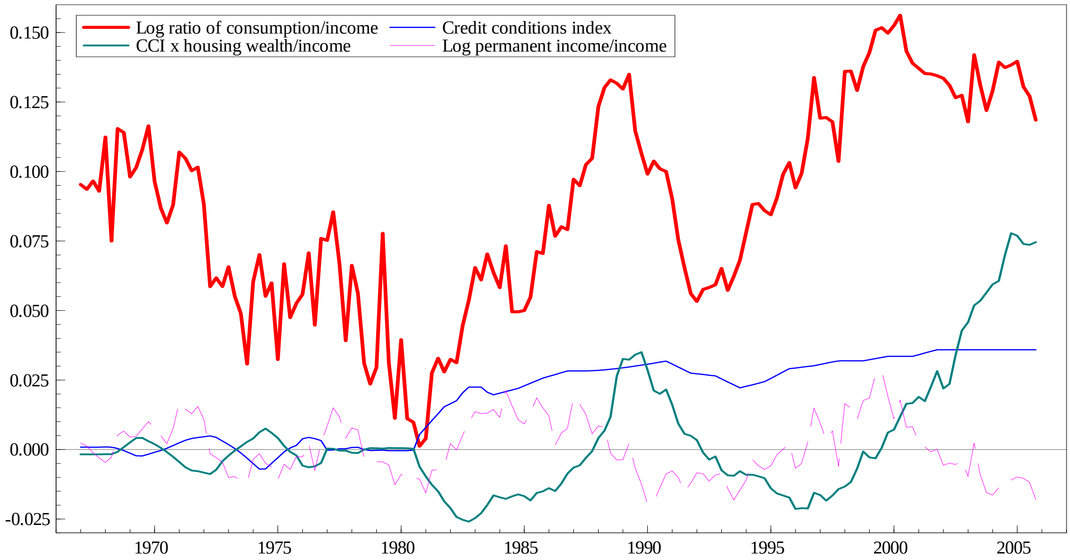

Figure 6b: The fitted long-run contributions to log consumption/income of net liquid assets/income and illiquid financial assets/income.

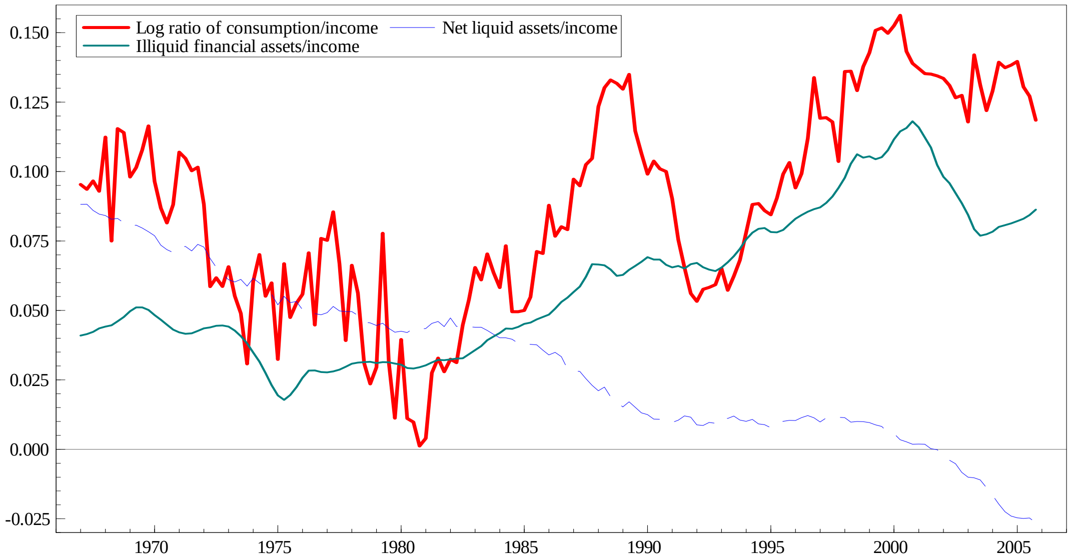

Figure 7: Consumption residuals by age group from Attanasio et al (2009).

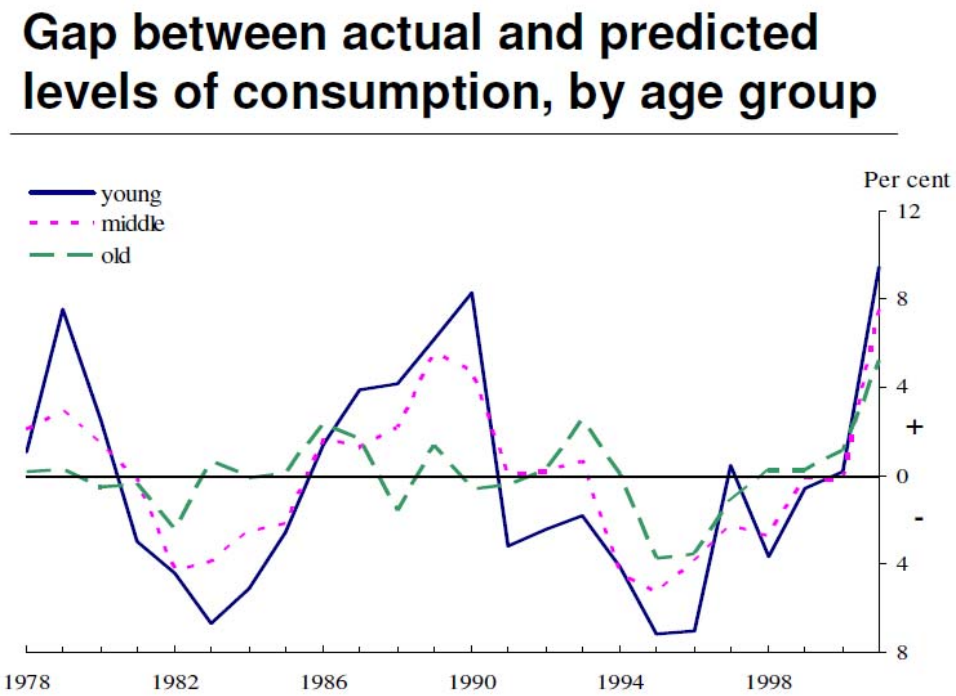

Figure 8: Matching FES and national accounts data on consumption growth, from Attanasio et al (2009).

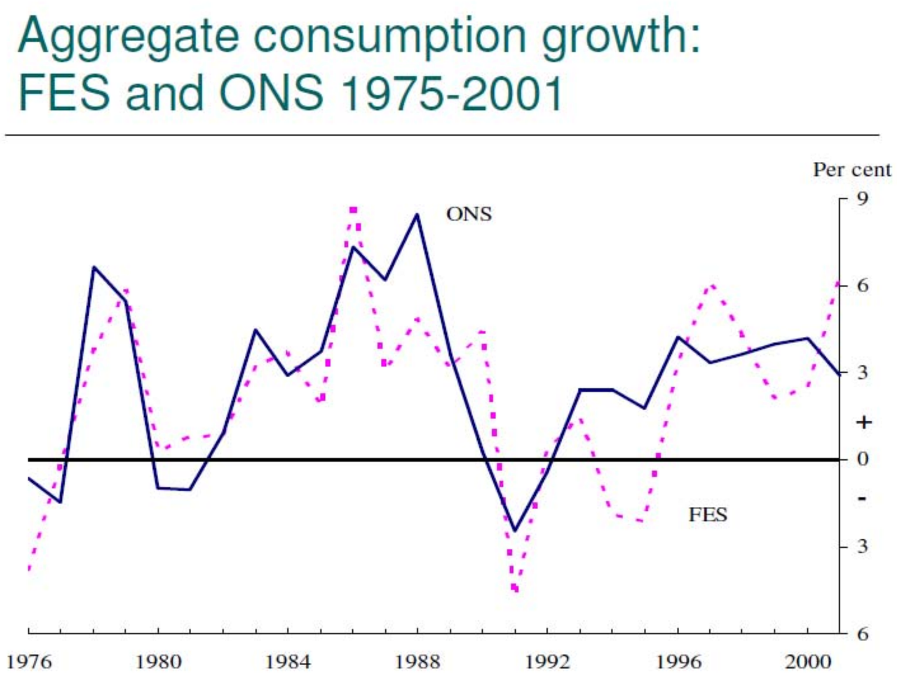

Figure 9: The fitted contribution of log user cost term to the log change in US residential housing stock/head.