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**CONSUMPTION, WEALTH AND CREDIT  
LIBERALISATION IN AUSTRALIA**

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# Consumption, wealth and credit liberalisation in Australia \*

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## ABSTRACT

A stable, long run consumption equation is estimated for Australia using quarterly data from 1977(2) to 2008(2). The model incorporates non-property income, income expectations, uncertainty, disaggregated household wealth, demography and, importantly, a relaxation in household credit conditions attributable to financial liberalisation and innovation (FLIB). Over 1977-2008, the log consumption to income ratio rose by around 14 percentage points. The relaxation of households' downpayment and collateral constraints together boosted the log consumption to income ratio by about 31 percentage points, given the rise in house prices. However, this was offset by around -24 percentage points because of increased indebtedness and -6 percentage points due to higher real interest rates. The remaining rise in the log consumption to income ratio is then attributed to rising optimism in household income expectations, rising illiquid financial wealth, to demographic changes and to short term factors. The indirect effects of FLIB in the model are powerful. Prior to FLIB, intertemporal consumption smoothing is difficult and housing capital gains are inaccessible: there is no "classical" housing wealth effect. Once credit markets are liberalised in the early 1980s however, there is a significant role for variable real interest rates, income expectations and housing collateral as determinants in the long run consumption equation. The estimated long run marginal propensities to consume are around 0.06 for housing assets (post-FLIB), 0.01 for illiquid financial assets and 0.20 for net liquid assets.

**Key words:** Consumption, household wealth, financial liberalisation

**JEL classification:** E21, E02, E44

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# 1 Introduction

The impact of credit conditions on the real economy is a pressing area of macroeconomic research in the wake of the 2007-09 "credit crunch" and global financial crisis. The task of this paper is to estimate an Australian consumption function that incorporates, through various channels, the structural relaxation of household borrowing conditions associated with financial liberalisation and innovation (FLIB). FLIB over the 1980s and 1990s coincided with: (i) a strong rise in household consumption to income (and an analogous decline in the household saving ratio); and (ii) one of the most profound household balance sheet expansions in the world. Across 1980 to 2008, the ratio of household debt to gross disposable income quadrupled, housing-related gearing (debt to assets) and debt servicing (mortgage payments to income) ratios tripled, and housing wealth to income more than doubled. It is difficult to account for these changes without acknowledging a role for FLIB in shifting household borrowing constraints.<sup>1</sup>

Existing time series consumption models for Australia, most without controls for the effects of FLIB, show mixed results on questions of cointegration over long samples, parameter stability and the significance of a "classical" housing wealth effect. One interpretation is that these issues may reflect an omitted variables or misspecification problem rather than suggesting the need for alternative econometric estimation techniques. Furthermore, several previous attempts to quantify FLIB's effects have relied on the Campbell and Mankiw (1989, 1991) "excess sensitivity" parameter within a consumption Euler equation. The "solved-out" consumption model of Ando and Modigliani (1963) instead offers a more flexible framework since it can incorporate explicit measures of credit conditions, household income forecasts and utilises (rather than discards) long run information on consumption, income and assets.

A stable, long run solved out consumption function can be estimated by conditioning on non-property income, variable real interest rates, income expectations and uncertainty, disaggregated household wealth and, importantly, an index of household credit conditions interacted with key components of the specification. These are incorporated in various stages to show the effects of each in improving the specification. The model is estimated as an equilibrium correction model using quarterly aggregate consumption data from 1977(2) to 2008(2).

The key innovation in the paper is the incorporation of a credit conditions index (*CCIH*) to capture the impact of FLIB in easing household borrowing constraints over the 1980s and 1990s. *CCIH* comprises four linear split trends mimicking a spline function extracted from a model of Australian house prices in Williams (2009). A thorough review of the institutional environment and extensive controls for economic and demographic variables permit the interpretation of this function as the change in non-price credit supply conditions induced by FLIB. *CCIH* avoids obvious endogeneity issues associated with alternative measures such as the credit to GDP ratio, credit growth or interest spreads.

The incorporation of credit conditions in an Australian aggregate consumption model induces cointegration over a long sample. Parameter shifts are explained in terms of expansions and contractions in credit conditions. There is no "classical" housing wealth effect prior to FLIB, but there is a significant housing collateral effect after credit markets are liberalised. In a partial equilibrium, the model implies that the lowering of the downpayment constraint contributes a little under 14 percentage points to the long run rise in the consumption to income ratio, while housing wealth capital gains contribute a further 18 percentage points. Increased indebtedness however subtracts around 24 percentage points over 1977-2008 from the long run consumption to income ratio while higher real interest rates subtract a little over 6 percentage points. The model implies that the long run marginal propensities to consume (MPCs) out of wealth are around 0.06 for housing assets at the peak of the credit conditions index (as collateral in a liberalised credit market), 0.01 for illiquid asset assets (albeit this estimate is imprecise) and 0.20 for net liquid assets.

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<sup>1</sup>Note that as at 2008 household consumption represents around 55 per cent of Australian gross domestic product (GDP). Housing assets are about the same proportion of total household wealth.

## 2 Stylised facts

### 2.1 Consumption to income ratio

Australian consumption data feature the following stylised facts. First, there is a sharp rise in the aggregate consumption to non-property income ratio ( $C/NPY$ ) across the 1980s from an average of around 0.86 across the 1960s and 1970s to an average of 1.03 between 1992 and 1997 (Chart 1 at Attachment A). There is then a hump-shaped pattern as the ratio rises to a peak of 1.09 in mid-2002 before retreating to 1.02 by mid-2008.<sup>2</sup> These patterns are evident regardless of which household income measure is used - gross disposable income (GDI, the national accounts measure) or non-property gross disposable income (NPY). Blinder and Deaton (1985) show the latter to be the appropriate income metric for consumption modelling. This is because the real disposable property income component of national accounts GDI is distorted by inflation, as Muellbauer and Lattimore (1995) demonstrate. GDI includes realised property income (including imputed rental income but not capital gains) but excludes asset losses (or gains on liabilities) due to inflation. These issues necessarily imply that consumption and GDI are less likely to be cointegrated during inflationary periods. The inflationary distortions in GDI may partly explain why some empirical consumption models struggle to establish cointegration over long samples (see Section 3). To circumvent the problem, this paper employs the Australian household non-property income measure developed in Williams (2009).

Second, consumption actually exceeds non-property income for much of the post-1990 period indicating a greater reliance on property-related earnings and borrowing to sustain consumption levels. Chart 2 shows property income rising from less than 10 per cent of GDI across the 1960s and 1970s to a peak of 15.7 per cent in 1990 before slipping back to around 12 per cent of GDI by 2008. Across 1977 to 2008, household gearing ratios and debt servicing ratios more than doubled.<sup>3</sup> An equivalent way of thinking about this change is that the average household in 1977 held \$12 in housing assets for every \$1 in mortgage debt; whereas in 2008 the average household held only \$3.55 in housing assets for every \$1 in mortgage debt.

Finally, consumption is much less volatile than current income although both have become more stable (Chart 3). Over 1960-2008 the standard deviation of quarterly consumption growth (0.008) is about half that of income growth (0.017) - a typical result across countries. These standard deviations fall by 9 and 27 per cent for consumption and income growth respectively for the post-1990 period.

### 2.2 Household saving ratio

An analogous approach examines the trend decline in the household saving ratio (Chart 4). The national accounts define "net saving" as the residual of GDI less household final consumption less consumption of fixed capital. The net saving ratio as a proportion of GDI declines steadily from a mid-1970s peak, becomes negative in 2000 and 2002-2006 and then recovers to about +1 per cent of GDI in 2008.<sup>4</sup> Similar long term savings ratio declines are witnessed in the US, UK and Canada.

The national accounts measure however does not reflect the economic concept of saving: that is, current non-property income forgone in order to increase assets. The national accounts saving rate is likely to be overstated (but offset to the extent that rental income raises GDI) since net saving deducts an allowance for depreciation on fixed assets but makes no corresponding adjustment for changes in capital values (especially due to inflation).<sup>5</sup> A *non-property* savings rate is constructed as non-property income less household final consumption as a proportion of non-property income. This is a gross savings measure since it does not deduct depreciation. This ex-property savings rate declines more sharply after the mid-1970s than the national accounts measure. Negative rates begin earlier, in the late 1980s, and rates are consistently negative from 1997 onwards.<sup>6</sup>

<sup>2</sup>The log of this ratio is provided at Chart 6.

<sup>3</sup>RBA Bulletin Table B21. Gearing and debt servicing ratios related to mortgages tripled over the period.

<sup>4</sup>Note that the national accounts definition of the household sector includes unincorporated enterprises.

<sup>5</sup>See the previous section on the measurement of GDI.

<sup>6</sup>Arguably "rent and other dwelling services" in aggregate consumption could be classed as part-consumption item

## 2.3 Demographic, institutional and economic environment

The above stylised facts emerge in the following context. First, the Australian population is steadily ageing, driven principally by the maturing of the post-WWII "baby-boomer" generation. Chart 5 shows: a declining population proportion of "dependents" aged 0-21 years; a hump-shaped profile for "young" households of first home buying age (22-34 years); and rising proportions of "investor aged" households (35-64 years) and "retiree" households aged 65 plus. The population age structure impacts on the marginal propensity to consume (MPC) out of lifetime wealth, as demonstrated in Section 6. However, the structural decline in the savings ratio above sits at odds with the rising proportion of investor aged households, which life cycle theory predicts should be high savers. This paradox can only be resolved by introducing a role for shifts in household borrowing conditions.

The second dimension is the institutional environment. The Australian financial sector of the 1970s comprised a tightly regulated banking sector, including quantitative lending controls, and a rapidly growing, unregulated non-bank sector. Significant financial sector reforms include the dismantling of interest rate ceilings and other restrictions on trading and saving bank deposits and loans in 1980, 1982, 1984 and 1986; the floating of the Australian dollar and removal of most exchange rate controls in 1983; the deregulation of the Australian stock exchange and securities industry in 1984; the introduction of Basel I capital adequacy regulations in 1988; the introduction of the compulsory superannuation guarantee in 1992 and so on. A fuller description of these changes is provided in Williams (2009).

Financial liberalisation induced considerable changes in the structure of the banking industry through bank mergers and the entry of foreign banks and mortgage originators. Increased competition spurred the proliferation of cheap and flexible household debt instruments across the 1990s. Owner-occupiers benefited from the introduction of home equity loans with redraw and offset facilities, non-conforming loans and fixed rate loans. Key pro-investor innovations include home equity loans, deposit bonds, interest only and split-purpose loans. These allow greater repayment flexibility and tax advantages.<sup>7</sup>

Despite these reforms, restructures and innovations, the early 1990s may have seen a contraction in credit supply conditions. The State Banks of Victoria and South Australia and Pyramid Building Society collapsed. Major bank return on shareholder equity fell from an average of 20 per cent prior to 1991 to around -3.4 per cent in 1992.<sup>8</sup> Banks increased their capital ratios from 9.3 per cent in mid-1990 to a peak of 12.3 per cent in 1995(1).<sup>9</sup> Banking sector profitability recovered substantially in the second half of the 1990s. The ratio of the bank share price index (ASX/S&P200 (Banks)) relative to the aggregate share price index (ASX/S&P200) increased from 1.3 times across the early 1990s to 3.1 times by mid-2003.

FLIB may operate on consumption through several channels: lowering the mortgage downpayment constraint and debt servicing requirement (especially important to typically young, first time home buyers)<sup>10</sup>; enhancing the value of housing as mortgage collateral (especially important to older households with existing housing wealth); and facilitating intertemporal consumption smoothing, thereby raising the importance of the real interest rate and income expectations.<sup>11</sup> Williams (2009) develops an index of household non-price credit conditions (*CCIH*) from an Australian house price model that

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and part-asset return (that is, property income that home owners pay to themselves as imputed rent). This is yet another difficulty posed by housing appearing in the household's objective function and budget constraint.

<sup>7</sup>See RBA (2003) and RBA (2002) for a fuller description.

<sup>8</sup>RBA (2007), Graph 32.

<sup>9</sup>RBA Bulletin Table B06: consolidated group bank total capital ratio (Tier 1 and 2 capital).

<sup>10</sup>Loan to valuation ratio (LTV) and debt servicing ratio (DSR) constraints are known to have been relaxed in Australia. For a fuller discussion of the survey evidence, see RBA and APRA (2007). However, Australia does not possess good time series data on bank LTV and DSR requirements (unlike in the UK, see Fernandez-Corugedo and Muellbauer (2006)).

<sup>11</sup>See Aron and Muellbauer (2000) and Muellbauer (2007). On the supply side it also relaxes the balance of payments constraint since financial institutions can borrow from abroad using wholesale markets rather than relying on growth in national savings to provide deposits (see Muellbauer and Murphy (1990)).

avoids obvious endogeneity with other economic and demographic factors:

$$CCIH = \varphi_1 ma_4split79(1) - \varphi_2 ma_4split92(1) + \varphi_3 (ma_4split98(1) - 1.5split07(3)) \quad (1)$$

where  $ma_4split79(1)$  is a four quarter moving average of a linear trend starting in 1979(1). The relative weights depicted in Chart 6 are  $\varphi_1 = 0.0020$ ,  $\varphi_2 = 0.0024$  and  $\varphi_3 = 0.0021$ . These are the estimated short run coefficients from the house price model of Williams (2009). The coefficient on  $split07(3)$  is imposed at -1.5 to reflect a downturn in credit conditions, associated with the global financial crisis, of about the same magnitude as experienced in the early 1990s recession. Chart 6 shows a striking correlation across the 1980s between the  $\log(C/NPY)$  ratio and  $CCIH$ .

The third dimension is the pronounced expansion in Australian household balance sheets. Chart 7 depicts the increase in household net worth relative to annualised quarterly non-property income (4Y) for: housing assets ( $HA$ ), illiquid financial assets ( $FA$ ), liquid assets ( $LA$ ), household credit ( $CR$  defined as mortgage credit plus other personal credit) and net liquid assets (defined as  $NLA = LA - CR$ ).<sup>12</sup> Housing assets doubled as a proportion of annualised non-property income, from 2.6 times income in 1977 to 5.5 times in 2008. Illiquid financial assets more than tripled from just 0.8 times income in 1977 to 2.9 times income in 2008. Households simultaneously decreased their net liquid assets from +0.2 times annualised income in 1977 to -1.0 times income in 2008.

Finally, Australian households have made positive equity withdrawals from the housing stock for much of the recent decade, despite traditionally being net investors in housing through housing construction, renovations and regular mortgage principal repayments. Housing equity withdrawal (HEW) is defined approximately as the growth in the stock of residentially-secured household credit less gross dwelling investment. The ratio of Australian HEW to income shows a clear upward trend in Chart 8 and increasing synchronisation with US and UK measures. Enabled by FLIB, housing equity withdrawn may be used for consumption (smoothing), debt consolidation or the rebalancing of asset portfolios following house price rises.<sup>13</sup> HEW can thus be viewed as the balancing of a financing decision and an investment decision, with FLIB greatly affecting the former.

Overall, the evidence provided by Charts 5-8 invites the hypothesis that in an environment of easing borrowing constraints, rising asset values and property income, households rely less on forgone consumption from current non-property income to fund their life-cycle needs. It is difficult to account for the changes in consumption and balance sheet behaviour, especially given the demographic evidence, without accepting a role for shifts in credit conditions.

### 3 Literature review

The potential importance of shifts in non-price credit supply conditions has long been acknowledged. Australia's former Reserve Bank Governor Ian Macfarlane for example made statements in 1989, 1990, 1991 and 1995 on the policy relevance of credit-related regime shifts (see Macfarlane (1995, 1991)). In the economic literature, attempts to proxy credit supply influences on credit markets or consumption include: the stock of credit to GDP or household income (Bayoumi (1993), de Brouwer (1996), Hiebert (2006)); interest spreads between borrowing and lending rates (Jappelli and Pagano (1989), Scott (1996), Bacchetta and Gerlach (1997), de Brouwer (1996)); the proportion of young households likely to be credit constrained (Jappelli and Pagano (1989), de Brouwer (1996)); log credit acceleration (Lattimore (1994)) and a measure of mortgage rationing constructed by Meen (1990). However with the exception of Meen (1990), all are likely to suffer from endogeneity with other economic and

<sup>12</sup>Wealth data sources and construction are explained in Section 7.3.1 and Attachment B.

<sup>13</sup>RBA (2005) and Schwartz et al. (2008) provide a cross-sectional decomposition of HEW activity using a 2004 RBA household survey. The most common method of equity withdrawal is through debt increases on existing mortgages (refinancing), but the actual dollar value of HEW is dominated by a small number of large property transactions. By contrast, equity injection is dominated by large number of small injectors - mainly indebted young households purchasing properties from older non-indebted households (and making regular mortgage principal repayments). The bulk of HEW in 2004 was re-invested in other assets (58.5 per cent), 17.6 per cent was used to fund durable consumption (mostly home decoration-related and car purchases) and 7.7 per cent was used to repay other debt.

demographic variables (income, interest rates, risk, expectations and so on) and fail to be non-price in nature. These issues are addressed in Muellbauer and Murphy (1993), Muellbauer (1997), Aron and Muellbauer (2000) and Fernandez-Corugedo and Muellbauer (2006).

The Australian consumption literature has, broadly, followed one of three approaches. None of them directly capture the transmission of credit conditions shifts to real activity. The first approach, popular in the 1990s, focuses on the consumption Euler equation and Campbell and Mankiw's (1989, 1991) so-called " $\lambda$  test" of the rational expectations permanent income hypothesis (REPIH). Debelle and Preston (1995) find a significant excess sensitivity parameter ( $\hat{\lambda}$ ) on current income growth, in contradiction of the REPIH, which declines from 40-45 per cent in the 1970s to 20-25 per cent across the 1980s and 1990s. They interpret this as a declining proportion of liquidity constrained consumers, attributable to FLIB. Blundell-Wignall et al. (1992) similarly find a significant and declining excess sensitivity parameter across the 1970s and 1980s. In contrast, Olekalns (1997) and de Brouwer (1996) find liquidity constraints insignificant from the early 1980s. Regardless, the Euler equation framework provides at best an indirect credit conditions measure. The approach does not condition on long run consumption, income or wealth levels, uncertainty or demography nor does it capture the multiple channels through which FLIB operates. Section 5.3 provides further discussion.

The second approach involves time series estimation based on a solved out consumption function, for example Lattimore (1994), Tan and Voss (2003), Fisher and Voss (2004), Hiebert (2006) and Fisher et al. (2010). The time series literature delivers mixed results on issues of cointegration over long samples, parameter stability and the significance of a steady state housing wealth effect. These issues are often attributed to wide-ranging structural changes in financial and labour markets affecting household behaviour, particularly over the 1980s. Arguably the results could be improved by proper controls for non-property income, credit regime shifts, income expectations and uncertainty, variable interest rates, demography and the components of household net worth.

Lattimore's (1994) specification is of particular interest. After general to specific model reduction, he estimates the following parsimonious specification using annual data over 1951/2 to 1990/1:

$$\begin{aligned} \Delta \log c_t &= -0.162 + 0.261\Delta \log y_t + 0.457(\log y_t - \log c_{t-1}) + 0.135A_{t-1}/y_t \\ &\quad - 0.147HEFF_{t-1} + 0.0641\Delta\Delta \log CREDIT_t + 0.358YOUNG_t \\ &\quad - 0.442PMID_t - 0.0063STRIKE_{t-1} - 0.649UE_t \\ R^2 &= 0.932, se = 0.0069 \end{aligned} \tag{2}$$

where  $c$  is real per capita aggregate consumption,  $y$  is real per capita non-property income and  $A_{-1}/y$  is a weighted combination of net liquid and illiquid (including housing) assets to income. The weights are 0.7 and 0.3 respectively.  $HEFF$  is the ratio of house prices to average labour earnings multiplied the proportion of non-owner-occupiers.  $\Delta\Delta \log CREDIT$  is aggregate credit acceleration and a proxy for cyclical variations in credit constraints.<sup>14</sup>  $YOUNG$  is the proportion of the non-dependent population aged 20-34 years and  $PMID$  is the proportion of the non-dependent population aged 45-65.  $STRIKE$  is the number of days lost through industrial disputes per hour worked (a proxy for labour market changes), and  $UE$  is the unemployment rate.<sup>15</sup> The model holds that the dominant long run influences on Australian consumption are weighted assets to income ( $A_{-1}/y$ ) and weighted house prices to income ( $HEFF$ ), with smaller roles played by the demographic variables ( $YOUNG$  and  $PMID$ ). Income growth ( $\Delta \log y$ ), log credit acceleration ( $\Delta\Delta \log CREDIT$ ) and the unemployment rate ( $UE$ ) are important in the short run, with a lesser role for  $STRIKE$ .

The Lattimore model offers some promising insights. The specification offers a robust and stable long run solution inclusive of the 1980s albeit this is with annual data and only as recent as 1990/1.

<sup>14</sup>Note that Lattimore (1994) reports the level of log credit in his results equation, however his discussion refers exclusively to the acceleration in log credit. Equation 2 makes the assumed correction.

<sup>15</sup>The Accords between the government and the unions during the 1980s agreed to low nominal wage outcomes and zero or negative real wage growth. The Accords contributed to record low industrial disputation by the end of the 1980s. Note that the unemployment rate could be interpreted either as a proxy for uncertainty or structural changes in the labour market.

The annual speed of adjustment is 0.457 (with a high t-statistic of 7.0) indicating that temporary shocks take a little over 2 years to unwind. The stable long run solution might be attributable to two aspects. First, Lattimore removes property income from the national accounts household GDI measure thereby removing the distortion of inflation. The adjusted income measure shows a little more volatility but, unlike the national accounts measure, it does not show a hump-shaped 1970s savings build-up and subsequent unwind in the 1980s. This finding not only highlights the importance of proper household income measurement on theoretical and statistical grounds, but demonstrates the econometric implication that consumption and national accounts disposable income may not be cointegrated during inflationary episodes.<sup>16</sup>

Second, Lattimore offers a role for credit constraints. Based on the imposed weights above, the implied long run MPCs out of net liquid assets and illiquid assets (including housing) are 0.21 and 0.09 respectively. However, the latter is offset by *HEFF*. The negative sign on *HEFF* indicates that a higher ratio of house prices to labour income raises the downpayment constraint on young, pre-home-owning households. The prospect of cyclical liquidity constraints is captured by the log credit acceleration variable ( $\Delta\Delta \log CREDIT$ ). The variable is potentially endogenous since aggregate credit may anticipate consumption and this might explain why Lattimore is unable to find significant effects for income expectations. Nonetheless Lattimore's short run cyclical measure of credit conditions provides an interesting contrast with the long run, structural measure sought in this paper.

The third approach in the Australian consumption literature employs cross-sectional data and panel estimation techniques. Dvornak and Kohler (2007) find a significant housing wealth effect based on Case et al.'s (2005) US approach using state-level panel data on consumption, incomes, stock market wealth, net dwelling wealth and net other financial wealth. Their study is discussed further in Section 7.3.1. La Cava and Simon (2005) and Worthington (2006) find that "financial constraints" have shifted using longitudinal household survey data. In their studies, financial constraints are defined roughly as the inability to afford household bills, meals, leisure activities and so on. The incidence of these constraints are only partly related to shifts in credit supply conditions and offer only an indicative guide to FLIB effects at the macroeconomic level. The corollary of the foregoing discussion is that while the literature acknowledges a potential role for credit regime shifts, there is as yet no direct, time series measure of credit supply conditions for Australia.

## 4 Consumption theory

### 4.1 The Euler equation

The representative household maximises utility subject to an intertemporal budget constraint as follows:

$$\max U_t = \sum_{s=1}^T \left(\frac{1}{1+\delta}\right)^{s-1} u(c_{t+s-1}) \quad (3)$$

*subject to*

$$c_t = (1+r)A_{t-1} + \sum_{s=1}^T \left(\frac{1}{1+r}\right)^{s-1} E_t(y_{t+s-1}) \quad (4)$$

The preference function is assumed convex and monotonic ( $u' > 0$ ,  $u'' < 0$ ), utility ( $u$ ) is time separable and additive, log real consumption per capita ( $c$ ) is non-durable and there are no habits or adjustment costs, the subjective discount rate ( $\delta$ ) is constant across households and the leisure-work decision is exogenous. The lifetime budget constraint assumes linearity (perfect capital markets/no borrowing constraints) and consists of the real return on the (net and homogenous) real asset endowment ( $A_{t-1}$ )

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<sup>16</sup>Tan and Voss's (2003) study bears this out. Consumption, national accounts income and wealth are only cointegrated during the benign inflation outcomes of the 1990s.

plus lifetime income discounted at a constant real market rate ( $r$ ). Note that  $y_t$  is log real household non-property income per capita and  $E$  is the expectations operator.

From the first order conditions, the consumption efficiency condition equates the current marginal utility of consumption with the discounted expected marginal utility of future periods:

$$u'(c_t) = \frac{1+r}{1+\delta} E_t(u'(c_{t+1})) \quad (5)$$

Hall's (1978) rational expectations permanent income hypothesis (REPIH) predicts that under three additional assumptions - certainty equivalence, rational expectations and  $\delta = r = \bar{r}$  - the Euler equation becomes a martingale process:

$$c_t = c_{t-1} + \varepsilon_t \quad (6)$$

and  $\varepsilon_t$  represents stochastic innovations about permanent income (with a zero mean).<sup>17</sup>

## 4.2 The solved out consumption function

Ando and Modigliani's (1963) "solved-out" consumption function provides a more flexible theoretical framework. Unlike the Euler equation, which employs first differenced data to achieve stationarity, the solved out consumption function incorporates rather than discards long run information on consumption, assets and income levels. Furthermore it can test for explicit policy changes both directly within the consumption equation and indirectly through the income forecasting model.<sup>18</sup> The solved out consumption function therefore provides the most appropriate platform for evaluating the impact of evolving credit supply conditions.

The solved out consumption function is achieved by substituting the efficiency condition (5) into the intertemporal budget constraint (4):

$$c_t = \frac{1}{\omega} ((1+r)A_{t-1} + \sum_{s=1}^T (\frac{1}{1+r})^{s-1} E_t(y_{t+s-1})) = \frac{1}{\omega} W_t \quad (7)$$

where  $1/\omega$  is the marginal propensity to consume out of lifetime resources ( $W_t$ ). The inverse marginal propensity to consume is  $\omega = \sum_{s=1}^T (\frac{1}{1+r})^{s-1}$  for quadratic preferences and for CES preferences,  $\omega = \sum_{s=1}^T ((\frac{1}{1+\delta})^\sigma (\frac{1}{1+r})^{1-\sigma})^{s-1}$ , where the effects of  $\delta$  and  $r$  are weighted by the elasticity of substitution ( $\sigma$ ).<sup>19</sup>

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<sup>17</sup>Certainty equivalence implies the quadratic function  $u(c_t) = \frac{1}{2}(\beta - c_t)^2$  where  $\beta$  is the satiation or bliss point and  $c < \beta$ . Marginal utility ( $u'$ ) is then linear and so only the point estimate (mean) of future income matters, rather than the higher moments. Alternatively, with constant elasticity of substitution (CES) preferences, the Euler equation becomes:

$$c_t^{-1/\sigma} = \frac{1+r}{1+\delta} E_t(c_{t+1})^{-1/\sigma}$$

where  $u(c_t) = c_t^{-\rho}$  and  $\rho = 1/(1-\sigma)$ .  $\sigma$  is the (constant) sensitivity of consumption across periods to changes in relative prices:

$$\log E(c_{t+1}) - \log c_t = \sigma(\log(1+r) - \log(1+\delta))$$

<sup>18</sup>As an example of the former, the introduction of the GST in 2000 may have permanently lowered the consumption to income ratio. As an example of the latter, households may expect a diminished Keynesian impact from fiscal stimulus on future income following the floating of the Australian dollar in 1983.

<sup>19</sup>Note that the dependent variable in this paper is log real per capita aggregate consumption ( $c$ ) because the paper's foci are the overall effects of changes in household wealth and credit conditions. An alternative view is that utility flows from durables consumption are difficult to measure and therefore durables should be excluded (for example, Tan and Voss (2003), Fisher and Voss (2004), Blinder and Deaton (1985)). Alternatively, consumption could be defined as non-durables goods and services plus the imputed value of services from durables.

Aron et al. (2008) develop a log linear empirical representation as follows:

$$\begin{aligned}
c_t/y_t &= \gamma A_{t-1}/y_t + y_t^p/y_t \\
&= \gamma A_{t-1}/y_t + 1 + (y_t^p - y_t)/y_t \\
\log c_t &\approx \log(\gamma A_{t-1}/y_t + 1) + \log(y_t^p/y_t) + \log y_t
\end{aligned} \tag{8}$$

where  $y_t^p$  is expected lifetime permanent non-property income. A first order Taylor expansion around  $x = 0$  gives  $\log(1+x) \simeq x$  when  $x$  is small and, since asset returns are small for most consumers,  $\log(\gamma A_{t-1}/y_t + 1) \simeq \gamma A_{t-1}/y_t$ .<sup>20</sup> Also note that  $(y_t^p/y_t - 1) \simeq \log(y_t^p/y_t)$ . The Taylor approximation avoids the log assets formulation which is a poor approximation when asset levels are low and does not allow the disaggregation of household assets (Muellbauer (2007)). These approximations yield the long run consumption function:

$$\log c_t \approx \gamma A_{t-1}/y_t + \psi \log(y_t^p/y_t) + \log y_t \tag{9}$$

$\log(y_t^p/y_t)$  can be proxied as a weighted moving average of expected future income growth rates (see Section 5). The weight on permanent income ( $\psi$ ) could be less than one to allow a degree of household myopia. The long run marginal propensity to consume out of net worth is  $\gamma = (1+r)/\omega$  and depends on the intertemporal parameters, including  $r$  (in the REPIH case and additionally  $\delta$  and  $\sigma$  in the CES case) and demography (see Section 6).

Finally, the presence of habits, convex adjustment costs, measurement error and time aggregation problems (Muellbauer (1988)) and "rules of thumb" behaviour (Thaler (1990)) suggest estimation of the consumption function as a partial adjustment model.<sup>21</sup> Partial adjustment implies  $\Delta c_t = a\Delta c_{t-1} + \varepsilon_t$  in the Euler equation context and  $c_t = \phi(W_t/\omega) + (1-\phi)c_{t-1}$  in the solved out consumption function where  $a$  and  $\phi$  are adjustment parameters. The "classical" solved out consumption function in dynamic form, where  $\phi$  is the speed of adjustment, becomes:

$$\Delta \log c_t \approx \phi(\alpha_0 + \gamma A_{t-1}/y_t + \psi \log(y_t^p/y_t) + \log y_t - \log c_{t-1}) + \varepsilon_t \tag{10}$$

## 5 Income forecasting equations

### 5.1 Specification

Unlike the Euler equation, the solved out consumption function requires an explicit income generating process for  $y_t^p$ . This neatly resolves the problem of income persistence which underlies Deaton's (1988) paradox and the excess smoothness debate. Aron et al. (2008), based on Campbell (1988), define the log ratio of permanent to current income as:

$$\log(y_t^p/y_t) \approx \left( \sum_{s=1}^k (1-\eta)^{s-1} E_t \log y_{t+s} \right) / \left( \sum_{s=1}^k (1-\eta)^{s-1} \right) - \log y_t \tag{11}$$

$$\equiv E_t \Delta \log y m_{t+k} \tag{12}$$

<sup>20</sup>Aron et al. (2008) also incorporate a second order Taylor expansion for log assets using  $\log(1+x) = x - 0.5x^2$ , excluding the remainder. That is:

$$\log c_t = \gamma A_{t-1}/y_t - \frac{1}{2}(\gamma A_{t-1}/y_t)^2 + \log(y_t^p/y_t) + \log y_t$$

They find similar results to the simpler first order approximation with UK data suggesting that this exercise is unnecessary.

<sup>21</sup>In "rules of thumb" behaviour households fully optimise consumption over the long run. However, in the short run the marginal costs of adjustment are greater than the marginal benefits so households rely on simple "rules of thumb" to partially adjust consumption plans.

where  $\Delta \log ym_{t+k}$  is a moving average of forward looking income growth rates over  $k$  periods discounted by some risk-adjusted real interest rate (Hayashi (1982)). Friedman (1963) argues that households forecast permanent income over a time horizon ( $k$ ) considerably shorter than their lifetimes owing to capital market imperfections and "uninsurably uncertain" future income.<sup>22</sup> Charts 9 and 10 depict discounted future real per capita non-property income growth for Australia over three and ten year time horizons ( $k = 12; k = 40$ ). Income growth beyond 2008 is held constant at the average quarterly rate for 1959-2008 of 0.4 per cent. The quarterly discount rates shown are 0.15, 0.10 and 0.05, all plausible values of  $\eta$ .

There is little difference in  $\Delta \log ym_{t+k}$  over  $k = 12$  and over the longer time frame where  $\eta = 0.15$ . The discount factor choice becomes important when using a 10 year time horizon and where future income is considerably higher than current income (that is, before about 1972 and after 1991). The advantage of using  $k = 40$  is that it covers a range of possible values for  $\Delta \log ym$  determined by the income uncertainty premium. Truncating the geometric formula after  $k$  quarters also has less impact when  $k = 40$ . The choice of discount rate is somewhat arbitrary. This paper assumes households discount future income at roughly 20 per cent per annum ( $\eta = 0.05$ ). The variation in  $\Delta \log ym_{+40}$  this allows (especially over the 1990s) assists identification in later consumption modelling.

## 5.2 Estimation

The perfect foresight case is provided by  $\Delta \log ym_{+40}$ . Relaxing this assumption, households are assumed to form rational expectations about future income based on some information set of known economic variables (like an econometrician).  $E_t \Delta \log ym_{+40}$  is estimated in AutoMetrics (Doornik (2009)) conditional on "naive", "basic" and "sophisticated" information sets. Estimation results are provided in Tables 1 and 2 at Attachment A.<sup>23</sup>

The "naive" case (EY1) in Table 1 assumes that households rely only on a trend, the current income level and income growth rates over the previous 5 years. The model performs poorly with a high standard error of 0.0228. Attanasio and Weber (1994) however emphasise the influence of asset prices on future income expectations so a "basic" information set additionally consists of levels and four quarter changes in asset prices and long and short term interest rates. The parsimonious specification (EY2a) includes the (ma4) level of real interest rates ( $r$ ), log real house prices ( $\log p_{t-1}^h$ ) and the change in log real house prices ( $\Delta_4 \log p_{t-1}^h$ ). Also included are a linear trend and two split trends starting in 1972(4) and 1990(2). The split trends represent the increase and decrease in productivity growth over the 1970s and 1990s respectively. The standard error of the model is over five times smaller than in the case of naive expectations.

A more conservative approach would be to assume that households do not have *a priori* knowledge of these productivity shifts. Table 2 shows the preferred parsimonious results when the split trends are excluded from the General Unrestricted Model (GUM). The standard error of EY2b more than doubles relative to EY2a. Additional significant variables are the level and annual change in log real share prices ( $\log s_{t-1}$  and  $\Delta_4 \log s_{t-1}$ ), change in log nominal mortgage interest rates ( $\Delta_4 \log i_{t-1}$ ) and the real ten year Treasury bond rate ( $r10TB_{t-1}$ ). The latter has a positive sign indicating that higher long term government bond rates signal faster future income growth.<sup>24</sup>

The third information set is a "sophisticated" one that additionally incorporates (in the GUM) levels and changes in the log real exchange rate, log terms of trade, log bilateral USD exchange rate, log real

<sup>22</sup>The latter terminology is Carroll's (2001).

<sup>23</sup>General to specific model reduction is used with a target significance level of 5 per cent. The models are highly autocorrelated so Heteroskedasticity and Autocorrelation Consistent Standard Errors (HACSEs) are reported. \*\*\*, \*\* and \* denote significance at the 1, 5 and 10 per cent levels respectively for all tables presented in this paper. Descriptive statistics for all variables are provided at Attachment B. Variable sources and descriptions are provided at Attachment C.

<sup>24</sup>See Lowe (1995), Tarditi (1996) and Kulish and Rees (2008) on the determinants of the long term bond rate. Higher long term interest rates may result from persistent positive overseas shocks, which are interpreted by Australian households as favourable for future domestic income growth and perhaps not fully offset by domestic monetary policy.

US GDP (representing foreign demand), the annual trade balance to GDP ratio, the annual budget balance to GDP ratio, real and nominal log oil prices and impulse dummies for drought periods.<sup>25</sup>

The parsimonious model (EY3a) in Table 1 includes the positive influences of log real house prices ( $\log p_{t-1}^h$ ), a trend, a split trend for the 1990s productivity growth acceleration, the eight quarter change in the log terms of trade ( $\Delta_8 \log tot_{t-1}$ ) and the (four quarter sum of the) budget balance to GDP ratio ( $(BS/GDP)_{t-1}$ ). The latter is also interacted with a step dummy for the floating of the Australian dollar in 1983, showing a negative coefficient.<sup>26</sup> In combination, these two variables indicate that a sophisticated household would rationally expect a mild positive Keynesian effect on future incomes from fiscal policy before 1983 but a negative Ricardian equivalence effect thereafter as the economy was opened up. That is, post-1983 increases in net government spending actually *lower* households' expectations of future income.

Other negative influences in EY3a are the real interest rate ( $r_{t-1}$ ), log real exchange rate ( $\log rer_{t-1}$ ) and, with a four quarter lead, a dummy for the severe 2002(3) to 2003(4) drought. The standard error of EY3a is about half that of the basic model (EY2a) and a tenth of the naive version (EY1). A more conservative approach may again be to consider the households' sophisticated information set excluding *a priori* knowledge of the post-1990(2) productivity growth acceleration or the drought. Removing these variables from the GUM yields the parsimonious model EY3b shown in Table 2.<sup>27</sup>

EY3b includes the four quarter change in log real share prices ( $\Delta_4 \log s_{t-1}$ ), log nominal mortgage rates ( $\Delta_4 \log i_{t-1}$ ), log real US GDP growth ( $\Delta_4 \log usgdp$ ); and the (ma4) level of log real share prices ( $\log s_{t-1}$ ), log real oil prices ( $\log oil_{t-1}$ ) and the real 10 year Treasury bond rate ( $r10TB$ ). As for EY2b, higher long term interest rates are interpreted as signalling higher future household income growth. The parsimonious model also includes the Ricardian effect of the annual budget balance to GDP ratio but the pre-1983 Keynesian effect is not significant. As for EY2b, the standard error of EY3b rises but is still half that of EY1. EY1, EY2b and EY3b are used to generate fitted values for  $E_t \Delta \log y_{m+40}$  in the subsequent consumption modelling. Charts 11 and 12 provide plots of these fitted values compared to the perfect foresight case.

### 5.3 Euler equation with excess sensitivity

The household information sets above can be applied as instruments in a simple test of Campbell and Mankiw's (1989, 1991) so-called " $\lambda$  model" on Australian data. Equation 6 earlier predicts that per period consumption will follow a random walk  $\Delta c_t = \varepsilon_t$  under the REPIH assumptions. The error term ( $\varepsilon_t$ ) represents stochastic innovations in permanent income and should be orthogonal to all information known at t-1, implying consumption growth is unforecastable.

Campbell and Mankiw's (1989, 1991) test assumes that a fraction of households ( $\lambda$ ) will be Keynesian consumers and base their consumption on current disposable income ( $Y$ ), for example due to myopia or liquidity constraints.<sup>28</sup>  $\lambda$  can be interpreted as the excess sensitivity of consumption to predictable changes in current income. The remaining households follow the predictions of the REPIH so that consumption changes are determined purely by stochastic innovations in permanent income ( $\varepsilon_t$ ):

$$\Delta C_t = \lambda \Delta Y_t + (1 - \lambda) \varepsilon_t \quad (13)$$

The CES version (with  $c$  and  $y$  in real per capita terms) based on Hansen and Singleton (1983) is:

<sup>25</sup> Where farm GDP falls by more than 10 per cent over a 2 year period, impulse dummies are introduced from the start of the downturn until that level of farm production is recovered. An ma4 is taken of the impulse dummies. The budget balance data constrains the sample to 1972(4).

<sup>26</sup> The \$A float dummy equals 1 before 1983(4) and 0 thereafter.

<sup>27</sup> Alternatively, one could condition on the drought dummy and then remove its contribution from the fitted value of  $\Delta \log y_{m+40}$ .

<sup>28</sup> Other potential contributors to the empirical failure of the REPIH include extrapolative expectations, convex adjustment costs, habits, measurement errors (in high frequency data) and time aggregation problems (in low frequency data) in aggregate consumption (see Muellbauer (1988)), as well as credit constraints and precautionary savings motives (see Carroll (2001)).

$$\Delta \log c_t = (1 - \lambda)\mu + \lambda\Delta \log y_t + \sigma(1 - \lambda)(1 + r_t) + \varepsilon_t \quad (14)$$

where  $\mu$  is a constant and  $\sigma$  is the elasticity of intertemporal substitution. If the real interest rate ( $r$ ) is constant the equation collapses to:

$$\Delta \log c_t = (1 - \lambda)\mu + \lambda\Delta \log y_t + \varepsilon_t \quad (15)$$

where  $\lambda$  is the consumption share of current-income constrained households in this log-linear version. If  $\lambda$  is non-zero, then the permanent income hypothesis is violated since consumption is partly forecastable. If the hypothesis that FLIB has relaxed household borrowing constraints is true, then  $\hat{\lambda}$  should decline across the sample (also violating the parameter constancy assumption of OLS).

An instrumental variables (IV) approach is appropriate since innovations in current income ( $\Delta \log y_t$ ) will likely be correlated with innovations in permanent income ( $\varepsilon_t$ ), violating OLS assumptions.<sup>29</sup> The instruments used to generate predicted values of  $\Delta \hat{y}_t$  are the "basic" and "sophisticated" information sets from the income forecasting equations presented in the previous section. All instruments are dated  $t-2$  since measurement errors in consumption and time aggregation problems may induce a first order moving average process in the residuals (Campbell and Mankiw (1989, 1991)).

Table 3 presents the results for the sample period 1973(1) to 2008(2). The conclusions are similar using either instrument set for  $\Delta \log \hat{y}_t$  so only the results based on the sophisticated information set are presented. Column (i) estimates Equation 15 for aggregate consumption growth showing the consumption share of liquidity constrained households ( $\lambda$ ) around 0.48. Column (ii) and (iii) estimate the model for non-durable consumption growth ( $\Delta \log c_t^{nd}$ ). Column (ii) shows  $\lambda$  at around 0.40. Column (iii) also includes the variable real interest rate (dated time  $t-2$ ) and also shows  $\lambda$  to be 0.40. The real interest rate is negative, contradicting Equation 14, with a t-statistic of -1.1.

In all cases the REPIH is violated since  $\Delta \log c_t$  is partly forecastable. Chart 13 provides the recursive estimates of  $\hat{\lambda}$  associated with the model in Column (ii). The upward drift in  $\hat{\lambda}$ , especially across the 1980s, suggests a *rising* consumption share affected by liquidity constraints. This conclusion seems implausible given the institutional developments that were occurring over the period. The corollary of this section is that the Euler equation setting is a poor framework in which to demonstrate the consumption effects of credit conditions. The results are not conditioned on long run information on consumption, income or asset levels. As will be shown, the more flexible solved out consumption framework employed in this paper easily outperforms the simple Euler equation as a framework in which to demonstrate credit conditions effects.

## 6 Wealth effects and demography

For any utility function homothetic in consumption the solved out consumption function will take the form  $c_t = \frac{1}{\omega} W_t$  where  $W_t$  is lifetime resources over  $T$  periods as defined in Equation 7. This section computationally establishes the range of plausible values for the marginal propensity to consume (MPC) out of household net worth in Equation 9,  $\gamma = (1 + r)/\omega$ , assuming quadratic and CES preferences (and homogenous net assets). The REPIH predicts that, for the special case of quadratic preferences and where the subjective discount rate is equal to the real interest rate ( $\delta = r$ ),  $\omega$  is:

$$\omega = \sum_{s=1}^T \frac{1}{(1 + r)^{s-1}} \quad (16)$$

---

<sup>29</sup>The "errors in variables" problem leads the OLS estimator to be biased and inconsistent. The remedy is to use instruments such as lagged data that are highly correlated with  $\Delta \log y_t$  but uncorrelated with  $\varepsilon_t$  in the limit.

The CES case with constant real interest rate ( $r$ ) and subjective discount rate ( $\delta$ ) is:

$$\omega = \sum_{s=1}^T \left( \left( \frac{1}{1+\delta} \right)^\sigma \left( \frac{1}{1+r} \right)^{1-\sigma} \right)^{s-1} \approx \sum_{s=1}^T \left( \frac{1}{1+\sigma\delta + (1-\sigma)r} \right)^{s-1} \quad (17)$$

assuming small values for  $\delta$  and  $r$ . Let  $x = 1/(1+r)$  under quadratic preferences and  $x = (\frac{1}{1+\delta})^\sigma (\frac{1}{1+r})^{1-\sigma}$  under CES preferences noting that  $x \in [0, 1]$ . The inverse marginal propensity to consume is the geometric series:

$$\omega = 1 + x + x^2 + \dots + x^{T-1} = \frac{(1 - x^T)}{1 - x} \quad (18)$$

Tables D1 and D2 at Attachment D, assuming quadratic utility and CES utility respectively, show the implied  $\omega$  and  $\gamma$  arising from different assumptions about age demography and the level of the real interest rate. The age of the household is expressed as lifetime years remaining. Bequests are assumed to be zero so the simulations represent an *upper* bound on the net wealth MPC. On the other hand, the "infinitely-lived" case illustrates the Ricardian household with dynastic or inter-generational utility. It provides a *lower* bound on the MPC estimates.<sup>30</sup>

Note that these tables concern only the comparative statics of the "income effect" via the wealth MPC. Aggregate consumption depends on the balance of income and substitution effects and this balance depends on the relative numbers of savers and borrowers. Without additional assumptions therefore the *net* effect of changes in the real interest rate on consumption are indeterminate. Note also that  $\gamma$  aggregated across households will depend on the distribution of wealth across age groups and changes in the demographic composition of the population and intertemporal parameters across time ( $r$ ,  $\delta$ ,  $\sigma$  and  $T$ ).

Younger households show a much lower wealth MPC than older households. This is intuitive. Young households have more years to live and so consume less of their assets each year. Furthermore, younger households are more sensitive than older households to the intertemporal parameters  $r$ ,  $\delta$  and  $\sigma$ . This also implies that consumption (via the wealth MPC) becomes less sensitive to real interest rate changes, and therefore the real effects of monetary policy, as the population ages.

In the quadratic preferences case (Table D1) and at the 1979-2008 average real interest rate of 5.7 per cent, an "old" household with 10 years remaining has an MPC of 0.13 while the MPCs for "middle aged" (40 years remaining) and "young" households (60 years remaining) are around 0.06.<sup>31</sup> The lower bound is provided by the infinitely-lived (Ricardian) household which has an MPC of 0.06. Higher real interest rates have a greater impact on the wealth MPCs of younger households. For example, real interest rates peaked at 12 per cent in the June quarter of 1990. This implies, if households believed such rates were permanent, very high wealth MPCs of 0.16 for old households and 0.11 for younger (and infinitely lived) households.

The CES case (Table D2) is simulated by assuming  $\sigma = 0.2$  and  $\delta = 0.05$ . On these assumptions, real interest rate comparative statics are in the same direction as in the quadratic preferences case and MPCs are roughly equivalent in magnitude (using the 1979-2008 average real interest rate). The additional comparative statics are that a higher subjective discount rate raises the net worth MPC ( $\gamma$ ) and matters most for young households. The intertemporal elasticity of substitution coefficient ( $\sigma$ ) determines the relative weight between  $\delta$  and  $r$  in Equation 17. A higher elasticity of substitution, of say  $\sigma = 0.5$ , lowers the impact of perceived permanent increases in the real interest rate on the wealth MPC but raises the importance of the subjective discount rate. The choice is again most relevant for younger households.

<sup>30</sup> An intermediate case between these two bounds - where households do care about their children's inheritance but not their children's children's inheritance and so on - could be simulated by deducting some fixed amount from lifetime wealth.

<sup>31</sup> The real interest rate here is proxied by the standard variable bank mortgage rate less the four quarter change in the log household consumption deflator:  $r = i - \Delta_4 \log p$ . A "neutral" real interest rate simulation is provided below.

A useful exercise is to find the prevailing wealth MPCs with a "neutral" real interest rate. The "neutral" rate is the real interest rate at which trend inflation is constant and monetary policy is therefore neither expansionary nor contractionary.<sup>32</sup> In his 2002 testimony to a House of Representatives Standing Committee, former Reserve Bank of Australia (RBA) Governor Ian Macfarlane expressed the RBA's view that (at that time) the "neutral" real rate of interest for Australia was in the range of 3-3.5 per cent (Macfarlane (2002)). With quadratic preferences (Table D1) this implies wealth MPCs of 0.12 for "old" households (10 years remaining) compared with around 0.04 for "young" households (60 years remaining). The lower bound, provided by the infinitely-lived (Ricardian) household, is 0.03. The CES case (Table D2) is identical.

Another useful benchmark is to calculate an aggregate wealth MPC point estimate based on the average person's remaining lifetime. The average age of the Australian population has increased almost monotonically from around 30.9 years in 1971 to 37.4 in 2008 (Australian Bureau of Statistics (ABS) 3201). Average life expectancy as at 2005-2007 is 79.0 years for males and 83.7 years for females (ABS 3302) having increased by 6.0 years and 4.1 years over 20 years for males and females respectively. Taking the mid-points, life expectancy is 81.4 years in 2006 and 76.3 in 1986. The difference between life expectancy and average age implies that the average person in 2006 had 44.2 years remaining compared to 42.9 years remaining in 1986. Thus the increase in the average age of the population has been more than offset by an increase in life expectancy.

Under quadratic preferences and at the 1979-2006 average real interest rate (5.7 per cent), the wealth MPC of the average Australian would be 0.06. At the RBA's "neutral" real interest rate of 3-3.5 per cent, the wealth MPC of the average person would be around 0.04-0.05. These magnitudes are the same under CES preferences.<sup>33</sup> These analyses provide a plausible range of aggregate wealth MPCs for Australia based on the interplay between age demographics and the intertemporal parameters: 0.04-0.06 assuming either quadratic preferences or CES preferences.

## 7 Consumption models without credit conditions

### 7.1 The "classical" solved out consumption model

A slightly modified "classical" solved out consumption function with homogenous household net assets ( $A_{t-1}$ ) is estimated in AutoMetrics using quarterly aggregate consumption data from 1977(2) to 2008(2) as follows:

$$\Delta \log c_t \approx \phi(\alpha_0 + \gamma A_{t-1}/y_t + \psi E_t \Delta y m_{t+k} + \log y_t - \log c_{t-1}) + \beta_1 \Delta \log y_t + \varepsilon_t \quad (19)$$

The error term  $\varepsilon_t$  is no longer the innovation in permanent income (as in the REPIH model) but represents transitory consumption and measurement error. The specification also includes log current income growth and therefore nests the excess sensitivity hypothesis. The point estimate of  $\phi$ , the speed of adjustment and coefficient on  $\log(y_t/c_{t-1})$ , will be super-consistent if cointegration holds. There may, however, be some endogeneity bias in estimates of  $\psi$  and  $\beta_1$  since both parameters operate on terms that contain current income ( $\log y_t$  enters negatively in  $\Delta y m_{t+k}$  and positively in  $\Delta \log y_t$ ). This might cause some downward bias in  $\psi$  and some positive bias in  $\beta_1$ . Nonetheless, as will be seen, this does not appear to be a serious problem because as more controls are introduced,  $\hat{\psi}$  tends towards

<sup>32</sup>The neutral rate is not directly identifiable but will vary over time depending on the productive capacity of the economy. For example it will be higher at faster rates of population and productivity growth or where labour force participation is increasing. Archibald and Hunter (2001) provide a summary of the applied issues. A simple approximation might take the trend real interest rate based on a Hodrick-Prescott filter.

<sup>33</sup>Note that the CES case simulations are not especially sensitive to the choice of  $\sigma$  within a plausible range. For example assuming a higher elasticity substitution of say,  $\sigma = 0.5$ , the wealth MPC range (covering the 3-3.5 per cent neutral real interest rate case and the 1979-2008 average real interest rate case) increases only slightly to 0.05-0.06 for the average-aged person. However, if one assumes a higher subjective discount rate of say  $\delta = 0.15$ , this range rises to: 0.06-0.08 with  $\sigma = 0.2$ ; or 0.09-0.10 with  $\sigma = 0.5$ .

the prior of  $1 - \eta$  and  $\hat{\beta}_1$  becomes smaller and less significant.

Models 1, 2 and 3 respectively estimate the model using the naive (*EY1*), basic (*EY2b*) and sophisticated (*EY3b*) versions of  $E_t \Delta y m_{40}$  as described in Section 5.2.<sup>34</sup> Table 4 reports the short run coefficients. The speeds of adjustment ( $\phi$ ) for all three models are low - less than 10 per cent per quarter with t-statistics of 1.8, 3.0 and 3.9 respectively - providing weak evidence of cointegration. The estimated long run weights on log permanent income ( $\psi$ ) are 0.75, 1.1 and 1.2 respectively which are within a standard error of 0.95 (that is,  $\hat{\psi} \approx 1 - \eta$  where  $\eta = 0.05$ ).

Household net worth achieves a t-statistic of only around 1.7-1.8 under naive and basic income expectations, improving to 2.1 with sophisticated expectations. The (annualised) long run marginal propensities to consume of net assets ( $\gamma$ ) are 0.04, 0.02 and 0.02 respectively. These are lower than the 0.04-0.06 range (quadratic or CES preferences) suggested in Section 6. The models concur on  $\beta_1$  and imply that 12-13 per cent of households are Keynesian consumers.

Overall, the models' standard errors are high, estimated wealth MPCs are implausibly low and evidence of cointegration is weak. Models 2 and 3 also fail diagnostic tests for heteroskedasticity. The "classical" solved out consumption function for Australia thus provides only weak evidence of a stable long run relationship. This is interpreted as an omitted variables problem.

## 7.2 Augmented "classical" consumption model

The model can be augmented further by introducing a variable real interest rate ( $r_{t-1}$ )<sup>35</sup> and a measure of income uncertainty ( $\theta$ ). In addition, the consumption of borrowers in the presence of liquidity constraints may be more sensitive than savers to changes in short run interest rates (see Jackman and Sutton (1982), Stiglitz (1999), Bernanke (2007) and Muellbauer (2007)). The specification therefore adds the four quarter change in nominal mortgage rates weighted by the ratio of household credit to annualised income ( $\Delta_4 \log i_{t-1} \times (CR_{t-1}/4y_t)$ ), although it is rarely significant in later models.<sup>36</sup>

The solved out consumption function thus becomes:

$$\begin{aligned} \Delta \log c_t \approx & \phi(\alpha_0 - \alpha_1 r_{t-1} - \alpha_2 \theta_{t-1} + \gamma A_{t-1}/y_t + \psi E_t \Delta y m_{t+k} + \log y_t - \log c_{t-1}) \\ & + \beta_1 \Delta \log y_t - \beta_2 \Delta_4 \log i_{t-1} \times (CR_{t-1}/4y_t) + \varepsilon_t \end{aligned} \quad (20)$$

Estimation is again conducted in OxMetrics (Table 5). Model 4 relies on naive income expectations and performs poorly since  $\phi = 0$  cannot be rejected. Models 5 and 6 incorporating basic and sophisticated information sets for income forecasting are more promising, particularly Model 6. Most importantly in Model 6 the quarterly speed of adjustment rises to 13 per cent and is significant at the 1 per cent level. Also strongly significant are income expectations with a long run weight of 1.1 (within a standard error of 0.95). The model's standard error also improves relative to Model 3. Uncertainty is proxied by the two year change in the log unemployment rate and appears only in the dynamics.<sup>37</sup> However the net wealth estimates are poor: barely significant and with the long run MPC implausibly low at 0.01 (inconsistent with the 0.04-0.06 range established in Section 6). Real interest rates are insignificant and, although weighted nominal interest changes are significant in Model 5, they disappear using the wider information set for *EY3b*. The long run solution is again less than satisfactory and continues to point to an omitted variables problem.

<sup>34</sup>HACSEs are reported in parentheses for Models 1-9. For Models 10 onwards, estimation is conducted in TSP and standard errors are reported in parentheses. Again, data sources and variable construction are set out in Attachment B.

<sup>35</sup>The sign of  $\alpha_1$  will depend on the balance of income and substitution effects.  $r$  is proxied by the real standard variable mortgage borrowing rate.

<sup>36</sup>This is somewhat surprising since around three quarters of the Australian mortgage stock is at variable interest rates, compared to one half in the UK and less than a quarter in the US (RBA (2009): Box B).

<sup>37</sup>The log unemployment rate level was tested in the long run solution but was not significant. Also tested and insignificant were inflation volatility and nominal interest rate volatility. A step dummy for the introduction of the GST from 2000(3) was also tested but was not significant.

## 7.3 Consumption model with disaggregated wealth

### 7.3.1 Specification

The classical solved-out consumption function hitherto assumes that the initial asset endowment is homogenous, continuously tradable and perfectly divisible. The marginal propensity to consume (MPC) out of assets may instead differ across asset classes (and over time in the case of housing assets) depending on trading liquidity, credit access, psychological factors, bequest motives and changing regulations in markets for those assets.<sup>38</sup> A three-fold disaggregation of household assets is suggested by Aron et al. (2008), Muellbauer (2007) and Aron et al. (2010).

The first dimension of disaggregation depends on liquidity. Liquid assets may play a buffer stock role which suggests a higher MPC out of liquid assets compared to non-liquid assets, where the latter face transaction costs (Otsuka, 2006). This suggests separating liquid assets (including debt) from non-liquid assets. Debt should be included in liquid assets (negatively) rather than non-liquid assets. This is because most forms of household debt can also perform a precautionary savings role through cheap refinancing or home equity loans that provide penalty-free prepayment and redraw options.<sup>39</sup>

The second dimension hinges on access to credit. Muellbauer and Murphy (1990), Muellbauer (2007) and Aron et al. (2010) emphasise the existence of a collateral channel from housing capital gains to consumption which depends on the degree of credit market liberalisation. Traditional consumption models generally fail to establish a "classical" housing wealth effect on consumption. This is because owner-occupied housing assets are also durable consumption goods (see Muellbauer (2007), pp272-273). The positive wealth effects from housing capital gains may be offset by negative relative price effects that encourage "trading up" and "trading down" into larger or smaller houses.<sup>40</sup> Furthermore, the impact on consumption may in fact be negative where the credit market is tightly regulated.<sup>41</sup> This is because increases in house prices raise the saving requirement (downpayment constraint) on first time buyers, typically young households. However in liberalised credit markets, first time buyers may face a relaxed downpayment constraint while older, existing home owners are able to access housing equity through refinancing or home equity loans (with redraw and offset facilities). The latter gives rise to a housing collateral effect on consumption which is time-varying with the state of credit conditions.

The foregoing discussion suggests a three-fold disaggregation of household wealth into housing assets ( $HA$ ), illiquid financial assets ( $IFA$ ) and net liquid assets ( $NLA$ ). Note that a parameter shift in the housing wealth MPC due to credit conditions will be explored in Section 8. For now, the empirical specification from Equation 20 becomes:

$$\begin{aligned} \Delta \log c_t \approx & \phi(\alpha_0 - \alpha_1 r_{t-1} - \alpha_2 \theta_{t-1} + \gamma_1 HA_{t-1}/4y_t + \gamma_2 IFA_{t-1}/4y_t + \gamma_3 NLA_{t-1}/4y_t \\ & + \psi E_t \Delta y m_{t+k} + \log y_t - \log c_{t-1}) + \beta_1 \Delta \log y_t \\ & - \beta_2 \Delta_4 \log_{t-1} \times (CR_{t-1}/4y_t) + \varepsilon_t \end{aligned} \quad (21)$$

<sup>38</sup>Pissarides (1978) and Case et al. (2005) offer further discussion. Psychological factors are emphasised by Thaler (1990). "Mental accounting" may lead households to allocate assets for different purposes or see wealth increases as permanent for some asset types and uncertain or temporary for others.

<sup>39</sup>RBA (2009) (Box B) shows that about three quarters of Australian mortgages are at variable rates at which there are no penalties for prepayment. The prevalence of variable rate loans is affected by country-specific tax arrangements (Ellis (2006)). Mortgage interest is not tax deductible for owner-occupiers in Australia, while owner-occupied housing capital gains are tax-exempt. This creates an option value on prepayments if interest rates fall (Leece (2004)), as they did across the 1990s. As further evidence of the changing role of mortgage debt in consumption smoothing, note that Chart 8 depicts a structural increase and higher volatility in housing equity withdrawal as a proportion of household income across the sample period.

<sup>40</sup>The ease of "trading up" and "trading down" will depend on country-specific housing market frictions. See Williams (2009) on the importance of threshold effects in the Australian housing market.

<sup>41</sup>Italy (Andersen and Kennedy (1994), Boone et al. (2001) and Slacalek (2009) and Japan (Muellbauer and Murata (2009)) provide examples.

### 7.3.2 Wealth data and priors

The RBA provides quarterly Australian household wealth data on housing ( $HA$ ) and financial assets ( $FA$ ) back to 1977(2), although the latter is annual before 1988 and must be interpolated.<sup>42</sup> This is the level of disaggregation used by Tan and Voss (2003), Fisher and Voss (2004) and Fisher et al. (2010). This paper goes a step further by treating household deposits in RBA Bulletin Table B20 as liquid assets ( $LA$ ). A quarterly series is available from 1988. Pre-1988 data is constructed as M3 times the household factor income share spliced with the post-1988 deposits series.<sup>43</sup> Illiquid assets are then constructed as  $IFA = FA - LA$  and net liquid assets are  $NLA = LA - CR$  where  $CR$  is outstanding household credit.  $CR$  consists of housing credit ( $HC$ ) plus other personal credit ( $OPC$ ). There is the possibility of measurement error in the pre-1988 decomposition of  $FA$  and  $NLA$ . The strategy for mitigating this problem is to employ strong priors about the likely size of the disaggregated wealth MPCs drawn from Australian and overseas empirical studies.

Dvornak and Kohler (2007) stocktake the international evidence on household wealth MPCs (summarised in Table 6). Long run MPC estimates for total household wealth range from 0.02-0.05 for Australia. Models 1 to 6 earlier estimated the total net wealth MPC between 0.01 and 0.04. These estimates are too low compared to: the 0.04-0.06 range (quadratic or CES preferences) established computationally in Section 6; and the range of empirical estimates for the US, Canada and the UK.

The range of estimates are much wider for stock market wealth. Tan and Voss (2003) estimate an MPC between 0.04 to 0.16. The top of this range is double the nearest overseas estimate. The evidence on the housing wealth MPC is even more mixed. Tan and Voss (2003) find no long run housing wealth effect at all for Australia, whereas for a panel of US states and a panel of 14 countries, Case et al. (2005) find a larger housing wealth effect than share market wealth effect.

Dvornak and Kohler (2007) attribute the insignificance of the housing MPC to housing and stock market wealth multicollinearity. Following Case et al.'s (2005) US approach, they estimate Australian consumption functions using quarterly state-level panel data from 1984(4) to 2001(4) on consumption, incomes, stock market wealth, net dwelling wealth and net other financial wealth. Geographically distinct data sets help disentangle the two impacts using various panel estimation methods.<sup>44</sup> They estimate the following state-level equation (in real per capita levels):

$$C_t = \alpha + \gamma Y_t + \beta_1 S_t + \beta_2 H_t + \beta_3 O_t + \varepsilon_t \quad (22)$$

where  $C$  is consumption,  $Y$  is post-tax earnings (equivalent to state-level GDI),  $S$  is stock market wealth,  $H$  is housing wealth net of mortgage debt and  $O$  is other financial wealth (currency, term deposits and non-equity superannuation holdings net of household personal debt). Their solved out consumption function additionally assumes that income is an AR(1) process over an infinite horizon and that there are no bequests. The model is estimated in levels which, unlike the log specification (see Section 4.2), does not guarantee long run homogeneity between consumption, income and wealth. The model's steady state coefficients may therefore be unreliable.<sup>45</sup>

In their preferred results (fixed effects IV estimation and mean group estimation), they estimate the long run MPCs at around 0.06-0.09 for stock market wealth, 0.03 for net housing wealth and 0.07-0.09 for net other financial wealth. Income MPCs appear too low at around 0.4-0.6. This weakness in the specification was not pursued since their focus is on the wealth MPCs which were relatively

<sup>42</sup>Post-1988 quarterly data is published in RBA Bulletin Table B20. Pre-1988 data for housing and financial assets were provided by the RBA on request.

<sup>43</sup>Post-1988 data shows strong growth in money market funds. As substitutes for traditional bank deposits and with low transaction costs, they are also likely to play a buffer stock savings role and attract a higher wealth MPC than for other types of financial wealth. It would similarly be useful to separate direct equity holdings and superannuation assets. Unfortunately pre-1988 financial assets data are not separable to this level of detail.

<sup>44</sup>These include fixed-effects instrumental variables, panel dynamic ordinary least squares (DOLS), mean group and seemingly unrelated regressions estimation.

<sup>45</sup>That said, Dvornak and Kohler (2007) note that over their sample period the coefficients show little difference whether the model is estimated in levels (with coefficients interpreted as MPCs) or logs (with coefficients interpreted as consumption elasticities).

stable across specifications. Their recursive estimates show some downward drift in the stock market wealth MPC and some upward drift in the housing wealth MPC. This again suggests a role for credit conditions.

Finally, Dvornak and Kohler (2007) also estimate the model using aggregate data and struggle to establish cointegration. The long run income MPC is 0.59-0.80, the stock market wealth MPC is 0.04-0.10, the MPC for other financial wealth is 0.12-0.14 and the housing wealth MPC is insignificant (-0.02 to 0.01). They attribute the latter result to multicollinearity between housing and stock market wealth which supports their use of state-level panel data to disentangle the two effects. The alternative however, pursued in this paper, is to continue the use of aggregate time series data but to employ additional controls - especially for credit supply conditions.

### 7.3.3 Estimation

The OxMetrics estimation results incorporating disaggregated wealth effects (Equation 21) are provided at Table 7. For Models 7 (basic expectations) and Model 9 (perfect foresight), the long run wealth MPCs are 0.07 for (gross) housing wealth ( $\gamma_1$ ), 0.05 for illiquid financial wealth ( $\gamma_2$ ) and 0.21 for net liquid assets ( $\gamma_3$ ). The estimates of the weight on log permanent income ( $\psi$ ) are similar for Model 7 and Model 9 (0.78 and 0.75 respectively) rising to 1.03 for Model 8. Assumptions about the information set used by households to forecast permanent non-property income thus can have a significant influence on the relative weight assigned to income expectations and wealth in explaining the steady state consumption to income ratio.

Model 8 (sophisticated expectations) achieves the lowest standard error and the highest quarterly adjustment speed at 12.1 per cent. A greater role is assigned to income expectations and a lesser role assigned to household wealth. The speed of adjustment is still quite low suggesting that equilibrium correction after a temporary shock takes more than eight quarters. The wealth MPC estimates are 0.03 for housing wealth, 0.02 for illiquid financial wealth and 0.09 for net liquid assets, but none are significant at the 5 per cent level.

In terms of the other controls, Models 7-9 are broadly in agreement.<sup>46</sup> The coefficient on current income growth is strongly significant within a range of 0.11-0.12. Uncertainty measured by the eight quarter change in the log unemployment rate remains significant in the dynamics while the long run real interest rate effect is negligible. Recursive estimation shows parameter instability on the long run variables for all three models. Low adjustment speeds also suggest that the omitted variables problem, while diminished, remains unresolved.

## 8 Consumption models with credit conditions

### 8.1 Specification

The next stage incorporates credit conditions. The methodological groundwork is laid out in Aron et al. (2008), Muellbauer (2007) and Aron et al. (2010) for the UK, US and Japan. Early work on an Australian credit conditions index is conducted in Williams (2009). Equation 21 can be restated with time subscripts on the key parameters that may shift with credit conditions:

$$\begin{aligned} \Delta \log c_t \approx & \phi(\alpha_{0t} - \alpha_{1t}r_{t-1} - \alpha_{2t}\theta_{t-1} + \gamma_{1t}HA_{t-1}/4y_t + \gamma_2IFA_{t-1}/4y_t \\ & + \gamma_3NLA_{t-1}/4y_t + \psi_t E_t \Delta y_{t+k} + \log y_t - \log c_{t-1}) \\ & + \beta_{1t} \Delta \log y_t - \beta_{2t} \Delta_4 \log i_{t-1} \times (CR_{t-1}/4y_t) + \varepsilon_t \end{aligned} \quad (23)$$

The easing of household borrowing conditions due to FLIB may have the following impacts. The autonomous consumption intercept ( $\alpha_{0t}$ ) should rise because FLIB lowers the downpayment facing

<sup>46</sup>The exception is the nominal interest rate effect which gives contradictory result in each model. It is dropped in later specifications.

young households, meaning they need to forgo less consumption to enter the housing market. The coefficients on the real interest rate ( $\alpha_{1t}$ ) and expected income ( $\psi_t$ ) should rise since easier credit conditions facilitate intertemporal consumption substitution. The coefficient on uncertainty ( $\alpha_{2t}$ ) may fall as borrowing to overcome income fluctuations becomes easier; though equally it could rise to the extent that highly indebted households feel the effects of uncertainty more acutely. Likewise  $\beta_{1t}$  may fall because of a reduced proportion of credit constrained households (reduced weight on current income).  $\beta_{2t}$  may fall because households can more easily refinance to overcome temporary cash flow difficulties induced by nominal interest rate fluctuations. Finally, the long run marginal propensity to consume out of housing assets ( $\gamma_{1t}$ ) increases with FLIB because housing collateral becomes more accessible in liberalised credit markets (as discussed in Section 7.3.1).

The following Australian version of Equation 23 is estimated in TSP using quarterly data for 1977(2) to 2008(2):

$$\begin{aligned} \Delta \log c_t \approx & \phi(\alpha_0 + \zeta CCIH_t + CCIH_t \times \alpha_1 posr(ma4)_{t-1} + CCIH_t \times \gamma_1 HA_{t-1}/4y_t \\ & + \gamma_2 IFA_{t-1}/4y_t + \gamma_3 NLA_{t-1}/4Y_t + CCIH_t \times \psi_1 E_t \Delta y m_{t+40} + \alpha_3 \Delta_4 DEMFTB_t \\ & + \log y_t - \log c_{t-1}) + \beta_1 \Delta \log y_t + \beta_2 \Delta_8 \log ue_{t-1} + dummies_t + \varepsilon_t \end{aligned} \quad (24)$$

$$\begin{aligned} CCIH = & \varphi_1 split79(ma4) - \varphi_2 split92(ma4) + \varphi_3 (split98(ma4) - 1.5 split07) \\ \varphi_1 = & 0.0020; \quad \varphi_2 = 0.0024; \quad \varphi_3 = 0.0021 \end{aligned} \quad (25)$$

Note that all interaction terms take the form of  $CCIH_t \times (x - mean(x))$  where  $mean(x)$  is the post-1979(1) arithmetic mean. The Australian specification differs from Aron et al.'s (2008) in several respects. First, the Australian wealth to income ratios are highly collinear and grow almost monotonically across the sample (see Chart 7). The freely estimated illiquid financial assets coefficient ( $\gamma_2$ ) is in most estimations statistically insignificant (the point estimate is a little under 0.01). The insignificance of  $\gamma_2$  is unsatisfactory as it results in higher coefficients on the other positive long run variables ( $CCIH$  intercept and gross housing assets). The appropriate solution in a time series context is to utilise extraneous information. Muellbauer (2007) estimates the steady state coefficient on a similarly defined illiquid financial assets variable at 0.018 for the UK and 0.014 for the US. The subsequent estimations adopt a conservative approach and set  $\gamma_2$  at 0.01.

Second, the effects of  $HA_{t-1}/4y_t$ ,  $E_t \Delta y m_{40}$  and  $r_{t-1}$  enter only through their interaction with  $CCIH$ . The non-interacted (levels) effects of these terms were tested but were not significant. The economic interpretation is that prior to FLIB (that is, pre-1979) Australian households were highly credit constrained and unable to access housing capital gains or borrow against expected future income.<sup>47</sup> The direct coefficient on the real interest rate is also set to zero because it is highly collinear with the degree of credit liberalisation. Real interest rates should necessarily be higher in a liberalised credit market that relies on prices rather than quantitative controls to clear the market. Real interest rates instead enter through the  $CCIH$  interaction term ( $CCIH_t \times posr_{t-1}(ma4)$ ). Negative values of  $r(ma4)$  are set to zero since these more likely reflect (pre-FLIB) peak periods of quantitative credit rationing rather than the true cost of borrowing.<sup>48</sup>

Third, uncertainty is measured by the two year change in the log unemployment rate and enters through the dynamics rather than the steady state. Other uncertainty proxies such as the log unemployment rate and unemployment rate, inflation volatility, interest rate volatility and downside housing risk were tested but were not significant. Fourth, the model adds the annual change in the proportion

<sup>47</sup>The treatment of these intercept terms effectively assumes that credit constrained households are at a corner solution of the intertemporal budget constraint where they do not respond to changes in income expectations or real interest rates (see Flemming (1973)). If the level effect on  $EY3b$  is included its long run coefficient is about 0.36-0.46 but is always insignificant. The coefficient on the interaction term  $EY3b \times CCIH$  is consequently lower so that the combined point estimate of  $\psi$  on expected income rises from 0.36-0.46 in 1977 to just under 1 by 2008 (which satisfies the prior that  $\psi \approx 1 - \eta$ ). These assumptions are addressed further in Section 8.3.

<sup>48</sup>The negative value quarters are 1977(2), 1977(3), 1977(4), 1980(1) and 1980(2).

of the population that are of first home buyer age ( $\Delta_4 DEMFTB$ , where  $DEMFTB$  is the ratio of 22-34 year old persons to the total population). Young households are likely to be saving for a housing loan deposit so an increase in  $\Delta_4 DEMFTB$  should lower the consumption to income ratio. This addition to the model allows the influence of the downpayment constraint (in terms of its impact on the consumption to income intercept) to be separated into credit conditions and demographic structure effects.  $CCIH$  was interacted with this demographic variable but was not significant.  $CCIH$  was also interacted with current income growth but was insignificant. Also tested but insignificant was a step dummy for the 2000(3) introduction of the 10 per cent goods and services tax (GST). Lastly, numerous permutations of delta log interest rate effects were tested but none were significant.

## 8.2 Results and interpretation

The model is estimated in TSP 5.0 (Hall and Cummins (2006)) and the estimation results are provided in Table 8. Models 10, 11 and 12 are estimated using basic, sophisticated and perfect foresight income expectations respectively. Steady state coefficients are shown for the long run variables and thus should be multiplied by the speed of adjustment (coefficient on  $\log(y_t/c_{t-1})$ ) to find the short run coefficient. All variables (except current income growth in Models 11 and 12) are significant at the 1 per cent level.

The quarterly speed of adjustment for all three models more or less doubles to between 18.1 to 21.1 per cent compared to previous models without credit conditions (that is, Models 7, 8, 9). Thus temporary shocks now take about a little over a year, or  $5\frac{1}{2}$  quarters, to be unwound. Likewise the models' standard errors fall by about 15 per cent and, in terms of  $R^2$ , explain about half of the quarterly variation in consumption. The preferred model is Model 11 (sophisticated) on the basis of standard error, speed of adjustment and plausibility of income expectations.<sup>49</sup>

Model 11 can be interpreted as follows. A strong t-statistic of 4.9 on  $\log(y_t/c_{t-1})$  indicates the model is properly specified as an equilibrium correction model. The model implies that the steady state consumption to income ratio depends positively on credit conditions, disaggregated household wealth and income expectations; and negatively on the real interest rate and changes in the proportion of young households (22-34 year olds). In the structural dynamics are current income growth and the two year change in the log unemployment rate.

$CCIH$  rises from zero at the start of the sample to around 0.15 in 2008(2) and the  $CCIH$  intercept coefficient ( $\zeta$ ) is 1.04. This implies that the direct impact of easing credit conditions, through the relaxation of the downpayment constraint, raises the long run consumption to income ratio by about 15.5 percentage points. Note that this is only the partial equilibrium effect in conditional model, not a general equilibrium result.

Household income expectations play no role before 1979 but become highly significant as credit markets are liberalised (that is, as  $CCIH$  rises).<sup>50</sup> The implied long run weight on permanent income at the 2008 level of  $CCIH$  is 0.98, consistent with the prior that  $\hat{\psi} \approx 0.95$ . Similarly, the real interest rate has no impact on consumption at the start of the sample. However by 2008, a one percentage point increase in the real interest rate lowers the long run consumption to income ratio by 1.3 percentage points. These findings suggest greater opportunities for intertemporal consumption substitution in a liberalised credit market, with a greater allocative role for the real interest rate as quantitative controls are relaxed after 1979.

The long run wealth MPC is constrained to 0.01 for illiquid financial assets and estimated at 0.23 for net liquid assets. The latter is a little higher than expected and higher than Aron et al.'s (2008) estimates of 0.13 for the UK and 0.17 for South Africa, although it is within a standard error of the latter. The higher estimate for Australia could be due to measurement error in the net liquid assets data (for example, related to the estimates of pre-1988 deposits data). Money market funds became an important liquid asset for households across the 1990s but are not separately identifiable from pre-1988 financial assets. They are therefore included in  $IFA$  rather than  $NLA$  as would be

<sup>49</sup>The perfect foresight assumption is less realistic but delivers a model with superior fit and speed of adjustment.

<sup>50</sup>The zero intercept (pre-FLIB) constraint on the permanent income weight is relaxed in Section 8.3.

preferable (see Section 7.3.2). The growth in money market funds might mean that liquid assets are under-measured which forces a higher coefficient ( $\gamma_3$ ) on *NLA*. Alternatively, the high coefficient on *NLA* could simply reflect greater liquidity and flexibility in household debt instruments in Australia compared to overseas (see Ellis (2006) for a comparative study).

The long run housing wealth MPC is zero at the start of the sample and rises to 0.07 in 2008.<sup>51</sup> The housing wealth term interacted with *CCIH* is strongly significant (t-statistic of 2.7). Like the net liquid assets MPC, the post-FLIB housing wealth MPC of 0.07 is a little high at about double the UK estimate of 0.03 (Aron et al. (2008)), the US estimate of 0.04 (Aron et al. (2010)) and Dvornak and Kohler's (2007) panel estimate of 0.03 for Australia.<sup>52</sup>

Introducing a role for credit conditions thus explains the insignificance of the classical housing wealth effect in some previous studies. In a tightly regulated credit market, such as that of the 1970s, housing wealth is inaccessible. Increases in housing wealth do not translate into consumption increases. However in liberalised credit markets, housing wealth can be accessed through mortgage refinancing, redraw facilities on home equity loans, or as collateral for new loans. These mechanisms enable housing capital gains to be accessed for consumption, portfolio management or other purposes.

The remaining parts of the model are changes in demographics, the log unemployment rate and income growth. A falling proportion of young households (high-saving 22-34 years olds) in the total population ( $\Delta_4 DEMFTB$ ) raises the steady state consumption to income ratio by about 3.8 percentage points across 1978-2008.<sup>53</sup> The unemployment rate effect ( $\Delta_8 \log ue_{t-1}$ ) is a short run effect. A one percentage point increase in the unemployment rate over the previous two years, from say 5 per cent to 6 per cent, temporarily lowers quarterly consumption growth by about 0.3 per cent. Finally, current income growth takes a coefficient of around 0.05 but, unlike previous models above, is not significant now that additional controls for wealth, credit conditions and demography have been introduced.

### 8.2.1 Cointegration

All models presented in this paper jointly estimate the steady state and dynamic solutions. Banerjee et al. (1986), Kremers (1989) and Kremers et al. (1992) show that direct estimation provides more efficient estimation of the long run parameters where there is a unique cointegrating vector suggested by economic theory. This is because direct estimation of the cointegrating relationship conditions on information contained in both the structural and equilibrium correction dynamics. Using this strategy, cointegration implies and is implied by strongly significant coefficients on the long run variables and equilibrium adjustment parameter. Attachment B provides unit root tests showing that all long run variables are I(1) in levels and stationary in first differences.<sup>54</sup>

An alternative approach is to conduct augmented Dickey and Fuller (1979, 1981) (ADF) tests on the residual of the long run equations (that is, excluding information from the structural dynamics). This involves regressing  $\log(c/y)_t$  on the terms in parentheses of Equations 19, 20, 21 and 24 corresponding to Models 1 to 12. The ADF test statistics on the residuals of these long run equations are provided in Table 9. The residual only becomes stationary at the 1 per cent level for Models 10, 11 and 12.<sup>55</sup> Models 10, 11 and 12 imply that, conditional on the intercept shift in credit conditions, a cointegrating vector exists between the following I(1) variables: the log consumption to non-property income ratio; the three wealth variables; income expectations; real interest rates; and the change in

<sup>51</sup>This is calculated as the long run coefficient times the 2008 value of *CCIH*.

<sup>52</sup>Dvornak and Kohler's (2007) MPC might be lower because it relates to *net* housing wealth (that is, net of mortgage debt which would have an offsetting and higher negative MPC).

<sup>53</sup>The proportion of 22-34 year old persons relative to the total population falls from 20.6 per cent in 1977 to 18.2 per cent in 2008.

<sup>54</sup>*DEMFTB* is interpolated from annual data and is treated as I(2).  $\Delta_4 DEMFTB$  is believed to be I(1) and combines with the other I(1) variables to deliver a stationary residual on the long run equation.

<sup>55</sup>The residual is also stationary (at the 5 per cent level) for long run equation 2. However the the dynamic specification (Model 2 in Table 5) shows a quarterly equilibrium adjustment speed of only 6.7 per cent and a barely significant household net wealth effect, which suggests that cointegration is not achieved.

the proportion of young households in the population. The credit conditions interactions ensure that income expectations, the real interest rate and housing wealth are not part of the long run solution before 1979 but become increasingly important as  $CCIH$  rises. The evidence in Table 9 thus strongly supports the hypothesis that credit conditions are the critical omitted component of previous solved out Australian consumption models.

### 8.3 Further improvements

Model 11 can be further improved by freely estimating  $\varphi_1$ ,  $\varphi_2$ , and  $\varphi_3$  in Equation 25 and setting  $\zeta = 1$  in Equation 24. In addition, the time-varying weight on permanent income ( $\psi_t$ ) can be constrained to 0.95 at the peak of  $CCIH$  in 2008(2). That is, let  $\psi_t = \psi_0 + \psi_1 CCIH_t$  and then impose  $\psi_0 + \psi_1 CCIH_{\max} = \psi_{\max} = 0.95$ . This is the maximum weight households could place on permanent income in a liberalised credit market, as defined in Section 5.1.

The sophisticated expectations version of this model is estimated in TSP and presented as Model 13 in Table 10. The quarterly speed of adjustment improves to 23 per cent, from 18 per cent for Model 11 and is even higher than the perfect foresight case of Model 12. The standard error also improves (1.8 per cent lower than Model 11).  $\psi_1$  is estimated at 4.8 with a t-statistic of 2.2 and the maximum value of  $CCIH$  is 0.14. This implies that the initial (pre-FLIB) weight on permanent income,  $\psi_0$ , is around 0.3.  $\varphi_1$  is freely estimated at 0.0018 (previously 0.0020). This lower value reflects the slightly greater weight now attributed to permanent income during the 1980s.  $\varphi_2$  is correspondingly less negative at -0.0021 (previously -0.0024) while  $\varphi_3$  remains unchanged at 0.0021.

## 9 Reconciling the stylised facts

The paper began with a series of stylised facts (Section 2) that can now be explained relying on Model 13 in Table 10. The dependent variable, the log consumption to income ratio, rises by 13.6 percentage points across 1977 to 2008. Table 11 summarises the partial equilibrium steady state effects of changes in the long run explanatory variables between 1977 and 2008 on the log consumption to income ratio. Charts 14 and 15 provide the same decomposition graphically.<sup>56</sup>

The partial equilibrium impact of  $CCIH$  can be interpreted as FLIB's relaxation of the down-payment constraint, which most acutely affects the saving patterns of young households. Holding other variables constant,  $CCIH$  contributes 13.7 percentage points towards the long run rise in the dependent variable across 1977 to 2008. Furthermore, FLIB relaxes the housing collateral constraint facing older, home-owning households. Housing collateral is inaccessible before 1979 so housing capital gains have no consumption impact. After credit market liberalisation however, housing capital gains are "unlocked" and contribute 17.6 percentage points towards the long run rise in the consumption to income ratio. Illiquid financial assets contribute an additional 2.1 percentage points. The greater indebtedness of households however subtracts, through net liquid assets, an offsetting -23.7 percentage points from the long run consumption to income ratio. Model 13 implies long run wealth MPCs of 0.06 for housing assets (at the 2008  $CCIH$  level), 0.01 for illiquid financial assets (imposed) and 0.20 for net liquid assets.

The relaxation of credit constraints also facilitates households' intertemporal consumption smoothing. Households' rising optimism about future income expectations (using a sophisticated information set) raises the long run consumption to income ratio by 4.9 percentage points relative to 1977. Offsetting this, higher real interest rates are a natural feature of the post-FLIB credit market which relies on the price mechanism rather than quantitative restrictions to allocate credit (Cameron et al. (2006)). The (positive-only) real interest rate increases by 5.6 percentage points over 1977 to 2008. This subtracts -6.2 percentage points from the long run consumption to income ratio. Finally, a falling

<sup>56</sup>Note that the long run impacts do not sum to the total change in  $\log(c/y)_t$  due to the unexplained variation and short run dynamics (for example,  $\Delta_8 \log ue$  can be negative for long periods although it is I(0) across the full sample).

proportion of (typically high-saving) young households aged 22-34 years in the population contributes 3.7 percentage points to the rise in the long run consumption to income ratio.

The apparent "excess smoothness" of consumption relative to current income is resolved by the use of an explicit income forecasting model within the solved out consumption equation. Since trend reversion plays a key role in the income forecasting model, real per capita non-property income is clearly far from a random walk. The influence of permanent income on consumption explains much of the greater smoothness in consumption compared with current income (Chart 3). Moreover, the increased importance of permanent income in the model as credit markets are liberalised helps explain the reduction in the standard deviation of consumption growth across the sample.

The graphical decompositions in Charts 14 and 15 illuminate, like actors entering and exiting the stage, the decade to decade partial equilibrium influences on the consumption to income ratio. Age demography (the increase in the proportion of young households) for example depresses consumption in the late 1970s and early 1980s but contributes thereafter and especially so between about 1995 and 2002. The pattern broadly follows the aging of the post-WWII "baby-boomer" generation as predicted. Easing credit conditions, acting directly through the downpayment constraint, raise consumption during the 1980s and again from 1998 to 2007. A lull from 1992 to 1998 reflects post-recession capital consolidation by Australia's banking sector. FLIB also relaxes the housing collateral constraint (especially on older households) which contributes to strong housing collateral effects after 1998 (the now investor-aged "baby boomers" again).<sup>57</sup> In addition, optimistic income expectations boost consumption from around 1991 to 1995 and from 1997 to 2006. Illiquid financial assets provide a small but steadily increasing contribution.

Offsetting these positive influences, the rising indebtedness of households leads net liquid assets to become a significant dampener on consumption from about 1994. Positive real interest rates maintain a dampening impact on the consumption to income ratio for most of the sample period. The exception is the period from 2001-2004 during which real interest rates fell precipitously as monetary policy responded to the technology stock crash and September 11 attacks. Many commentators have suggested that global interest rates were too low during this period and may have contributed to the severity of the subsequent financial crisis. The results of this paper provide some support for the first part of that assessment. That is, in light of the significant positive influences already operating on consumption across 2001-2004 - easy credit conditions, booming house prices and highly optimistic income expectations - Australian real interest rates do appear to have been unnecessarily expansionary. That said, the RBA maintained higher official rates than in the US and tightened policy settings earlier. Sound financial regulation and banking practices further ensured Australia avoided the worst excesses of the sub-prime boom and bust.<sup>58</sup>

## 10 Conclusion

The 2007-09 "credit crunch" and global financial crisis provide the sobering lesson that changes in credit supply conditions can have real and manifold effects on household behaviour beyond those implied by traditional interest rate channels. The introduction of a credit conditions measure in a solved out consumption function delivers a cointegrated solution over a long sample, explains parameters shifts in key variables, and shows a significant post-FLIB housing collateral effect. An equilibrium correction model using quarterly data from 1977 to 2008 demonstrates that previous mixed evidence on these matters may be the result of omitted controls. Additional features that improve the model include non-property income, explicit models of households' income forecasts, income uncertainty, variable real interest rates and heterogenous wealth effects.

The relaxation of the downpayment constraint facing young borrowers appears to directly increase the consumption to income ratio by about 14 percentage points across 1977-2008. The paper also

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<sup>57</sup>Of course this is a highly constrained credit conditions index consisting of only four split trends. A more sophisticated spline function for credit conditions might reveal more variation.

<sup>58</sup>See Debelle (2008, 2009).

elucidates an important role for housing collateral as credit markets are liberalised, but no housing wealth effect on consumption prior to FLIB. Long run wealth MPCs are estimated at around 0.06 for housing assets (at the peak of access to credit), 0.01 for illiquid assets (although this is difficult to estimate) and 0.20 for net liquid assets. Other relevant long run influences are the real interest rate, household income expectations and growth in the proportion of young households.

The improvements in the final model demonstrate the merits of adopting a more flexible representation of credit conditions (compared to models using the credit conditions index as estimated in the house price model of Williams (2009)). The way forward therefore is to combine the consumption model with models of house prices, mortgage credit and housing equity withdrawal. Conditioning on the extra information provided by these models should enable a more flexible representation of the credit conditions index and more accurate estimation of the long run parameters (particularly the wealth MPCs). Furthermore, the conditional consumption model developed in this paper could be incorporated within a larger, structural model used by policy-makers. This paper hopefully provides a useful step in that direction.

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## Attachment A: Charts and tables

Chart 1 : Consumption to income ratios

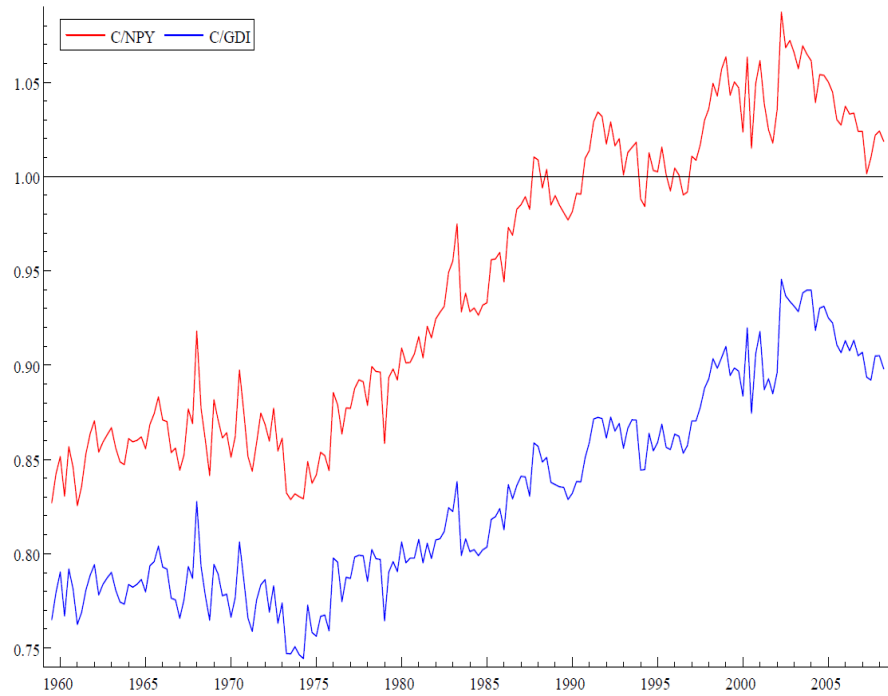
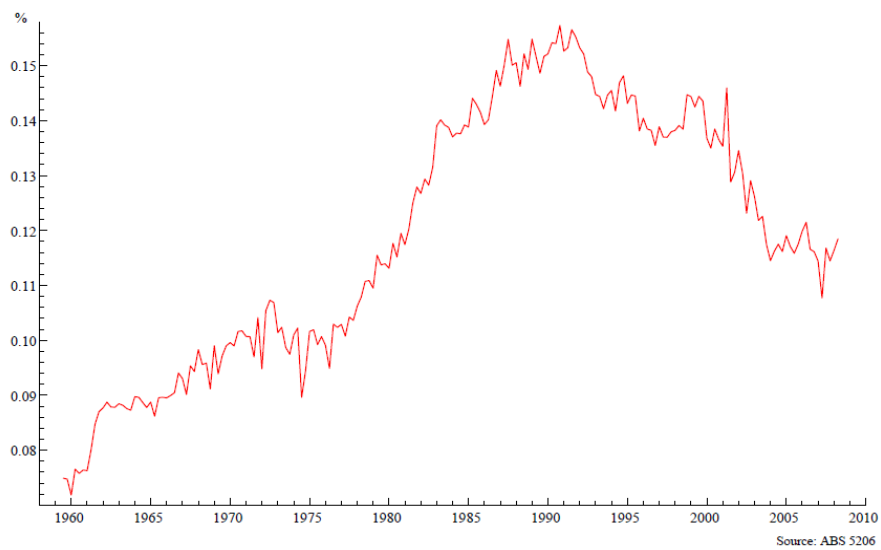
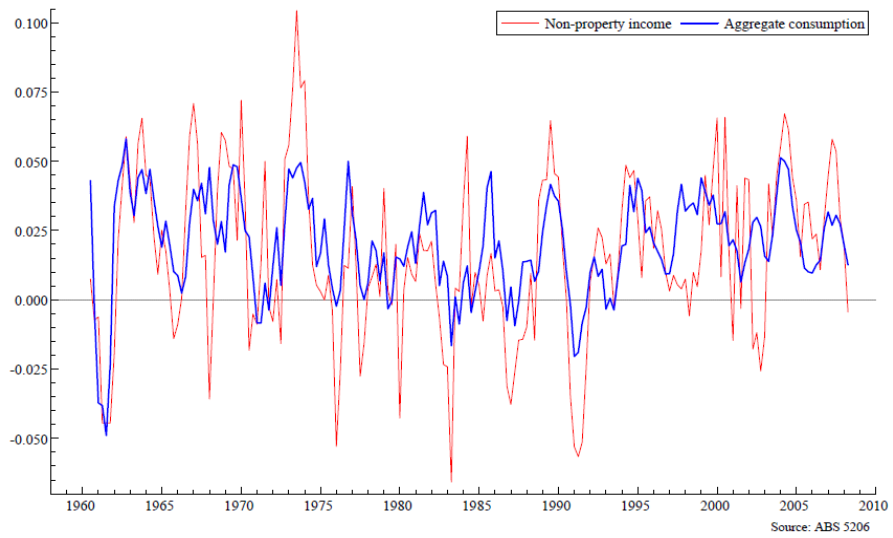


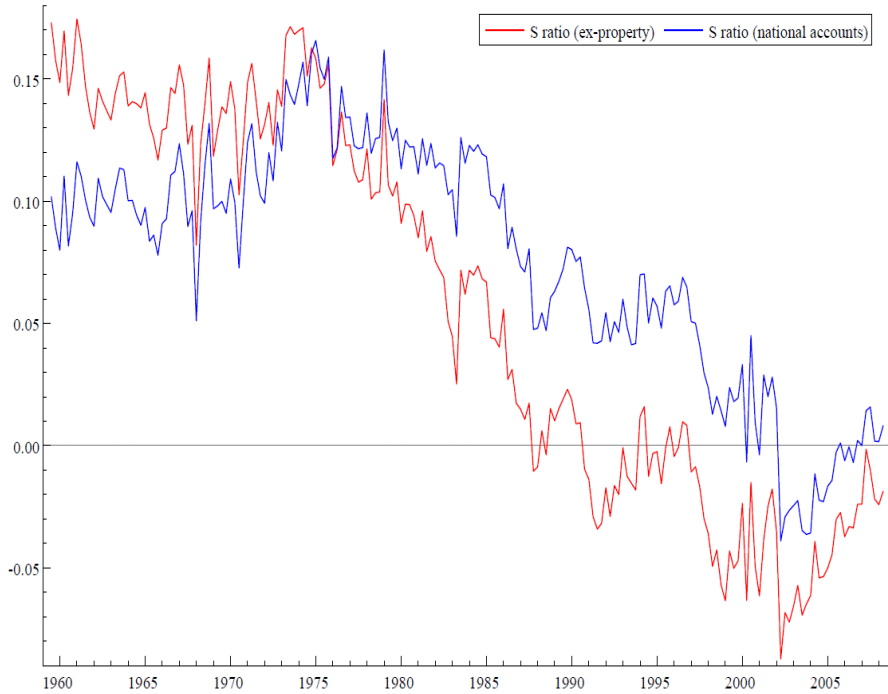
Chart 2 : Property income  
(percentage of gross household disposable income)



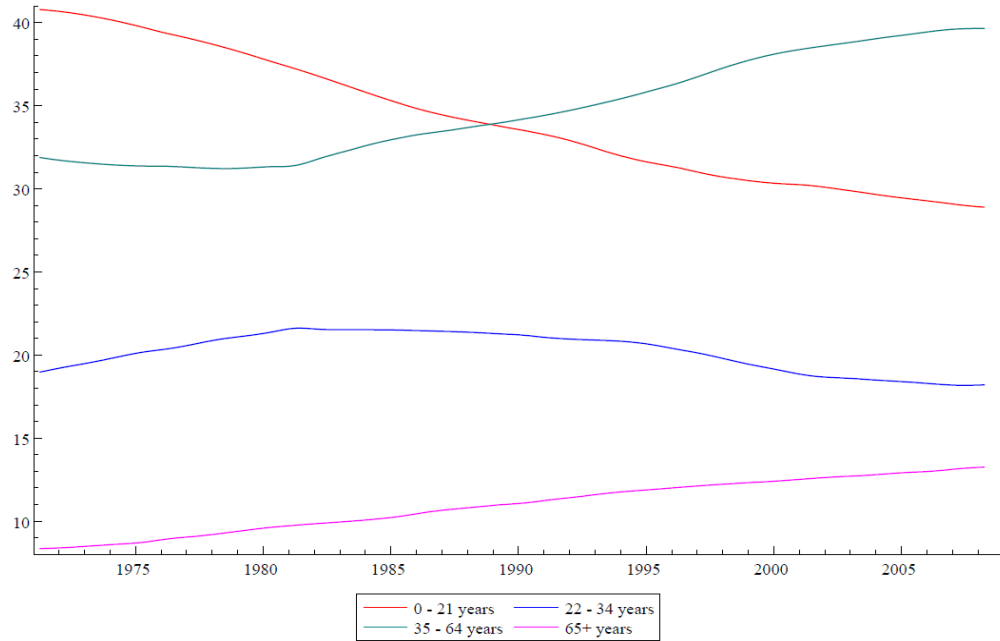
**Chart 3 : Aggregate consumption and non-property income**  
(per capita, annual percentage change)



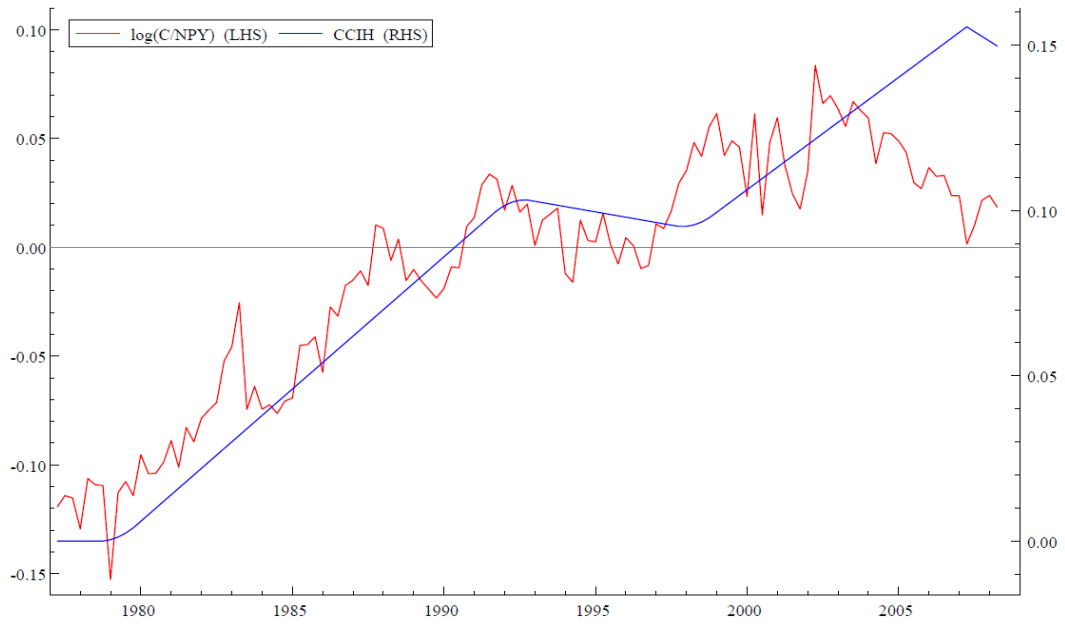
**Chart 4 : Savings ratios**



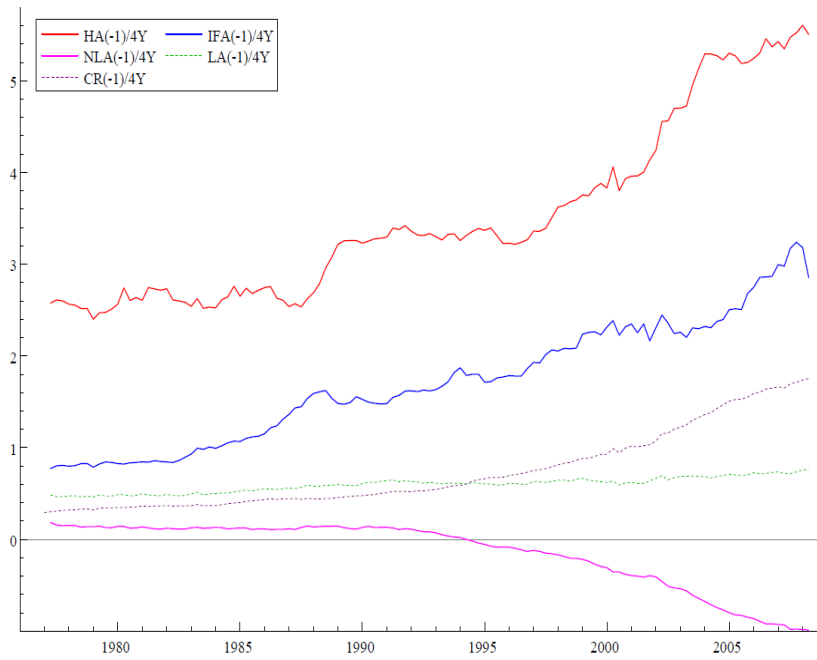
**Chart 5 : Demographics**  
(age groups as a proportion of population)



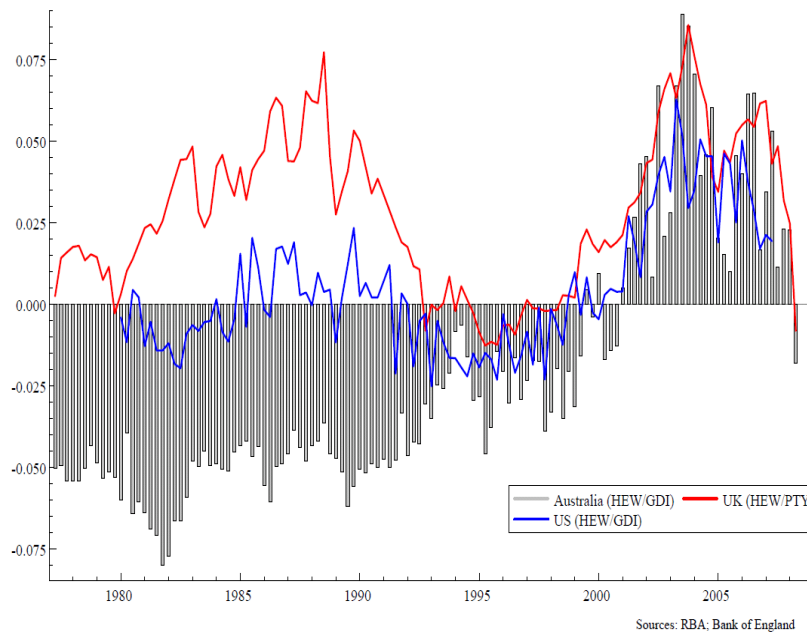
**Chart 6 :  $\log(C/NPY)$  and the credit conditions index**



**Chart 7 : Household net worth**  
(relative to annualised non-property income)



**Chart 8 : Housing equity withdrawal**  
(HEW to household GDI)<sup>59</sup>



Sources: RBA; Bank of England

<sup>59</sup>UK income measure is post-tax income.

Chart 9 : Permanent income  $k = 12$   
( $\Delta \log y_{m+12}$ )

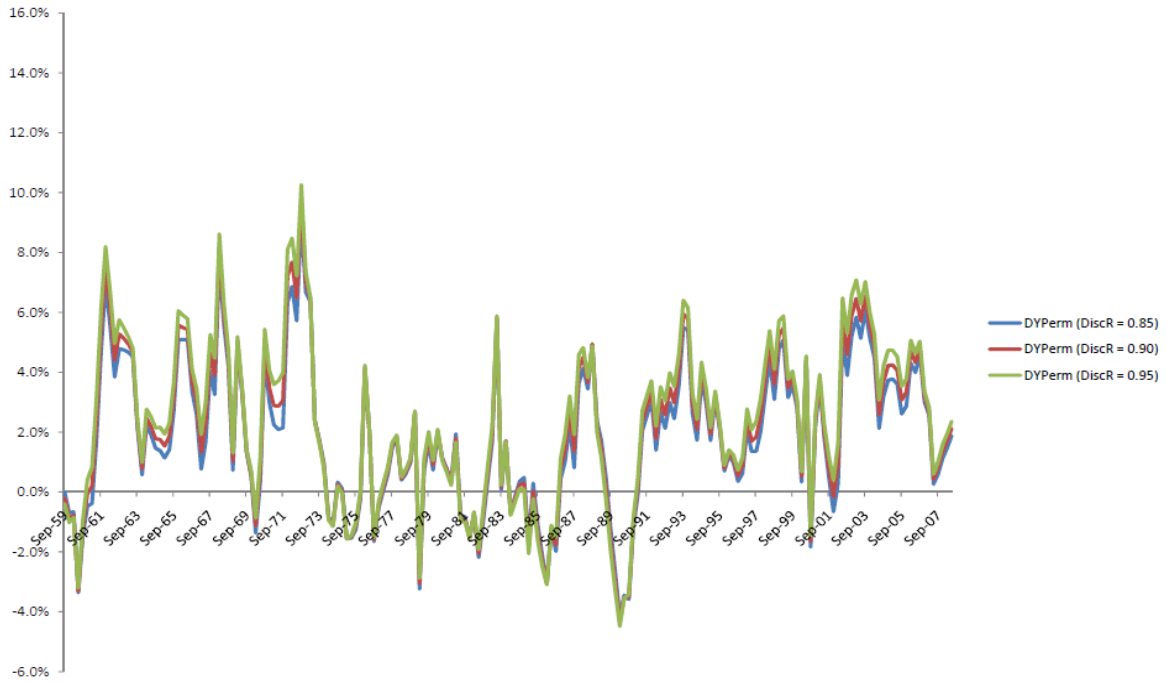
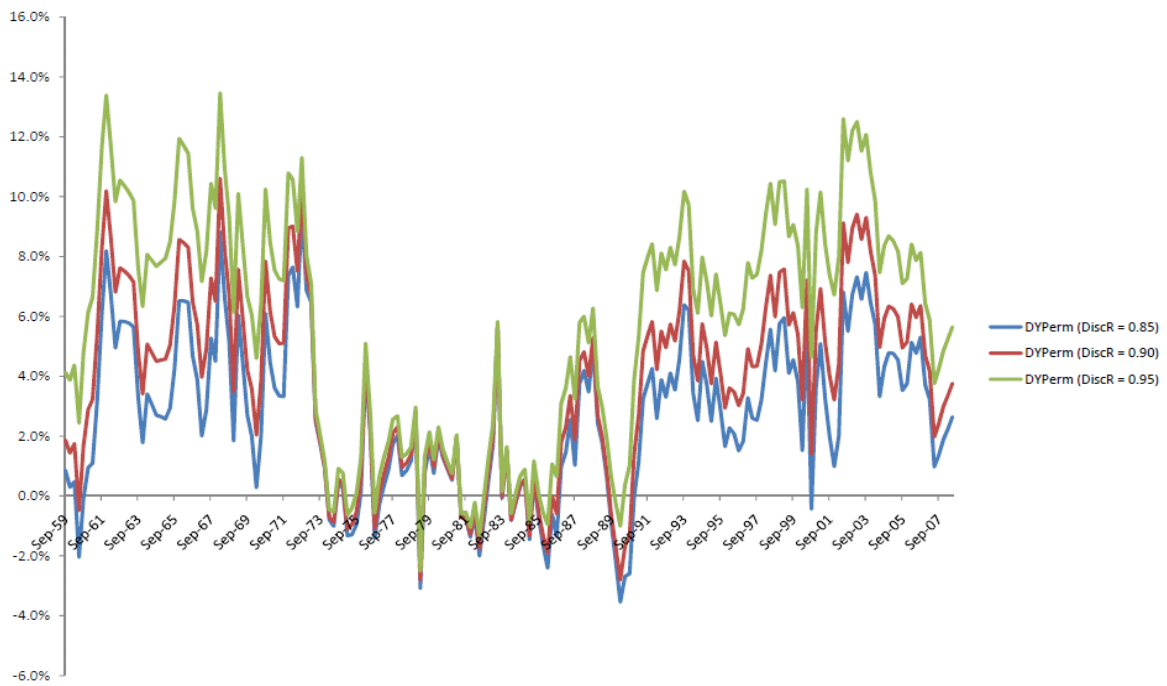
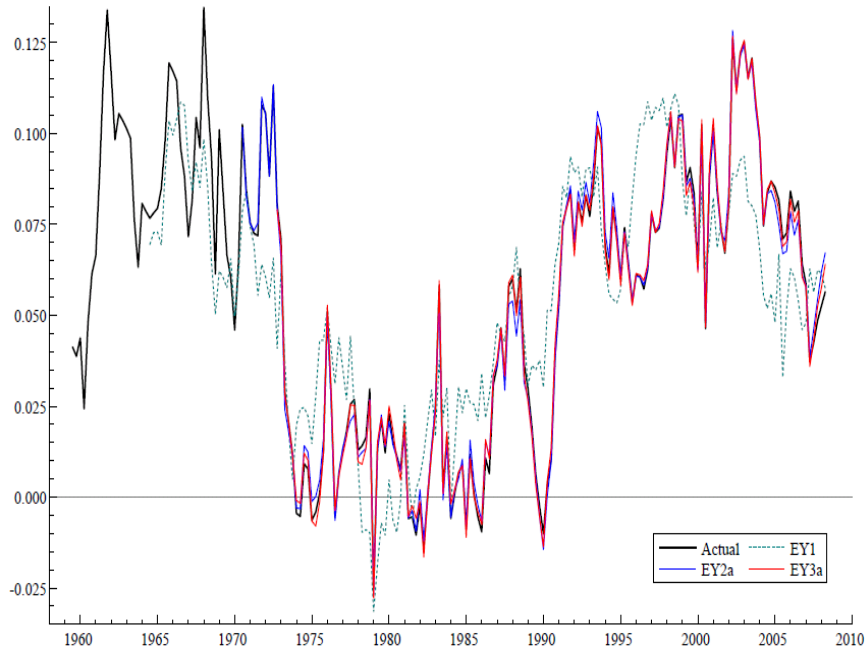


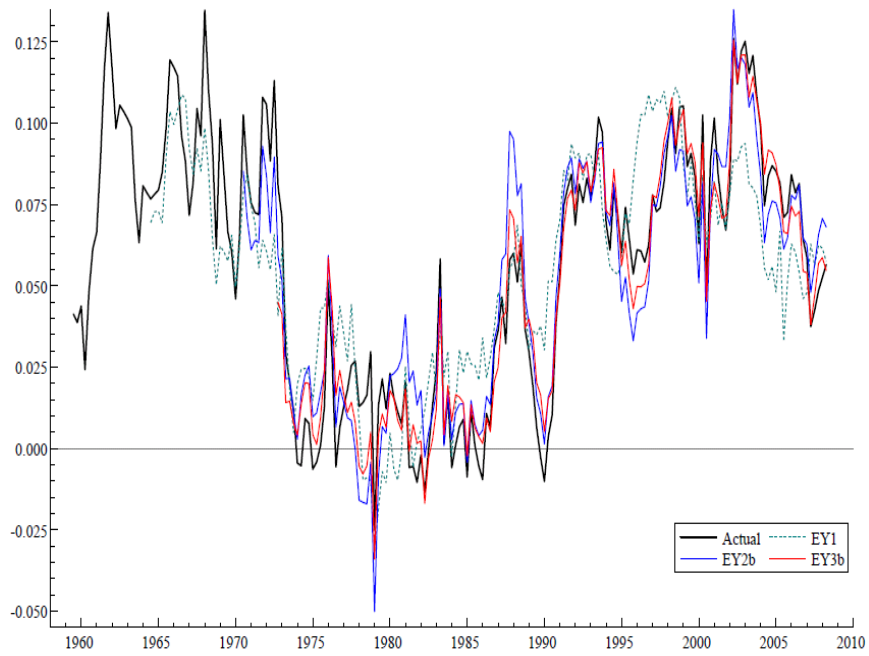
Chart 10 : Permanent income  $k = 40$   
( $\Delta \log y_{m+40}$ )



**Chart 11 : Income expectations**  
( $E_t \Delta \log y_{m+40}$ )



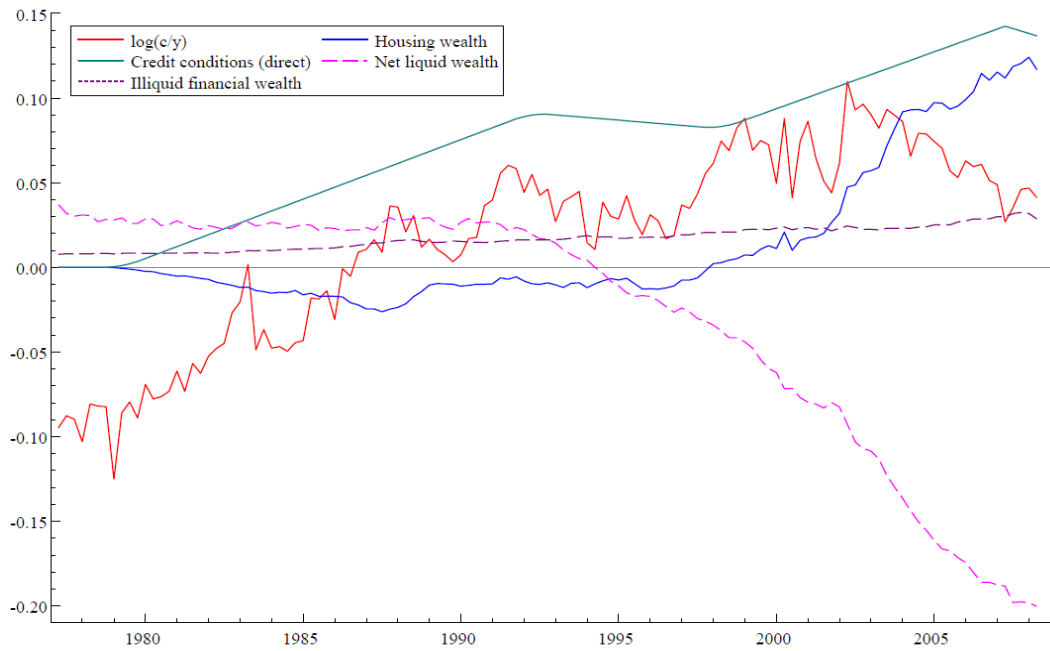
**Chart 12 : Income expectations (cont.)**  
( $E_t \Delta \log y_{m+40}$ )



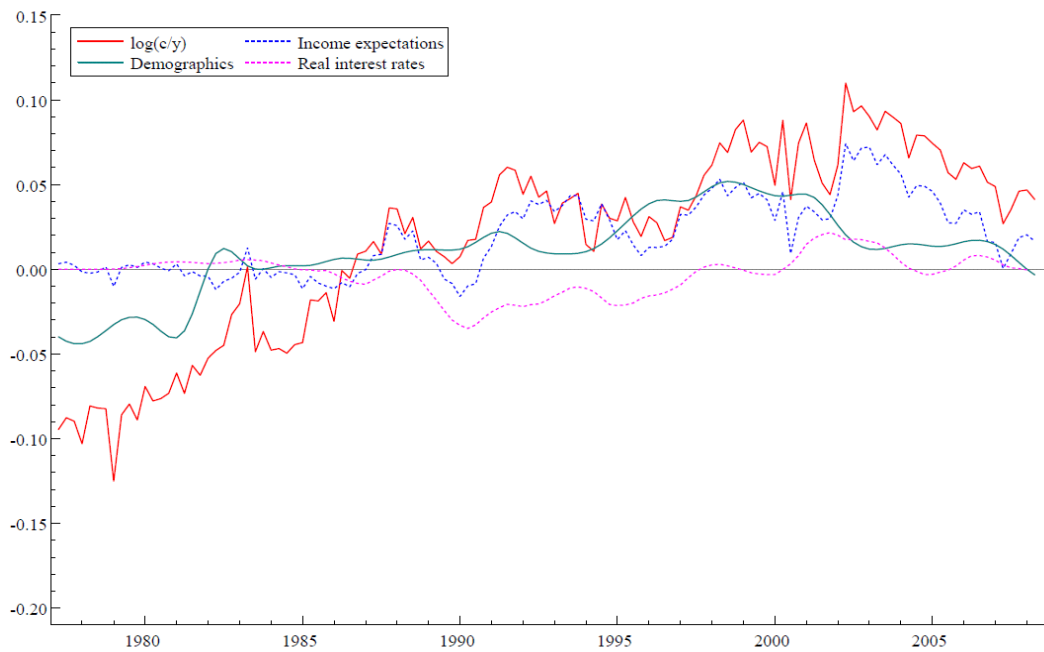
**Chart 13 : Recursive estimates of  $\hat{\lambda}$**   
(non-durable consumption)



**Chart 14 : Conditional long run impacts on the consumption to income ratio<sup>60</sup>**  
(based on Model 13)



**Chart 15 : Conditional long run impacts on the consumption to income ratio (cont.)**  
(based on Model 13)



<sup>60</sup>Note that Charts 14 and 15 show the de-meaned contributions from the interaction terms:  $\alpha(x - \text{mean}(x)) \times CCIH_t$  where  $\alpha$  is the long run coefficient and  $x$  is either  $HA_{t-1}/4Y_t$ ,  $E_t \Delta \log y_{t+k}$  or  $posr_{t-1}(ma4)$ .

**Table 1 : Income expectations***Dependent var =  $\Delta \log y_{m+40}$* 

	<b>Naive (EY1)</b> <i>1964(3)-2008(2)</i>		<b>Basic (EY2a)</b> <i>1964(3)-2008(2)</i>		<b>Sophist. (EY3a)</b> <i>1972(2)-2008(2)</i>	
<i>Constant</i>	-3.3302***	(0.3803)	-6.1778***	(0.1623)	-5.7663***	(0.0798)
<i>log y<sub>t</sub></i>	-0.5841***	(0.0659)	-1.0764***	(0.0275)	-1.0831***	(0.0129)
<i>Δ<sub>4</sub> log y<sub>t</sub></i>	0.2950***	(0.0839)	0.0723***	(0.0199)		
<i>Δ<sub>4</sub> log y<sub>t-4</sub></i>	0.5126***	(0.0939)				
<i>Δ<sub>4</sub> log y<sub>t-8</sub></i>	0.5967***	(0.1009)				
<i>Δ<sub>4</sub> log y<sub>t-12</sub></i>	0.6255***	(0.1027)				
<i>Δ<sub>4</sub> log y<sub>t-16</sub></i>	0.4890***	(0.0710)				
<i>trend</i>	0.0020***	(0.0002)	0.0059***	(0.0003)	0.0009***	(0.0000)
<i>split72(4)</i>			-0.0049***	(0.0003)		
<i>split90(2)</i>			0.0046***	(0.0001)	0.0044***	(0.0000)
<i>r<sub>t</sub>(ma4)</i>			-0.0355	(0.0330)	-0.1388***	(0.0249)
<i>log p<sub>t-1</sub><sup>h</sup>(ma4)</i>			0.0501***	(0.0075)	0.0851***	(0.0043)
<i>log rer<sub>t-1</sub>(ma4)</i>					-0.0381***	(0.0046)
<i>Δ<sub>4</sub> log p<sub>t-1</sub><sup>h</sup></i>			0.0235***	(0.0122)		
<i>Δ<sub>8</sub> log tot<sub>t-1</sub></i>					0.0242***	(0.0057)
<i>(BS/GDP)<sub>t-1</sub></i>					0.1099***	(0.0198)
<i>\$Adum × (BS/GDP)<sub>t-1</sub></i>					-0.1238***	(0.0355)
<i>drought<sub>t+4</sub>(ma4)</i>					-0.0046***	(0.0012)
Standard error	0.0227926		0.0041851		0.00230572	
R <sup>2</sup>	0.67486		0.989103		0.996651	
Normality ( <i>p-value</i> )	0.1303		0.1774		0.2683	
RESET ( <i>p-value</i> )	0.9999		0.3182		0.7477	

**Table 2 : Income expectations (cont.)***Dependent var =  $\Delta \log y_{m+40}$* 

	<b>Basic (EY2b)</b> <i>1964(3)-2008(2)</i>		<b>Sophist. (EY3b)</b> <i>1972(4)-2008(2)</i>	
<i>Constant</i>	-5.4496***	(0.5433)	-4.7484***	(0.0683)
$\log y_t$	-0.9075***	(0.0901)	-0.8259***	(0.0683)
<i>trend</i>	0.0020***	(0.0002)	0.0021***	(0.0002)
$r_t(ma4)$	-1.3347***	(0.2557)	-1.6021***	(0.2191)
$r10TB_t(ma4)$	0.5015**	(0.2473)	0.8004***	(0.2259)
$\log p_{t-1}^h(ma4)$	0.1589***	(0.0332)	0.1797***	(0.0263)
$\log s_{t-1}(ma4)$	0.0803***	(0.0121)	0.0342**	(0.0144)
$\Delta_4 \log s_{t-1}$	0.0135***	(0.0121)	0.0183**	(0.0074)
$\Delta_4 \log i_t$	0.0530***	(0.0182)	-0.0398***	(0.0140)
$\Delta_4 \log usgdp_{t-1}$			0.1705*	(0.0906)
$\log oil_{t-1}(ma4)$			-0.0271***	(0.0053)
$(BS/GDP)_{t-1}$			0.1317	(0.1002)
Standard error	0.0148764		0.0105141	
R <sup>2</sup>	0.860262		0.930353	
Normality ( <i>p-value</i> )	0.7613		0.0353	
RESET ( <i>p-value</i> )	0.0607		0.5417	

**Table 3 : Euler equations with excess sensitivity**

1973(1) – 2008(2)

	<b>(i)</b> <i>Dep var = <math>\Delta \log c_t</math></i>		<b>(ii)</b> <i>Dep var = <math>\Delta \log c_t^{nd}</math></i>		<b>(iii)</b> <i>Dep var = <math>\Delta \log c_t^{nd}</math></i>	
<i>Constant</i>	0.0030***	(0.0009)	0.0034***	(0.0008)	0.0042***	(0.0011)
$\Delta \log \hat{y}_t$	0.4788***	(0.1571)	0.4012***	(0.1397)	0.4004***	(0.1394)
$r_{t-2}(ma4)$					-0.0194	(0.0172)
Std error	0.00893849		0.00794626		0.00793146	

**Table 4 : "Classical" consumption model**

*Dependent var =  $\Delta \log c_t$*

1977(2) – 2008(2)

	(1)		(2)		(3)	
<i>Constant</i>	-0.0057	(0.0049)	-0.0064	(0.0044)	-0.0074**	(0.0034)
$\log(y_t/c_{t-1})$	0.0452*	(0.0253)	0.0669***	(0.0226)	0.0867***	(0.0225)
$A_{t-1}/4y_t$	0.0017*	(0.0009)	0.0015*	(0.0009)	0.0014**	(0.0007)
$EY1_t$	0.0341	(0.0316)				
$EY2b_t$			0.0737***	(0.0282)		
$EY3b_t$					0.1046***	(0.0327)
$\Delta \log y_t$	0.1198***	(0.0328)	0.1300***	(0.0315)	0.1186***	(0.0300)
Std error	0.0063297		0.00622068		0.0061079	
R <sup>2</sup>	0.151584		0.180557		0.210001	
<i>p-values:</i>						
AR 1-5	0.8717		0.7712		0.7574	
ARCH 1-4	0.6705		0.0998		0.0094	
Normality	0.9393		0.7731		0.8742	
Hetero	0.4700		0.0146		0.0006	
RESET	0.3896		0.2474		0.5174	

**Table 5 : Augmented "classical" consumption model**

*Dependent var =  $\Delta \log c_t$*   
 1977(2) – 2008(2)

	(4)	(5)	(6)
<i>Constant</i>	0.0000 (0.0039)	-0.0050 (0.0050)	-0.0088** (0.0040)
$\log(y_t/c_{t-1})$	0.0252 (0.0224)	0.0793** (0.0306)	0.1275*** (0.0269)
$A_{t-1}/4y_t$	0.0011 (0.0007)	0.0012 (0.0008)	0.0011* (0.0006)
$EY1_t$	0.0007 (0.0342)		
$EY2b_t$		0.0763** (0.0300)	
$EY3b_t$			0.1419*** (0.0348)
$\Delta \log y_t$	0.1237*** (0.0298)	0.1243*** (0.0305)	0.1068*** (0.0294)
$r_{t-1}(ma4)$	-0.0248 (0.0258)	0.0031 (0.0254)	0.0272 (0.0220)
$\Delta_8 \log ue_{t-1}$	-0.0117*** (0.0024)	-0.0119*** (0.0025)	-0.0120*** (0.0028)
$\Delta_4 \log i_{t-1}CR_{t-1}/4y_t$	-0.0227*** (0.0065)	-0.0156*** (0.0057)	-0.0091 (0.0066)
Std error	0.0059962	0.00591042	0.00576057
R <sup>2</sup>	0.257666	0.278754	0.314832
<i>p-values:</i>			
AR 1-5	0.3602	0.4417	0.4384
ARCH 1-4	0.6050	0.4329	0.1015
Normality	0.6625	0.5819	0.5543
Hetero	0.3993	0.1673	0.0355
RESET	0.5816	0.7127	0.9739

**Table 6 : Wealth MPCs across countries**  
(range of estimates)**Total wealth**

Australia	0.02 - 0.05
US	0.03 - 0.07
Canada	0.05 - 0.08
UK	0.02 - 0.04

**Stock market wealth**

Australia	0.04 - 0.16
US	0.03 - 0.075
Canada	0.045 - 0.08
UK	0.04 - 0.045

**Housing wealth**

Australia	insignificant
US	0.03 - 0.05
Canada	n/a
UK	0.02 - 0.08

Source: Dvornak and Kohler (2007)

**Table 7 : Consumption model with disaggregated wealth**

*Dependent var =  $\Delta \log c_t$*

1977(2) – 2008(2)

	(7)	(8)	(9)
<i>Constant</i>	-0.0189** (0.0076)	-0.0183** (0.0083)	-0.0210** (0.0085)
$\log(y_t/c_{t-1})$	0.0751** (0.0298)	0.1210*** (0.0283)	0.0831*** (0.0271)
$HA_{t-1}/4y_t$	0.0052** (0.0023)	0.0040* (0.0023)	0.0055** (0.0024)
$IFA_{t-1}/4y_t$	0.0038 (0.0033)	0.0030 (0.0031)	0.0043 (0.0032)
$NLA_{t-1}/4y_t$	0.0158** (0.0070)	0.0114 (0.0077)	0.0172*** (0.0076)
$EY2b_t$	0.0583* (0.0307)		
$EY3b_t$		0.1245*** (0.0363)	
$\Delta \log ym_{40}$			0.0624** (0.0304)
$\Delta \log y_t$	0.1198*** (0.0315)	0.1057*** (0.0302)	0.1168*** (0.0310)
$r_{t-1}(ma4)$	-0.0322 (0.0353)	0.0006 (0.0324)	-0.0265 (0.0333)
$\Delta_8 \log ue_{t-1}$	-0.0118*** (0.0028)	-0.0119*** (0.0030)	-0.0123*** (0.0030)
$\Delta_4 \log i_{t-1}CR_{t-1}/4y_t$	0.0133** (0.0063)	-0.0079 (0.0069)	-0.0145** (0.0058)
Std error	0.00589781	0.00577956	0.00587257
R <sup>2</sup>	0.294105	0.322126	0.300134
<i>p-values:</i>			
AR 1-5	0.4121	0.3908	0.4399
ARCH 1-4	0.2226	0.0505	0.0520
Normality	0.5727	0.4921	0.8357
Hetero	0.3202	0.1294	0.2841
RESET	0.7918	0.9115	0.8843

**Table 8 : Consumption model with credit conditions<sup>61</sup>**

*Dependent var =  $\Delta \log c_t$*   
1977(2) – 2008(2)

		(10)	(11)	(12)
<i>Constant</i>	$\alpha_0$	-0.0608*** (0.0121)	-0.0641*** (0.0116)	-0.0750*** (0.0093)
$\log(y_t/c_{t-1})$	$\phi$	0.1830*** (0.0362)	0.1809*** (0.0371)	0.2112*** (0.0377)
<i>CCIH intercept</i>	$\zeta$	0.9398*** (0.2015)	1.0376*** (0.1849)	1.1526*** (0.1553)
$posr_{t-1}(ma4) \times CCIH_t$	$\alpha_1$	-7.4464*** (2.8300)	-8.9502*** (2.7454)	-9.0173*** (2.2454)
$HA_{t-1}/4y_t \times CCIH_t$	$\gamma_1$	0.5265*** (0.1719)	0.4649*** (0.1709)	0.4711*** (0.1435)
$IFA_{t-1}/4y_t$	$\gamma_2$	set to 0.01	set to 0.01	set to 0.01
$NLA_{t-1}/4y_t$	$\gamma_3$	0.2447*** (0.0593)	0.2318*** (0.0594)	0.2439*** (0.0500)
$EY2b_t \times CCIH_t$	$\psi_1$	7.6733*** (1.5442)		
$EY3b_t \times CCIH_t$	$\psi_1$		6.5547*** (1.2945)	
$\Delta \log y_{m+40} \times CCIH_t$	$\psi_1$			6.2603*** (1.0304)
$\Delta_4 DEMFTB_t$	$\alpha_3$	-0.1923*** (0.0418)	-0.1514*** (0.0403)	-0.1529*** (0.0343)
$\Delta \log y_t$	$\beta_1$	0.0735** (0.0329)	0.0516 (0.0333)	0.0457 (0.0329)
$\Delta_8 \log ue_{t-1}$	$\beta_2$	-0.0143*** (0.0027)	-0.0165*** (0.0025)	-0.0132*** (0.0025)
<i>dum78(2)</i>		0.0206*** (0.0052)	0.0197*** (0.0051)	0.0199*** (0.0051)
<i>dum86(1)</i>		-0.0177*** (0.0051)	-0.0171*** (0.0050)	-0.0171*** (0.0050)
<i><math>\zeta CCIH</math> max value</i>		0.1408	0.1554	0.1727
Std error		0.00499633	0.00491554	0.00489312
Adj R <sup>2</sup>		0.461320	0.479192	0.483347
DW		1.98969	2.06168	2.02428

<sup>61</sup>The estimated equation is:

$$\begin{aligned} \Delta \log c_t \approx & \phi(\alpha_0 + \zeta CCIH_t + CCIH_t \times \alpha_1(posr(ma4)_{t-1} - 0.0563) + CCIH_t \times \gamma_1(HA_{t-1}/4y_t - 3.5636) \\ & + \gamma_2 IFA_{t-1}/4y_t + \gamma_3 NLA_{t-1}/4y_t + CCIH_t \times \psi_1(E_t \Delta y_{m+40} - 0.0539) + \alpha_3 \Delta_4 DEMFTB_t \\ & + \log y_t - \log c_{t-1}) + \beta_1 \Delta \log y_t + \beta_2 \Delta_8 \log ue_{t-1} + dummies_t + \varepsilon_t \end{aligned}$$

$$\begin{aligned} CCIH_t = & \varphi_1 split79(ma4)_t - \varphi_2 split92(ma4)_t + \varphi_3(split98(ma4) - 1.5split07)_t \\ \varphi_1 = & 0.0020; \quad \varphi_2 = 0.0024; \quad \varphi_3 = 0.0021 \end{aligned}$$

**Table 9 : ADF tests on long run equation residuals**  
 1977(2) – 2008(2)

	<b>Lags (<i>s</i>)</b>	<b>t-adf stat</b>	<b>Order</b>
Long run equation 1	1	-2.784	I(1)
Long run equation 2	2	-3.103**	I(0)
Long run equation 3	0	-2.293	I(1)
Long run equation 4	1	-2.639	I(1)
Long run equation 5	0	-2.322	I(1)
Long run equation 6	0	-2.805	I(1)
Long run equation 7	0	-2.300	I(1)
Long run equation 8	0	-2.794	I(1)
Long run equation 9	0	-2.356	I(1)
Long run equation 10	0	-3.688***	I(0)
Long run equation 11	0	-3.839***	I(0)
Long run equation 12	0	-3.673***	I(0)

**Table 10 : Consumption model with credit conditions (cont.)**<sup>62</sup>

Dependent var =  $\Delta \log c_t$   
1977(2) – 2008(2)

(13)

<i>Constant</i>	$\alpha_0$	-0.0715***	(0.0110)
$\log(y_t/c_{t-1})$	$\phi$	0.2291***	(0.0425)
<i>split79(ma4)</i>	$\varphi_1$	0.0018***	(0.0005)
<i>split92(ma4)</i>	$\varphi_2$	-0.0021*	(0.0012)
<i>split98(ma4) – 1.5split07</i>	$\varphi_3$	0.0021***	(0.0008)
<i>posr</i> <sub>t-1</sub> ( <i>ma4</i> ) $\times$ <i>CCIH</i> <sub>t</sub>	$\alpha_1$	-8.1368***	(2.6806)
<i>HA</i> <sub>t-1</sub> / <i>4y</i> <sub>t</sub> $\times$ <i>CCIH</i> <sub>t</sub>	$\gamma_1$	0.4401**	(0.2101)
<i>IFA</i> <sub>t-1</sub> / <i>4y</i> <sub>t</sub>	$\gamma_2$	set to 0.01	
<i>NLA</i> <sub>t-1</sub> / <i>4y</i> <sub>t</sub>	$\gamma_3$	0.2020***	(0.0502)
<i>EY3b</i> <sub>t</sub>	$\psi_1$	4.7990**	(2.1386)
	$\psi_{\max}$	set to 0.95	
$\Delta_4$ <i>DEMFTB</i> <sub>t</sub>	$\alpha_3$	-0.1458***	(0.0346)
$\Delta \log y_t$	$\beta_1$	0.0412	(0.0331)
$\Delta_8 \log ue_{t-1}$	$\beta_2$	-0.0133***	(0.0026)
<i>dum78</i> (2)		0.0202***	(0.0051)
<i>dum86</i> (1)		-0.0166***	(0.0050)
<i>CCIH max value</i>		0.1367	
Std error		0.00482709	
Adj R <sup>2</sup>		0.497196	
DW		2.10644	

**Table 11 : Conditional long run impacts 1977 – 2008**

(percentage points; based on Model 13)<sup>63</sup>

Credit conditions (downpayment effect)	13.7
Real interest rates	-6.2
Illiquid financial wealth	2.1
Net liquid wealth	-23.7
Housing wealth (collateral effect)	17.6
Income expectations	4.9
Demographics	3.7
<b>Total <math>\log(c/y)_t</math> increase</b>	<b>13.6</b>

<sup>62</sup>The estimated equation is:

$$\begin{aligned} \Delta \log c_t \approx & \phi(\alpha_0 + CCIH_t + CCIH_t \times \alpha_1(posr(ma4)_{t-1} - 0.0563) + CCIH_t \times \gamma_1(HA_{t-1}/4y_t - 3.5636) \\ & + \gamma_2 IFA_{t-1}/4y_t + \gamma_3 NLA_{t-1}/4y_t + \psi_0 E_t \Delta y_{t+40} + CCIH_t \times \psi_1 (E_t \Delta y_{t+40} - 0.0539) \\ & + \alpha_3 \Delta_4 DEMFTB_t + \log y_t - \log c_{t-1}) + \beta_1 \Delta \log y_t + \beta_2 \Delta_8 \log ue_{t-1} + dummies_t + \varepsilon_t \end{aligned}$$

$$CCIH_t = \varphi_1 split79(ma4)_t - \varphi_2 split92(ma4)_t + \varphi_3 (split98(ma4) - 1.5split07)_t$$

$$let \psi_{\max} = 0.95 = \psi_0 + \psi_1 CCIH_{\max} \implies \psi_0 = 0.95 - \hat{\psi}_1 CCIH_{\max} \approx 0.3$$

<sup>63</sup>Note that the long run impacts do not sum to the total change in  $\log(c/y)_t$  due to the unexplained variation and short run dynamics (for example,  $\Delta_8 \log ue$  can be negative for long periods although it is I(0) across the full sample).

## Attachment B: Descriptive statistics and unit root tests

**Table B1 : Means and standard deviations**  
1977(2) – 2008(2)

Variable	Mean	Std dev	Variable	Mean	Std dev
$\log c$	-5.2644	0.1696	$\log(y^p/y_t)$	0.0516	0.0379
$\Delta \log c$	0.0045	0.0068	<i>EY1</i>	0.0529	0.0340
$\log y$	-5.2806	0.1286	<i>EY2a</i>	0.0514	0.0380
$\Delta \log y$	0.0034	0.0164	<i>EY2b</i>	0.0518	0.0371
$r(ma4)$	0.0531	0.0277	<i>EY3a</i>	0.0515	0.0379
$posr(ma4)$	0.0534	0.0272	<i>EY3b</i>	0.0510	0.0376
$A_{-1}/4y$	5.0687	1.2439	<i>rhp</i>	0.8803	0.3118
$HA_{-1}/4y$	3.5076	0.9570	$\Delta_4 rhp$	0.0329	0.0620
$IFA_{-1}/4y$	1.7035	0.6575	<i>s</i>	4.3502	0.4236
$NLA_{-1}/4y$	-0.1424	0.3609	$\Delta_4 s$	0.0467	0.1702
<i>DEMFTB</i>	20.296	1.2230	<i>tot</i>	4.2623	0.1304
$\Delta_4 DEMFTB$	-0.0729	0.1650	$\Delta_8 tot$	0.0180	0.0957
$\log ue$	1.9462	0.2373	<i>rer</i>	4.7495	0.1344
$\Delta_8 \log ue$	-0.0072	0.2191	$\Delta_4 usgdp$	0.0299	0.0191
$\Delta_4 \log i$	-0.0038	0.1289	<i>BS/GDP</i>	-0.0038	0.0214
$\Delta_4 \log i_{-1} \times CR_{-1}/4y$	0.0003	0.0938	<i>oil</i>	3.9307	0.4055
<i>r10TB</i>	0.0462	0.0222			

Augmented Dickey and Fuller (1979, 1981) tests conducted in PcGive for the consumption and housing equity equations show all variables to be I(1) in levels and stationary in first differences.<sup>64</sup> The orders of integration for consumption and current income are non-trivial in the Euler equation framework since income persistence leads to the excess smoothness paradox which contradicts the REPIH (see Deaton (1988) and Section 4.1). The order of integration for current income is less important in the solved out consumption function because there is an explicit model of the income generating process (see Section 5).<sup>65</sup>

The integration order of the demographic variable is difficult to determine since *DEMFTB* is interpolated from 37 annual observations. Although the power of the ADF test is quite weak, *DEMFTB* appears to be I(2) as it is stationary after two differences.<sup>66</sup>

<sup>64</sup>The ADF model takes the form:

$$\Delta x_t = \alpha + (\beta - 1)x_{t-1} + \sum_{i=1}^s \gamma_i \Delta x_{t-i} + \varepsilon_t$$

where  $x$  is the relevant variable,  $s$  is the number of lags needed to whiten the residual and  $H_0 : \beta - 1 = 0$  is the ADF hypothesis test. Models for assets to income ratios also include a drift term. Setting  $s = 3$  constrains the sample to 1978(3) to 2008(2).

<sup>65</sup>Note, the reported ADF results for  $\log c$  and  $\log y$  are not sensitive to the inclusion of a trend. The ADF test statistics including a constant and a drift term are -1.498 for  $\log c$  (0 lags) and -1.045 for  $\log y$  (1 lag); and -10.51\*\*\* for  $\Delta \log c$  (0 lags) and -15.30\*\*\* for  $\Delta \log y$  (0 lags). The results confirm that consumption and income are I(1) in levels and stationary in differences.

<sup>66</sup>The ADF test statistics on the annual data are -1.497 for *DEMFTB* (1 lag), -2.039 for  $\Delta DEMFTB$  (0 lags) and -5.827\*\*\* for  $\Delta \Delta DEMFTB$  (0 lags).

**Table B2 : Unit root tests– variables in levels**  
1978(3) - 2008(2)

Variable	Lags ( <i>s</i> )	t-adf stat	Order
$\log c$	0	1.723	I(1)
$\log y$	1	1.602	I(1)
$r$	0	-2.047	I(1)
$\Delta \log ym_{+40}$	1	-1.917	I(1)
$\log ue$	2	-2.251	I(1)
$\log i$	2	-1.864	I(1)
$\log p^h$	1	0.7225	I(1)
$A_{-1}/4y$	1	-2.511	I(1)
$HA_{-1}/4y$	0	-1.397	I(1)
$IFA_{-1}/4y$	0	-3.049	I(1)
$NLA_{-1}/4y$	0	0.048	I(1)

**Table B3 : Unit root tests– variables in differences**  
1978(3) - 2008(2)

Variable	Lags ( <i>s</i> )	t-adf stat	Order
$\Delta \log c$	0	-10.21***	I(0)
$\Delta \log y$	0	-14.89***	I(0)
$\Delta r$	0	-10.79***	I(0)
$\Delta(\Delta \log ym_{+40})$	0	-15.35***	I(0)
$\Delta \log ue$	1	-3.838***	I(0)
$\Delta \log i$	1	-3.970***	I(0)
$\Delta \log p^h$	0	-6.756***	I(0)
$\Delta(A_{-1}/4y)$	0	-12.37***	I(0)
$\Delta(HA_{-1}/4y)$	1	-5.813***	I(0)
$\Delta(IFA_{-1}/4y)$	0	-9.789***	I(0)
$\Delta(NLA_{-1}/4y)$	0	-9.254***	I(0)

## Attachment C: Data sources and construction

### Real aggregate consumption

*Source:* ABS 5206-08

*Frequency:* Quarterly, SQ1959 -; seasonally adjusted

*Alternatives:*

(i) Non-durables consumption: exclude "Clothing and footwear", "Purchase of vehicles" and "Furnishings and household equipment"

(ii) Non-housing consumption: exclude "Rent and other dwelling services"

(iii) Non-durables and non-housing: exclude above categories.

### Household gross disposable income

*Source:* ABS 5206-14

*Frequency:* Quarterly, SQ1959 -, seasonally adjusted

*Problems:* See Blinder and Deaton (1985)

*Alternatives:* Non-property household gross disposable income (see below)

### Non-property household gross disposable income

*Construction:* See Williams (2009).

*Problems:* Need to proxy for property tax payable and deduct from non-property income receivable.

### Consumer prices ( $p$ )

*Source:* Household consumption implicit price deflator: ABS 5206-08.

*Description:* Seasonally adjusted.

*Frequency:* Quarterly, SQ1959 -

*Problems:* Standard Paasche price index criticisms.

*Alternatives:* Consumer price index; alternative CPI measures (for example, ex-housing, ex-volatile items, trimmed mean etc) but these are subject to the standard Laspeyres price index criticisms (constant basket understates impact of falling import prices, substitution effects and quality improvements).

### Australian house prices

*Sources:* Australian Bureau of Statistics (ABS) (new method); MQ2002 -

ABS (old method); SQ1986 - DQ2001

Real Estate Institute of Australia (REIA); SQ1978 -

BIS Shrapnel (sourced from Treasury); MQ1959 -

*Description:* Composite national house price series splices data as follow: 1972(3)-1978(2) (BIS Shrapnel); 1978(3)-1986(1) (REIA); 1986(2)-2001(4) (ABS old method); 2002(1)-2008(2) (ABS new method).

*Frequency:* Quarterly, not seasonally adjusted.

*Problems:* See Williams (2009), Abelson and Chung (2005) and RBA (2004).

### Nominal mortgage rate ( $i$ )

*Source:* RBA Bulletin Table F05; January 1959 -

*Frequency:* Monthly, quarterly series uses 3-month average, not seasonally adjusted

*Description:* Standard variable mortgage interest rate offered by banks.

*Problems:* Represents the interest rate contemporaneously offered by banks. It does not represent the average interest rate prevailing on the outstanding mortgage stock, nor does it directly incorporate interest rates offered by non-bank lenders.

*Alternatives:* This is the longest household mortgage interest rate series (see RBA F05). Alternative interest rates are below.

**Other interest rates**

*Source:* RBA Bulletin Table F02

10 year Treasury bond; July 1969 -

5 year Treasury bond; January 1972 -

3 year Treasury bond; June 1992 -

*Frequency:* monthly, uses 3-month average

*Source:* RBA Bulletin Table F01

90 day bank bill; monthly, June 1969 -

*Frequency:* monthly, uses 3-month average

**Real mortgage interest rate ( $r$ )**

*Construction:*  $r_t = i_t - \Delta_4 \log p_t$

**Stock of housing credit outstanding ( $HC$ )**

*Source:* RBA Bulletin Table D01, D02

*Frequency:* Monthly; August 1976 -; use end quarter value

*Construction:* Includes housing loans (including securitisations) to owner-occupiers and investors on the balance sheets of Australian Financial Institutions (AFIs) and non-AFIs. A time series is constructed using JQ2008 value from D02 (actual level) and back-casting growth rates from RBA D01 which are adjusted for structural breaks and reporting changes.

*Problems:* RBA credit data counts small business credit as part of business credit, whereas ABS national accounts data includes small businesses in the household sector. Credit data contain multiple structural breaks and reporting changes, see RBA Bulletin's *Notes to Tables*. RBA D01 provides growth rates for credit aggregates adjusted for these changes.

*Alternatives:* None

**Stock of other personal credit outstanding ( $OPC$ )**

*Source:* RBA Bulletin Table D01, D02 (includes securitisations)

*Frequency:* Monthly; August 1976 -; uses end quarter value

*Construction:* Personal loans outstanding on the balance sheets of AFIs (including securitisations).

*Problems:* RBA credit data counts small business credit as part of business credit, whereas ABS national accounts data treats includes small businesses in the household sector. Also, does not include personal loans from non-AFIs.

*Alternatives:* None

**Housing assets ( $HA$ )**

*Source:* RBA (unpublished)

*Frequency:* Quarterly, MQ1977 -

*Construction:* Nominal level, \$ billion.

*Problems:* Series is trend-like making identification difficult.

*Alternatives:* None

**Financial assets ( $FA$ )**

*Source:* RBA (unpublished)

*Frequency:* Annual 1977-1988; Quarterly (ABS is primary source) 1988 -

*Construction:* Nominal level, \$ billion. A cubic spline is used to interpolate the pre-1988 data.

*Problems:* Annual before 1988. Disaggregated data for liquid and non-liquid (for example, super-annuation assets) financial assets are not available and must be approximated. Direct and indirect equity holdings are not separately identifiable.

*Alternatives:* All ordinaries accumulation index includes price effects plus dividend reinvestment. Also, RBA Occasional Paper No.8 Table 3.25 provides "Financial Assets of the Household Sector" (annual data). However the data are not updated beyond 1997 and do not provide pre-1987 data on equities.

**Liquid assets (*LA*)**

*Source:* RBA Bulletin Table B20 (household deposits) and D03 (monetary aggregates: M3); ABS 5204-06 (factor income shares)

*Frequency:* Quarterly, JQ1988 onwards; pre-1988 data not available.

*Construction:* Series uses actual household deposits from JQ1988 and is spliced with quarterly M3  $\times$  household factor income share to create a longer time series.

*Problems:* No consistent household deposits data available before 1988. Financial assets series cannot separately identify a long series for money market funds, which may also perform a buffer stock savings role due to their high liquidity and low transaction costs.

*Alternatives:* RBA Occasional Paper No.8 Table 3.25 provides "Financial Assets of the Household Sector". Annual data is available on household "notes and coin" (1953-1997), "deposits with banks" (1957-1997); "deposits with building societies" (1962-1997); and deposits with "all non-bank deposit taking institutions". However, the series are not updated beyond 1997 and cannot be reconciled with RBA B20 data.

**Net liquid assets (*NLA*)**

*Construction:*  $NLA = LA - CR$ , where  $CR = HC + OPC$ . Measured in nominal terms, \$ billion.

*Problems:* No direct measure.

*Alternatives:* This depends on measure of *LA*. Also depends on whether the measure of *CR* includes an estimate of small business credit. Small business is part of the household sector for income and consumption purposes but is incorporated under "business credit" in RBA Table D01 and D02. An estimate of small business credit is not included in the credit data used in this paper.

**Illiquid financial assets (*IFA*)**

*Construction:*  $FA - LA$ . Measured in nominal terms, \$ billion.

*Problems:* No direct measure is available. Direct and indirect equity holdings are not separately identifiable.

*Alternatives:* Depends on method of construction for *LA* and pre-1988 interpolation of annual *FA* data.

**Housing equity withdrawal (*HEW*)**

*Source:* RBA (unpublished; provided on request)

*Construction:* Change in household residentially-secured personal credit plus housing grants (mostly FHOS-related) less gross dwelling investment. Gross dwelling investment is gross fixed capital formation related to new and used dwellings, alterations and additions and ownership transfer costs related to residential dwellings.

*Frequency:* Quarterly, MQ1977 -

*Problems:* The series understates gross housing investment as it excludes land purchases from the non-household sector (and thus overstates housing equity withdrawal). See Schwartz et al. (2008). Also, the FHOS component of housing equity withdrawal is not separately identified.

*Alternatives:* None

**Estimated resident population (*ERP*)**

*Sources:* ABS 3105, June 1901 - (annual); ABS 3104-4, JQ1981 - (quarterly)

*Construction:* Splice series and interpolate using cubic spline in PcGive.

*Problems:* Pre-1971 population data (in ABS 3105) uses head count method. Post-1971 is estimated resident population.

*Alternatives:* None

### **Age proportions**

*Source:* ABS 3201

*Frequency:* Annual, 1971 -

*Construction:* All annual series are interpolated using cubic spline in PcGive.

Working age population proportion (*WA*): estimated resident population aged 15-64 years divided by ERP.

"Dependents" (*Dem1*): estimated resident population aged 0-21 years divided by ERP.

"First home buyers" (*Dem2* or *DEMFTB*): estimated resident population aged 22-34 years divided by ERP.

"Investors" (*Dem3*): estimated resident population aged 35-64 years divided by ERP.

"Retirees" (*Dem4* or *DEMRT*): estimated resident population aged 65+ years divided by ERP.

*Problems:* Age demographic levels data are trend-like with few turning points making econometric estimation difficult.

### **GST introduction**

*Description:* A 10 per cent goods and services tax was introduced in Australia on 1 July 2000 coinciding with substantial personal income tax cuts and the removal/modification of several wholesale and other indirect taxes.

*Construction:* The policy change is tested in all models as an binary impulse or step dummy.

*Alternatives:* None

### **Share prices**

*Source:* All Ordinaries Index - Datastream (OECD Main Economic Indicators) AUOSP001F.

*Frequency:* Monthly, January 1960 -

*Construction:* Use end-quarter

*Alternatives:* RBA Bulletin Table F07 publishes the ASX/S&P200 Share Price Index and the ASX/S&P200 Accumulation Index monthly from December 1979. "Market capitalisation of listed domestic equities" is also available monthly from June 1973.

### **USD bilateral exchange rate**

*Source:* RBA Bulletin Table F11

*Frequency:* Monthly, July 1969

*Construction:* USD/AUD (units of \$US per \$A)

*Problems:* None

*Alternatives:* Other bilateral exchange rates.

### **Real exchange rate**

*Source:* RBA

*Frequency:* JQ1970 -

*Construction:* Real trade weighted index.

*Problems:* Choice of weights and price indices. See Ellis (2001).

*Alternatives:* Real export weighted, real imported weighted, real G7 GDP weighted.

### **Real GDP**

*Source:* ABS 5206

*Frequency:* Quarterly, SQ1959 -

*Construction:* Chain volume, seasonally adjusted

### **Residential investment**

*Source:* ABS 5206 (Dwelling gross fixed capital formation: new and used dwellings; alterations and additions)

*Frequency:* Quarterly, SQ1959

**Unemployment rate**

*Sources:* Datastream (OECD Main Economic Indicators)

*Frequency:* Quarterly, August 1966 -

*Construction:* Seasonally adjusted

**Trade and current account balances**

*Source:* RBA Bulletin Table H01

*Frequency:* Quarterly, SQ1959-

**Budget surplus**

*Source:* RBA Bulletin Table E01, E02

*Frequency:* Monthly, July 1971 -

*Construction:* Quarterly series constructed as 3-month sum.

*Problems:* Headline balance available only - cash figures may obscure the timing of underlying economic transactions. From 1999, Australian public finances principally focus on accrual accounting measures (though headline/cash figures are still reported).

**Terms of trade**

*Source:* RBA Bulletin Table G04

*Frequency:* Quarterly, SQ1959 -

*Construction:* Seasonally adjusted

**Drought dummies**

*Source:* ABS 5206

*Construction:* Impulse dummies for quarters with severe reductions in farm GDP (from pre-drought peak until production returns to previous level). Dummies are constructed for SQ1994 to DQ1995 (drought1); JQ2002 to DQ2003 (drought2); and JQ2006 to DQ2008 (drought3). Drought2 is a relevant variable in the income forecasting equations.

*Problems:* GDP break-down into farm/non-farm GDP only available from SQ1995. Note that definition of "severe reduction" is arbitrary but is defined here as periods in which farm production dropped by at least 10 per cent over a two year period.

*Alternatives:* Payment of exceptional circumstances grants, although these are lagging and published time series do not exist. It is possible that a series could be constructed using historical budget papers but this was deemed unnecessary. Exceptional circumstances grants are paid to farm producers where they are victims of: a rare and severe event (a one in 20-25 year event); the event resulted in a severe downturn in farm income over more than 12 months and affected a significant number of farmers in a region or industry; and the event was not predictable or part of a process of structural adjustment (it does not cover downturns in commodity prices).

**Real US GDP**

*Source:* Datastream (Bureau of Economic Analysis)

*Frequency:* Quarterly, MQ1959 -

*Construction:* Constant prices (\$US billion), seasonally adjusted

**West Texas Intermediate (WTI) oil price**

*Source:* Datastream, (IMF International Financial Statistics).

*Frequency:* Monthly, January 1959 -

*Construction:* US dollars per barrel, converted to Australian dollars using monthly USD/AUD bilateral exchange rate. Quarterly series is end-quarter AUD price.

*Alternatives:* North Sea Brent, Dubai Crude, OPEC reference basket (weighted average of prices of oil blends produced by OPEC countries). The WTI (Texas Light Sweet) price benchmarks the New York Mercantile Exchange for oil futures contracts. As a light (low density so easier to convert into

petrol/gasoline) and sweet (low sulphur so less refining needed to satisfy environmental standards) crude it is an appropriate medium term benchmark for energy prices affecting Australian households.

*Issues:* Australia is a net oil importer but overall a net energy exporter (especially of coal, liquid natural gas and uranium). Higher WTI oil prices may negatively affect household purchasing power in the short term through higher petrol prices, however they may raise household disposable incomes in the medium term to the extent that they raise energy export prices overall.

## Attachment D: Demography and wealth MPC simulations

Table D1: Demography and consumption (I)

### Quadratic preferences

Impact on inverse marginal propensity to consume out of lifetime assets ( $\omega$ )

T (years remaining)		Real interest rate						1960-2008	1979-2008	1996-2008	Post-79 max Jun-90
		2.0%	3.0%	4.0%	5.0%	6.0%	7.0%	3.8%	5.7%	5.3%	12.0%
old	10	9.16	8.79	8.44	8.11	7.80	7.52	8.50	7.90	8.02	6.33
	20	16.68	15.32	14.13	13.09	12.16	11.34	14.34	12.46	12.81	8.38
	30	22.84	20.19	17.98	16.14	14.59	13.28	18.35	15.09	15.67	9.04
	40	27.90	23.81	20.58	18.02	15.95	14.26	21.11	16.60	17.38	9.25
	50	32.05	26.50	22.34	19.17	16.71	14.77	23.01	17.48	18.40	9.32
young	60	35.46	28.51	23.53	19.88	17.13	15.02	24.31	17.98	19.01	9.34
infinitely lived		51.00	34.33	26.00	21.00	17.67	15.29	27.18	18.67	19.91	9.35

Impact on marginal propensity to consume out of net worth:  $\gamma=(1+r)/\omega$

T (years remaining)		Real interest rate									
		2.0%	3.0%	4.0%	5.0%	6.0%	7.0%	3.8%	5.7%	5.3%	12.0%
old	10	0.11	0.12	0.12	0.13	0.14	0.14	0.12	0.13	0.13	0.16
	20	0.07	0.07	0.08	0.09	0.09	0.10	0.08	0.09	0.09	0.12
	30	0.05	0.05	0.06	0.07	0.07	0.08	0.06	0.07	0.07	0.11
	40	0.04	0.04	0.05	0.06	0.07	0.08	0.05	0.06	0.06	0.11
	50	0.03	0.04	0.05	0.06	0.06	0.07	0.05	0.06	0.06	0.11
young	60	0.03	0.04	0.04	0.05	0.06	0.07	0.04	0.06	0.06	0.11
infinitely lived		0.02	0.03	0.04	0.05	0.06	0.07	0.04	0.06	0.05	0.11

Table D2: Demography and consumption (II)

**CES preferences**

Assume  $\sigma = 0.2$   
 $\delta = 0.05$

Impact on inverse marginal propensity to consume out of lifetime assets ( $\omega$ )

		Real interest rate						1960-2008	1979-2008	1996-2008	Post-79 max Jun-90
T (years remaining)		2.0%	3.0%	4.0%	5.0%	6.0%	7.0%	3.8%	5.7%	5.3%	12.0%
old	10	8.94	8.64	8.37	8.11	7.86	7.63	8.42	7.94	8.04	6.64
	20	15.85	14.83	13.91	13.09	12.34	11.66	14.07	12.58	12.86	9.07
	30	21.21	19.26	17.59	16.14	14.88	13.78	17.87	15.29	15.76	9.96
	40	25.35	22.44	20.03	18.02	16.33	14.90	20.43	16.87	17.50	10.29
	50	28.56	24.71	21.64	19.17	17.15	15.50	22.15	17.79	18.55	10.41
young	60	31.05	26.34	22.71	19.88	17.62	15.81	23.30	18.33	19.18	10.46
infinitely lived		39.56	30.44	24.81	21.00	18.24	16.16	25.66	19.09	20.12	10.48

Impact on marginal propensity to consume out of net worth:  $\gamma=(1+r)/\omega$

		Real interest rate									
T (years remaining)		2.0%	3.0%	4.0%	5.0%	6.0%	7.0%	3.8%	5.7%	5.3%	12.0%
old	10	0.11	0.12	0.12	0.13	0.13	0.14	0.12	0.13	0.12	0.15
	20	0.07	0.08	0.08	0.09	0.09	0.10	0.07	0.08	0.08	0.11
	30	0.05	0.06	0.06	0.07	0.07	0.08	0.06	0.07	0.06	0.10
	40	0.04	0.05	0.05	0.06	0.07	0.07	0.05	0.06	0.06	0.10
	50	0.04	0.04	0.05	0.06	0.06	0.07	0.05	0.06	0.05	0.10
young	60	0.03	0.04	0.05	0.05	0.06	0.07	0.04	0.05	0.05	0.10
infinitely lived		0.03	0.03	0.04	0.05	0.06	0.07	0.04	0.05	0.05	0.10