The Response of Australian Consumption to Housing Wealth*
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Abstract

Large variations in house prices can lead to significant changes in the level of household wealth. Using Lettau and Ludvigson’s (2004) methodology we investigate the response of non-housing consumption to permanent and transitory changes in financial and non-financial (housing) wealth in Australia. Our results suggest that non-housing consumption expenditure does not respond to transitory fluctuations in either financial or non-financial wealth. This is true despite the fact that there is a relatively large transitory component in housing wealth. Cyclical fluctuations in house prices and any associated wealth effects do not appear to have a significant effect on the consumption path chosen by Australian households.

Keywords: consumption, wealth, housing wealth, cointegration, permanent and transitory shocks

JEL Classification: E21, C32
1. Introduction

A longstanding empirical question in macroeconomics is the relationship between household consumption and wealth. A key issue, particularly for macroeconomic policymakers, is the extent to which changes in wealth, due to large variations in asset prices, influence the level of household consumption and subsequently the level of aggregate demand. Traditionally researchers have attempted to answer this question by estimating the marginal propensity to consume (MPC) out of aggregate wealth or its components (see Ludvigson and Steindel, 1999; Poterba, 2000; Tan and Voss 2003; Case, Quigley and Shiller, 2005). Estimates of the MPC for wealth are frequently obtained using single equation methods, often under the assumption that changes in wealth can be treated as exogenous. Implicit in such an approach is the assumption that all of the adjustment to a change in wealth must come through changes in consumption.

In two recent papers, Lettau and Ludvigson (2001, 2004) demonstrate that estimates of wealth effects obtained by conventional regression methods can be very misleading. Instead they argue that in general, understanding the relationship between consumption and wealth requires a systems approach, where both consumption and wealth are allowed to behave endogenously. To illustrate this point Lettau and Ludvigson (2004) show that for the United States (U.S.) much of the post-war variation in household wealth, although highly persistent, is transitory in nature eliciting little or no response in household consumption. As a result, large movements in wealth are found to have only a small impact on consumption, much smaller than the estimates implied by earlier U.S. studies. The problem with conventional estimates of wealth effects is that
they can overstate the adjustment of consumption to changes in asset wealth because any future adjustment in wealth itself is ignored.

One feature of the U.S. wealth data that emerges from Lettau and Ludvigson’s work is the importance of fluctuations in stock prices in driving the transitory component of wealth. The stock market boom of the 1990s and its subsequent correction is a prominent example. However recent events such as the U.S. house price boom and the related sub-prime crisis have re-focused policy-makers attention from the effects of stock prices on wealth to the effects of fluctuations in house prices. While national housing booms are a somewhat recent feature of the data for many economies, Australia is one country that has exhibited a reasonably pronounced housing cycle over a number of years. Moreover in the Australian economy the private housing stock represents around sixty percent of household wealth, with the implication that fluctuations in house prices can have a large effect on total household wealth.

In this paper we use the methodology developed by Lettau and Ludvigson (2004) to investigate the response of household consumption to permanent and transitory fluctuations in financial and non-financial (housing) wealth in Australia. Since our main focus is on the effect of housing wealth, we discuss the issue as to whether it can be viewed as wealth in the same way as financial wealth (see Aoki, Proudman and Vlieghe, 2004; Buiter, 2008a). Our response to the issue of whether housing is wealth is to use a measure of consumption that excludes consumption expenditure on housing in the empirical analysis. We find that most of the variation in Australian wealth comes through changes in housing (non-financial) wealth. However there is little response in non-housing consumption to the transitory variation in non-financial wealth in Australia.
2. Theory

The Household Intertemporal Budget Constraint

We begin by generalizing Lettau and Ludvigson’s (2001, 2004) theoretical framework, decomposing non-human wealth \( A \) into two sub-components; financial wealth \( A_f \) and non-financial wealth \( A_n \), i.e. \( W = H_t + A_f + A_n \) and \( H_t \) is human wealth. As shown in the Appendix the log-linear approximation to the household’s intertemporal budget constraint is now given by

\[
c_t - \beta_f a_f - \beta_n a_n - \beta_y y_t \approx E \sum_{j=1}^{\infty} \rho^j (\beta_f \Delta y_{t+j} + \beta_n r_{af+j} + \beta_n r_{an+j} - \Delta c_{t+j})
\]

(1)

where \( r_{af} \) and \( r_{an} \) are the real returns to financial and non-financial wealth respectively. The coefficients \( \beta_f \), \( \beta_n \) and \( \beta_y \) are the steady-state shares \( A_f/W, A_n/W \) and \( H/W \) and should satisfy the restriction \( \beta_f + \beta_n + \beta_y = 1 \). The left-hand side of equation (1) is a generalization of Lettau and Ludvigson’s \( ca/y \) variable to \( ca_f a_n y \). Provided the right-hand side variables are stationary, equation (1) implies the existence of a cointegrating relationship for consumption, labor income, financial wealth and non-financial wealth.

Since equation (1) is derived from the household budget constant it is an (approximate) identity. To see this consider a shock that causes the left-hand side variable \( ca_f a_n y \) in equation (1) to become positive (this corresponds to dis-saving by the household). For the intertemporal budget constraint to hold it is necessary that some combination of the following changes occur. Either labor income growth or real returns on financial or non-financial wealth are expected to increase in the future or consumption
growth is expected to decline. By itself the intertemporal budget constraint makes no prediction about which of these changes will occur in order to maintain intertemporal budget balance.

To convert the budget constraint (1) into a behavioural model for consumption it is necessary to make some assumption about the determinants of expected consumption growth. A simple assumption typically associated with the permanent income hypothesis is that the log of consumption is approximately a random walk (possibly with drift). In this case equation (1) becomes,

\[ c_t - \beta_f a_t - \beta_a a_{at} - \beta_y y_t \approx E \sum_{j=1}^\infty \rho^j (\beta_y \Delta y_{t+j} + \beta_r r_{art+j} + \beta_r r_{amr+j}) \]  

which can be interpreted as a generalization of Campbell’s (1987) “saving for a rainy day” formulation of the permanent income hypothesis, to allow for time-varying asset returns. An attractive feature of equation (2) is that it treats the expected real returns to financial and non-financial assets in a similar manner to expected changes in labor income. Provided these real return series are stationary then we can see from equation (2) that the immediate effect of anticipated future changes in asset returns is on the saving variable \( ca, a, y \) rather than on the level of consumption.

A Long Run Model

Equation (1) forms the basis for our empirical analysis of the Australian consumption and wealth data. We can re-write equation (1) as

\[ c_t - \beta_f a_t - \beta_a a_{at} - \beta_y y_t = \beta_0 + \eta_t \]  

(3)
where the slope coefficients are steady-state share of wealth parameters and \( \beta_f + \beta_u + \beta_y = 1 \). The constant term arises from the linearization of the budget constraint.

The error term \( \eta_t \) is assumed to be mean zero stationary random variable. It consists of expected future log-differences of consumption and labor income (discounted) as well as expected future net returns on the different asset components (also discounted). Provided the variables on the right-hand side of equation (1) are stationary then the linear combination on the left-hand side must form a stationary or cointegrated vector. Assuming that \( c_t, y_t, a_{it}, \) and \( a_{nt} \) are first-difference stationary and that \( r_{af} \) and \( r_{nr} \) are stationary in levels, equation (3) represents a cointegrating relationship.

Re-writing equation (3) as

\[
c_i = \beta_0 + \beta_f a_{it} + \beta_u a_{nt} + \beta_y y_t + \eta_t
\]

we obtain what looks like a standard formulation for the long-run consumption function, \textit{albeit} in logarithms rather than levels. However it is a straightforward exercise to convert the elasticities in (4) into long-run marginal propensities for wealth and labor income.

Now Lettau and Ludvigson (2004) point out that if one interprets (4) as a long-run consumption function and uses it to estimate the effect of wealth on consumption, then what \( \beta_f \) (and \( \beta_u \)) measures is the \textit{ceteris paribus} effect of a permanent change in wealth on consumption. If all or even most changes in wealth are permanent this would be all that is required. However if wealth is also affected by quantitatively important transitory shocks then it may be inappropriate to use \( \beta_f \) or \( \beta_u \) to predict the effect on consumption of some anticipated change in wealth. If households view a given change in wealth as transitory then using these long-run parameters to estimate the MPC will overstate the
predicted change in consumption. The relative importance of transitory and permanent shocks to wealth cannot be inferred from long-run models like (4). To estimate the response of consumption to a transitory wealth shock requires estimation of the vector error-correction (VEC) model associated with (4).

*Is Housing Really Wealth?*

In generalizing Lettau and Ludvigson’s model we have implicitly assumed that an agent’s housing wealth can be treated in a manner that is analogous to their financial wealth. While this is a standard assumption in the empirical literature on consumption, its validity has been questioned by a number of authors who argue there is a fundamental difference between financial and housing wealth (Aoki, Proudman and Vlieghe, 2004; Carroll, 2004 and Buiter, 2008a,b). The basic idea is straightforward. For the average home-owner, a rise in house prices has two effects. It increases the value of their asset; however it also raises the opportunity cost of consuming the flow of services derived from the house. Consider a simple one-period budget constant,

\[ P_{nh}C_{nh} + P_hC_h = A_f + P_hH^* \]  

(5)

where \( C_{nh} \) is non-housing consumption, \( C_h \) is housing consumption, \( A_f \) is nominal financial wealth and \( H^* \) is the housing endowment. The price per unit of non-housing consumption is \( P_{nh} \) and the price per unit of housing services is \( P_h \). House prices enter both sides of the budget constraint and their net effect depends on the difference \((H^* - C_h)\). Where an agent is an owner-occupier and just consumes their endowment, housing wealth drops out of the budget constraint entirely. In effect any contribution to wealth from the increase in house prices is offset by the rise in the opportunity cost of
housing services. Buiter (2008a,b) shows that the absence of a wealth effect from changes in house prices also carries over to general dynamic models. He establishes the lack of a wealth effect on consumption from changes in house prices (provided they are driven by economic fundamentals) in a standard representative agent model and in the Yarri-Blanchard OLG model (Yarri, 1965; Blanchard, 1985).

While there is debate about the existence of a traditional wealth effect from housing, there are other mechanisms by which changes in housing wealth may affect consumption. Aoki, Proudman and Vlieghe (2004) emphasize the collateral channel. To the extent that households require collateral to borrow, rising house prices will increase housing equity and provide the opportunity to borrow at lower interest rates. In this case consumption will tend to respond to changes in house prices and housing wealth. However Buiter (2008b) makes the point that this collateral effect does not change the present-value of a household’s consumption stream, but will tend to raise current consumption and reduce future consumption – a transitory effect. Aggregate effects on consumption can arise from the distributional effects of house price changes if households have different marginal propensities to consume. Finally Buiter (2008b) notes that if a change in house prices is due to a speculative bubble rather than being driven by economic fundamentals, then there is a pure wealth effect.

Inspection of equation (5) suggests that if the value of housing services is correctly measured, then aggregate consumption will move approximately one-for-one with changes in housing wealth. However there is relatively little economic interest in such a finding. Rather in considering whether there are direct or indirect wealth effects associated with housing, a more sensible strategy seems to be to focus on the behavior of
non-housing consumption expenditure. If there is no pure wealth effect from housing and no important collateral channel then we would expect to see little response in non-housing consumption to changes in housing wealth. Furthermore we would argue that for policy-makers the important issue is whether housing wealth has effects on non-housing consumption, rather than on housing consumption (a large part of which is imputed).

3. Empirical Results

Data

In view of the above considerations, the consumption measure we use excludes consumption of housing services. Specifically, the measure of consumption is total household final consumption expenditure less household final consumption expenditure on rent and other dwelling services. Expenditure on rent and other dwelling services comprises dwelling rent paid by householders to the owners of dwellings, the imputed value of housing services accruing to owner-occupiers of both their principal residence and any additional residence they may have and expenditure on other dwelling services, for example, local council rates and expenditure on water and heating. Expenditure on rent and other dwelling services increased as a proportion of total household final consumption expenditure from around 14.5 percent in 1976 to around 17.5 percent in 1984. From 1985 to 2004, the proportion fluctuated between around 17.5 and 18.5 percent. An increase in the price of dwelling assets causes actual rents and imputed rents to increase thereby causing total final consumption expenditure as measured to increase. However, whether the increase in the price of dwelling assets leads to an increase in non-housing consumption expenditure is another matter as discussed earlier. For renters, expenditure on rent increases with the increase in house prices so their expenditure on
housing services will rise as housing services are an essential expenditure. They may substitute non-housing consumption for housing services or they may increase their consumption of both if the increase in the price of houses is associated with an increase in labor income. For owner-occupiers, the increase in house prices may or may not lead to an increase in their non-housing consumption spending. For these reasons, expenditure on rent and other dwelling services is excluded from total household final consumption expenditure.7

Labor income is the income derived by households from the supply of labor net of tax. It includes transfer payments, which are predominantly social benefit payments. Financial wealth is the total value of financial assets held by households net of financial assets owing. Non-financial wealth consists of the value of dwelling assets and consumer durables, net of debt. The precise definition and construction of the labor income and wealth series are described in Tan and Voss (2003). The series are divided by the implicit price deflator for total household final consumption expenditure and by the resident population to obtain real per-capita series. The series are quarterly and the full sample is 1976:4 – 2004:3. The logarithms of the real per-capita series are used in the empirical analysis.

To be consistent with the intertemporal budget constraint, the construction of the real per-capita series should be based on an implicit price deflator which corresponds to the actual measure of consumption used as Rudd and Whelan (2006) demonstrate. The Australian Bureau of Statistics publishes an implicit price deflator for total household final consumption expenditure but not for total household consumption excluding expenditure on rent and other dwelling services which would be the appropriate deflator.
to use given our consumption measure. In one other respect, our series are not consistent
with the intertemporal budget constraint since the value of durables should be excluded
from non-financial wealth given that our consumption measure includes expenditure on
durables. It is not possible to separate the value of durables from non-financial wealth
since only the series for total non-financial wealth is published by the Reserve Bank of
Australia. Both measurement issues are unlikely to be important. In particular, the
measurement error associated with the price deflator will be unimportant as long as the
price of the total consumption basket excluding rent relative to the price of the total
basket itself has not changed in a sustained and dramatic fashion over the sample.

Our analysis depends on the assumption that the share of each component of
wealth in total wealth is constant in the steady-state. Figure 1 shows the components of
wealth as a proportion of total wealth over the sample. Labor income is used as a proxy
for human wealth which is not directly observable. The figure shows that the share of
human wealth is relatively small and has steadily declined over the sample. Until
recently, the share of financial wealth has tended to grow over time while the share of
non-financial wealth has correspondingly declined, though on average, the shares are
around one-third and two-thirds, respectively. The strong increase in the non-financial
wealth share and corresponding decline in the financial wealth share seen in the figure
towards the end of the sample is due to the rapid increase in house prices that occurred
from early 2003. It would appear from the figure that the wealth shares are not constant
over the sample which suggests that the parameters in the $ca_y$ relationship may
display some temporal instability. We will consider this issue in detail.

Tests for Cointegration and Long-run Estimates
We test whether there is a cointegrating relationship among the series and conditional on finding evidence for cointegration proceed to obtain estimates of the long-run parameters.\textsuperscript{9} Both single equation and systems methods are used to test for cointegration. The single equation methods involve performing an OLS regression of consumption on a constant, labor income, financial and non-financial wealth and applying a number of unit root tests to the residuals. The tests we apply are the ADF test (Dickey and Fuller, 1981), the PP test (Phillips and Perron, 1988) and the $Z\tau$ test (Phillips and Ouliaris, 1990). Each is a test of the null hypothesis of no cointegration (Engle and Granger, 1987).\textsuperscript{10} The results of these tests for the full sample are shown in panel A of table 1. The PP and $Z\tau$ tests reject the null of no cointegration at the 10 percent level while the ADF test does not reject the null. On the basis of these test results there is evidence for cointegration. The results of Johansen’s (1991) system tests for the number of cointegrating relations are also reported in panel A. Both the trace and $\lambda$–max statistics fail to reject the null of no cointegration ($r=0$). Nevertheless, we proceed on the basis that there is a cointegrating relation among the series on the grounds that two of the single equation test statistics provide evidence for such a relation.

The second part of panel A presents the dynamic ordinary least squares (DOLS) estimates of the coefficients in the cointegrating relation. This method of estimation is due to Stock and Watson (1993) and it provides efficient estimates of the parameters in a cointegrating relation. The DOLS regression augments the OLS regression with $k$ leads and lags of the first difference of the right-hand side variables.\textsuperscript{11} Since the choice of $k$ is somewhat arbitrary, a range of values from 2 to 4 was tried. Panel A of table 1 reports the parameter estimates for $k=4$, however the parameter estimates are broadly similar for
\( k=2 \) and \( k=3 \). The log-linear budget constraint predicts that the estimated coefficient on labor income and the components of wealth should sum to unity as these coefficients represent the steady-state shares of human wealth and the components of non-human wealth in total wealth, respectively. However, this prediction is not quite accurate in the current context because consumption excludes expenditure on housing services. Specifically, if it is assumed that the log of total household consumption is proportional to the log of total household consumption excluding expenditure on rent and other dwelling services (the factor of proportionality \( \lambda \) is greater than one), the theory would predict that the coefficients in the cointegrating relation sum to \( 1/\lambda \). The DOLS estimates are broadly consistent with this prediction in that they sum to a number close to one (1.015) although it is slightly above one.\(^{12}\) The estimated coefficient on non-financial wealth is large while it is very small on financial wealth.\(^{13}\) The first-order autocorrelation coefficient of the residuals from the DOLS regression is 0.79, which is considerably less than one as would be expected of a relationship which is a cointegrating one. Also shown are the coefficient estimates from Johansen’s systems approach which are presented only for the purposes of comparison with the DOLS estimates as the Johansen tests statistics provided no evidence for cointegration. The estimated coefficient on both labor income and financial wealth is of the wrong sign and the coefficient on non-financial wealth is implausibly large.

The DOLS estimates can be used to construct the cointegrating residual \( c_{\alpha} \). A graph of this residual is shown in figure 2 and it appears to be stationary, consistent with the single equation tests for cointegration. However, towards the end of the sample there is a sequence of relatively large negative values and this is particularly the case for
the 2003-04 observations. These negative values are driven by the large increase in non-financial wealth associated with the boom in house prices over 2003-04. At the same time neither consumption nor labor income adjusted over this period to offset the increase in non-financial wealth.

The recent behavior of $ca_\pi y$ is open to two possible interpretations of the data. The first is that the sequence of negative values reflects the effects of a large but ultimately transitory shock. Implicit in this view is the requirement that there will be some future adjustment in the series which returns $ca_\pi y$ to zero thereby restoring the long-run relationship. The other interpretation is that the large (absolute) size of $ca_\pi y$ is an indication of a structural change in the relationship between consumption, labor income and the components of wealth. In an effort to discern which possibility is more likely supported by the data, a version of the $\text{SupF}$ test proposed by Hansen (1992) is used to test for parameter stability in the cointegrating regression. The null hypothesis of the test is that all the coefficients in the cointegrating relation including the constant are stable and the alternative is that there is a single structural break of unknown date in at least one of these coefficients. The test entails computing a sequence of Chow-tests for structural change in the cointegrating regression conducted for each break-date in a rolling window through the sample. The largest F-statistic ($\text{SupF}$) obtained is then compared to the appropriate critical value tabulated in Hansen (1992). For our specification, the $\text{SupF}$ statistic is 48.29, which is far larger than the 5 percent critical value thereby rejecting the null hypothesis of parameter stability. The $\text{SupF}$ occurred at 1998:3 indicating this as the most likely break date. However some instability in the
coefficient estimates is expected since the coefficients represent relative wealth shares, which have not remained constant over the sample as figure 1 shows.

Panel B of table 1 reports the results for the sample that ends in 1998:3, the break date, to ascertain whether the sub-sample results resemble the full sample results in view of the finding of parameter instability. The PP and $Z_{\tau}$ test statistics are larger than in the full sample and reject the null of no cointegration at the 10 percent level. While the ADF test statistic is also larger, it does not reject the null. Turning to Johansen’s test statistics, the $\lambda$-max statistic does not reject the null of no cointegration at the 10 percent level while the trace statistic is only marginally below the 10 percent critical value. Both statistics provide no evidence in favor of a second cointegrating relation. Overall, compared to the full sample results, the evidence for cointegration is somewhat stronger in the sub-sample. The DOLS coefficient estimates are remarkably similar to their corresponding full sample estimates and sum to 0.982, somewhat below one consistent with theory. Also reported are the estimates based on Johansen’s systems approach. This approach gives an estimate of the coefficient on labor income which is consistent with the DOLS estimate while the estimated coefficient on non-financial wealth seems implausibly large and is almost twice the corresponding DOLS estimate. Furthermore, the estimated coefficient on financial wealth is small and of the incorrect sign. In view of these findings, the results which are reported subsequently are based on the DOLS estimates of the cointegrating relation for each sample.

*Vector Error Correction Models*
This section reports the results from estimating the vector-error correction (VEC) model associated with the cointegrating relation found for each sample. The VEC model is given by,

$$\Delta X_t = \mu + \alpha \beta' X_{t-1} + \Pi_1 \Delta X_{t-1} + \ldots + \Pi_{k-1} \Delta X_{t-k+1} + \epsilon_t, \quad (6)$$

where $X_t$ is the vector of the series, $\Delta$ is the first difference operator, $\mu$ is a vector of intercepts, $\alpha$ is a column vector that contains the adjustment coefficient on the error correction term $\beta' X_{t-1}$ in each equation, $\Pi_i$ is the matrix of coefficients on the $i$'th lagged change in $X_t$ and $\epsilon_t$ is a vector of serially uncorrelated random disturbances with mean zero and covariance matrix $\Omega$. Each equation in the VEC model is estimated by OLS, conditional on the DOLS estimates of the parameters in the cointegrating relation which are contained in the column vector $\beta$ and which are used to form the error correction term. Importantly, the adjustment coefficient on the error correction term in each equation indicates how each variable in the system adjusts to restore long-run equilibrium following a shock to the error correction mechanism. Thus an understanding of the adjustment process to restore long-run equilibrium among the series requires the estimation of the vector error correction system.

Table 2 reports estimates of the VEC model for both the full sample and for the sub-sample. The VEC models were estimated with three lags which was the optimal lag length selected by the AIC criterion and the log-likelihood ratio statistic. Consider first the results for the full sample. The coefficient on the error correction term is statistically significant in the equations for both consumption and non-financial wealth at the 10 percent level so that both variables play a part in the adjustment process. The estimated error correction coefficient is negative and relatively small in the consumption equation.
In the non-financial wealth equation by contrast, this coefficient is positive and three times larger in absolute terms than for consumption. It is small and not statistically significant in the labor income and financial wealth equations. Taken together, these results imply that when private saving is low (the error correction term is positive) consumption is predicted to fall in the future and non-financial wealth is predicted to rise thereby restoring the long-run relationship while labor income and financial wealth are predicted to not change. Also, lagged changes in non-financial wealth predict current growth in consumption, labor income and non-financial wealth; in each of these equations the sum of the coefficients on the lagged changes in non-financial wealth is significant at the 5 percent level. The results for the consumption growth equation formally reject the martingale form of the permanent income hypothesis (Tan and Voss, 2003). In addition, growth in financial wealth appears to be unpredictable as the sum of the coefficients on the lagged changes of each variable, respectively, is statistically insignificant.

Turning to the sub-sample results, the error correction term is statistically significant at the 1 percent level in the equation for growth in non-financial wealth and at the 5 percent level in the consumption growth equation. The estimated error correction coefficient in the non-financial wealth equation is positive and over twice as large as it is in the full sample. For consumption, it is negative and somewhat larger than in the full sample. As in the full sample, the estimated error correction coefficient in the labor income and financial wealth equations is not statistically significant. These results show the evidence is stronger in the sub-sample that both consumption and non-financial wealth adjust to offset deviations from the cointegrating relation. Also, lagged changes in
non-financial wealth predict growth in consumption, labor income and non-financial wealth as in the full sample. Additionally, the growth in financial wealth is more predictable in the sub-sample as the sum of its own lagged changes is significant.

These inferences are contingent on the statistical adequacy of the estimated VEC models. Accordingly, table 2 also reports the results of diagnostic tests on the residuals from the estimated equations. For the full sample, there is evidence for non-normality in the residuals from the non-financial wealth equation. The non-normality appears due to outliers (kurtosis) rather than to skewness in the distribution of the residuals so that reliable inferences can still be made. There is also evidence for ARCH effects in the residuals from the financial wealth equation. For the sub-sample, there is evidence for non-normality in the residuals from the non-financial wealth equation but again the non-normality appears due to outliers; there is also evidence for ARCH effects. ARCH effects and non-normality due to kurtosis are also present in the residuals from the financial wealth equation. Importantly, there is no evidence for serial correlation in the residuals from any equation in both the full sample and sub-sample. In conclusion, the results of the diagnostic tests give confidence to the reliability of the standard errors upon which the inferences are based.

Dynamic Responses

In a VEC model, the existence of cointegration allows for the identification of shocks as either permanent or transitory. There are several ways to transform the errors ($\epsilon_i$’s) from the VEC model into shocks which have permanent and transitory effects. Following Gonzalo and Ng (2001) define the matrix
\[ G = \begin{bmatrix} \alpha'_\perp \\ \beta' \end{bmatrix}, \]

where \( \alpha_\perp \) is the orthogonal complement of \( \alpha \). It is straightforward to show that the transformed shocks \( \alpha'_\perp \varepsilon_i \) (of which there is three here) and \( \beta' \varepsilon_i \) (of which there is only one) have effects on the levels of the series which are permanent and transitory, respectively. To identify the three permanent shocks individually requires further identifying assumptions. This is not attempted here as there are no natural identifying restrictions to impose. The transitory shock is identified by virtue of it being the only one in the system. The permanent and transitory shocks are correlated and are made mutually orthogonal by the further transformation \( v_i = H^{-1} G \varepsilon_i \), where \( H \) is the lower triangular matrix such that \( HH' = G \Omega G' \). The matrix \( H \) is not unique and it will depend on the ordering of the variables.

The order of the series chosen here is \( X_i = (y_i, c_i, a_i, a_m)' \). Labor income is placed first as the estimated coefficient on the error correction term in its equation is highly insignificant in both samples. This means that labor income is weakly exogenous and plays no part in the adjustment process. That is also the case for financial wealth. However, as our primary concern is to investigate wealth effects on consumption it is paired with non-financial wealth in the ordering. The results of the permanent/transitory decomposition which follow are for the VEC model estimated under the restriction of weak exogeneity of labor income. Weak exogeneity of financial wealth is not imposed in order to keep its potential effects, specifically on consumption, unrestricted.\(^{16}\) The contemporaneous response of the series \( X_i \) to the orthogonal permanent and transitory shocks is given by \( G^{-1} H v_i \). Because the matrix \( G \) is in general not lower triangular, the
ith ordered series $X_i$ can respond contemporaneously to the $j$th structural innovation $v_j$, even if $j > i$. So, for example, consumption which is ordered second can potentially respond to all the structural innovations $v_i$, not just the first, and this was the case in the reported results.\(^{17}\)

Figure 3 shows the responses of the series in levels to a one-standard error orthogonal transitory shock. Also shown is the response of the error correction term. For the full sample model, there is a large increase in non-financial wealth in response to the transitory shock. The response peaks three quarters after the initial shock and then gradually declines to zero so that by twelve quarters non-financial wealth has returned to its initial level. By contrast, there is little response in financial wealth; it falls marginally before returning to its initial level. Labor income increases and then gradually declines while consumption initially falls and then increases before returning to its initial level. The error correction term which is a linear combination of the responses of the series to the transitory shock initially falls and then increases to zero.\(^{18}\) As this response primarily reflects the response of non-financial wealth, it is non-financial wealth that adjusts primarily to restore the cointegrating relation following a transitory shock.\(^{19}\) For the sub-sample, the responses to the transitory shock are similar to those from the full sample. There is a large increase in non-financial wealth which peaks after three quarters. Non-financial wealth then gradually declines to its initial level after dipping below that level for a time prior to convergence. Financial wealth initially increases but only marginally in response to the transitory shock and then declines before returning to its initial level. Labor income increases and reaches a peak response after five quarters and then declines. Consumption initially falls but thereafter its response pattern is similar to that of labor
income. Just as in the full sample model, it is the response in non-financial wealth that dominates and which primarily eliminates deviations from the cointegrating relation.

Table 3 reports the percentage contribution to the forecast error variance in the growth rate of each series which is attributable to the permanent shocks collectively and to the transitory shock at various forecast horizons. For the full sample, the transitory shock accounts for around 40 percent of the forecast error variance in consumption growth and for about the same percentage amount in non-financial wealth growth. Although the percentage contributions are similar, it should be noted that consumption growth is far less volatile than growth in non-financial wealth so that the forecast error variance in the growth of non-financial wealth is much larger than in the growth of consumption. The transitory shock accounts for a negligible amount of the forecast error variance in the growth of financial wealth and of labor income at all forecast horizons. The results for the sub-sample are similar to the full sample results. The transitory shock accounts for around 45 percent of the forecast error variance in non-financial wealth growth at all forecast horizons which is somewhat more than it does for consumption growth.

**Permanent and Transitory Components**

The moving average representation of the VEC model can be used to decompose the time series of each variable into its permanent component which is the stochastic trend in the series and its transitory component which is the time series of the deviations from its stochastic trend. Specifically, the vector of permanent components is given as

\[ X_t^p = X_0 + C(I) \sum_{i=1}^{\infty} (\epsilon_i + \mu) \]  

(7)
where $X_0$ is the vector of initial permanent components and $C(1)$ is the long-run impact matrix of the residuals from the VEC model. The vector of transitory components is given as $X_t^s = X_t - X_t^p$ and is stationary.

Figure 4 shows the transitory component in each series. Non-financial wealth takes very large swings away from trend (the zero line) and in each case, at least prior to 2003, reverted slowly back to trend. Since 2003 non-financial wealth has risen markedly above trend, considerably more than historically, and it is an open question as to whether it will revert back to trend in the future. By comparison the transitory component in consumption is small and consumption reverts quickly to trend. The lack of a large consumption response suggests that households view the large rise in non-financial wealth since 2003 as transitory and expect a downward correction of non-financial wealth to its trend. The transitory component in financial wealth is small. Transitory variation in labor income though somewhat larger than in consumption and financial wealth reverts quickly to its trend at least prior to 2003. Since then labor income has risen strongly above trend though by not much more than earlier in the sample.

By way of comparison, it is of interest to see whether the sub-sample VEC model produces similar decompositions of the series not only for the period to 1998:3 but also for the out-of-estimation period 1998:4 – 2004:3. To perform the decomposition, a time series of residuals is required for the estimation period which can be obtained directly from the sub-sample VEC model and for the out-of-estimation period. The out-of-estimation period residuals are obtained as the difference between the actual value of the series and the one step ahead forecast of the series from the sub-sample VEC model using
the actual data. One can then extract the permanent component from each series to obtain
the transitory component.

Figure 5 shows the transitory component in each series over both the estimation
and out-of-estimation periods which together comprise the full sample. The vertical line
marks 1998:3, the end of the estimation period. The plot of the transitory component in
consumption and labor income is remarkably similar to the corresponding plot obtained
from the full sample estimation shown in figure 4, even though the VEC model is
estimated with data to 1998:3. However, the plot of the transitory component in financial
wealth from the sub-sample estimation shows more variability than it does from the full
sample estimation but it is still considerably less volatile than the transitory component in
non-financial wealth. Figure 5 shows that the transitory component in non-financial
wealth rises strongly above trend from mid-2003 but, in comparison with the magnitude
of early deviations from trend, this does not appear as unprecedented as in figure 4. Again
there is a lack of a strong consumption response to this strong increase in non-financial
wealth above trend. As before, labor income rises strongly above trend towards the end of
the sample. Thus, the VEC model estimated with data to 1998:3 gives a decomposition of
the series into their permanent and transitory components that is not dissimilar, most
importantly over the out-of-estimation period, to that obtained from the full sample VEC
model. This finding suggests that the apparent instability in the parameter estimates
suggested by the SupF test results is not large enough to significantly alter the time series
behavior of the transitory component in each series. Nevertheless, it remains an open
question as to whether the rapid increase in non-financial wealth above its trend seen
towards the end of the sample in both models is in fact transitory, as the lack of a strong
consumption response in both models would suggest, or indicative of a changed structural relationship among the series.

Asset Return Predictability

The estimated VEC models provide evidence that growth in non-financial wealth responds to lagged $ca_{t-1}$. This suggests that $ca_{t-1}$ should have predictive content for the returns to non-financial wealth and possibly to financial wealth. To investigate this implication, the predictive power of $ca_{t-1}$ for the returns on housing and stocks are evaluated in this section, respectively. The return on housing is defined as the quarterly return on the Residential Property Index for houses provided by the Real Estate Institute of Australia. This index starts at 1982:2. The return on stocks is defined as the quarterly return on the Australian Stock Exchange (ASX) 200 stock market accumulation index. Our results are reported for excess returns defined as quarterly returns on stocks and houses in excess of the 3-month yield to maturity on bank accepted bills.

Table 4 reports the results from the regression of the $h$-quarter cumulative excess return on a constant and $ca_{t-1}$ for the full sample and for the sub-sample for housing (Panel A) and stocks (Panel B). Each panel shows the estimated coefficient on $ca_{t-1}$ together with its Newey-West $t$-statistic and the adjusted R-squared statistic from the regression. Panel A shows that $ca_{t-1}$ has predictive power for excess returns to housing for the full sample for investment horizons of four to twelve quarters inclusive. For these horizons, the estimated coefficient on $ca_{t-1}$ is positive and statistically significant. The adjusted R-squared statistic increases from 7 percent at the horizon of four quarters to 12 percent at eight quarters and then falls slightly to 10 percent at twelve quarters.
quarters. The results for the sub-sample are similar. The estimated coefficient on $ca_{f,a_n,y}$ is positive and statistically significant for investment horizons of six to eight quarters inclusive. Although the adjusted R-squared statistic is somewhat larger than for the full sample (it reaches a maximum of 15 percent at around six quarters), the results for the sub-sample are not as strong since the $t$-statistics on the coefficient of $ca_{f,a_n,y}$ are uniformly smaller. Panel B shows that $ca_{f,a_n,y}$ has predictive content for excess stock returns for investment horizons of one to six quarters inclusive but not for longer horizons in both the full sample and sub-sample. In both samples, the estimated coefficient on $ca_{f,a_n,y}$ is positive as expected and statistically significant for return horizons up to six quarters inclusive. The results are somewhat stronger for the sub-sample where the largest adjusted R-squared statistic is 11 percent compared to 7 percent in the full sample, both occurring at the four quarter horizon. In summary, the evidence presented here indicates that $ca_{f,a_n,y}$ has predictive content for excess returns to housing over medium term investment horizons (one to three years) and for stocks over shorter term horizons (one month to around one and half years).

4. Conclusion

Household wealth in Australia contains an important and relatively persistent transitory component which arises mainly from transitory variation in non-financial (housing) wealth. At the same time, household consumption is affected by transitory shocks but their impact is much smaller in magnitude than for wealth. In effect we observe a lot of short to medium term variation in housing wealth that never gets transmitted to consumption. A specific example of this occurs during the period 2003-04,
when a boom in Australian house prices pushed non-financial wealth to levels well above its long-run trend. Over the same period consumption showed little significant deviation from its trend. This suggests the mechanisms that potentially might link non-housing consumption to changes in housing wealth such as direct wealth effects, the collateral channel or even speculative bubbles have not played an important role in the Australian economy.

If our interpretation of the Australian data is correct, then at the end of our sample in 2004:3, non-financial wealth was well above its long-run trend. Thus, to re-establish its historical long-run relationship with consumption, labor income and financial wealth, non-financial wealth is required to decline back towards its long-run trend. Implicitly what this points to is a further downward correction in Australian house prices. However based on their consumption behavior this is exactly what Australian households were expecting and this suggests little need for concern from policy-makers. Finally, the lesson to be drawn from recent Australian experience is that a surge in house prices need not elicit a strong consumption response in which case households perceive the surge as temporary and anticipate a downward correction to house prices. Moreover, a slump in house prices need not elicit a weakening in consumption either. This suggests that policymakers need not be too concerned about the potential impact on consumption and aggregate demand of large transitory swings in house prices.
Appendix

This appendix describes the derivation of the log-linear budget constraint shown by equation (1) in the text. This development draws on Lettau and Ludvigson (2004), Fisher and Voss (2004) and Hamburg, Hoffman and Keller (2005). Aggregate household wealth is assumed to evolve according to the following accumulation equation

\[ W_{t+1} = (1 + R_{w_{t+1}})(W_t - C_t). \] (A1)

The variable \( W_t \) is aggregate wealth including human wealth \( H_t \) and non-human wealth \( A_t \). Private consumption is \( C_t \) and the return on aggregate wealth is \( R_{w_{t+1}} \). Campbell and Mankiw (1989) derive an expression for the log of the consumption to wealth ratio from a log-linearization of equation (A1). This expression, after dropping linearization constants, is

\[ c_t - w_t \approx E \sum_{i=1}^{\infty} \rho_w^i (r_{w_{t+i}} - \Delta c_{i+i}), \] (A2)

where \( c_t = \ln(C_t) \), \( w_t = \ln(W_t) \), and \( r_{w_t} = \ln(1 + R_{w_t}) \). The discount factor is \( \rho_w = 1 - C_t / W_t \), where \( C_t / W_t \) is the sample average consumption-wealth ratio, assumed to be constant.

The next step is to decompose the log of total wealth into its components of log human wealth \( h_t \), log financial wealth \( a_f \) and log non-financial wealth \( a_n \). It is straightforward to demonstrate the claim of Hamburg et al (2005) that the log of the sum of these components is approximately equal to the sum of the log of these components (apart from a constant term which we drop). That is,

\[ \beta_h H_t W_t \approx \beta_f A_f W_t + \beta_n A_n H_t, \] (A3)

where \( \beta_h = \bar{H_t} / W_t \), \( \beta_f = \bar{A_f} / W_t \) and \( \beta_n = \bar{A_n} / H_t \) are the sample averages assumed to be constant. The sample average \( H_t / W_t \) is designated as \( \beta_h \) since human capital will be related to labor income. By construction, \( \beta_f + \beta_n + \beta_h = 1 \).

Now derive an expression for the return components. Note that \( R_{w_t} \) is implicitly defined as

\[ (1 + R_{w_t}) = (1 + R_{h_t}) \frac{H_t}{W_t} + (1 + R_{a_f}) \frac{A_f}{W_t} + (1 + R_{a_n}) \frac{A_n}{H_t}, \] (A4)

where \( R_{h_t} \) is the return to human wealth and \( R_{a_f} \) and \( R_{a_n} \) are the return to financial and non-financial wealth, respectively. Following Campbell (1996), it can be shown that after taking the logs of both sides of equation (A4), the approximate relation

\[ r_{w_t} \approx \beta_h r_{h_t} + \beta_f r_{a_f} + \beta_n r_{a_n} \] (A5)

is obtained, where \( r_{h_t} = \ln(1 + R_{h_t}) \), \( r_{a_f} = \ln(1 + R_{a_f}) \) and \( r_{a_n} = \ln(1 + R_{a_n}) \). Substitute equations (A3) and (A5) into equation (A2) to obtain

\[ c_t - \beta_h h_t - \beta_f a_f - \beta_n a_n \approx E \sum_{i=1}^{\infty} \rho_w^i (\beta_h r_{h_{t+i}} + \beta_f r_{a_{f+i}} + \beta_n r_{a_{n+i}} - \Delta c_{i+i}). \] (A6)
Finally, define human capital as the present value of current and future after-tax labor income $Y_{t+j}$ so that

$$H_t = Y_t + E_t \sum_{j=1}^{\infty} \prod_{i=1}^{j} (1 + R_{t+i})^{-1} Y_{t+j}. \quad (A7)$$

The accumulation equation corresponding to equation (A7) is

$$H_{t+1} = (1 + R_{t+1}) (H_t - Y_t), \quad (A8)$$

which is analogous to equation (A1). Log-linearize equation (A8) to obtain the expression

$$y_t - h_t \approx E_t \sum_{i=1}^{\infty} \rho_i (r_{t+i} - \Delta Y_{t+i}), \quad (A9)$$

where $y_t = \ln(Y_t)$, $\rho_h = 1 - \bar{Y_i}/\bar{Y}$ and $\bar{Y_i}/\bar{Y}$ is the sample average labor income to human wealth ratio, assumed to be constant. Equation (A9) is analogous to equation (A2). Substitute equation (A9) for $h_t$ in equation (A6), assume $\rho_h = \rho_u = \rho$ and recall $\beta_h = 1 - \beta_f - \beta_u$, to obtain

$$c_t - \beta_f a_t - \beta_u a_{t+1} - \beta_y y_t \approx E_t \sum_{j=1}^{\infty} \rho^j (\beta_y \Delta Y_{t+j} + \beta_f r_{t+j} + \beta_u r_{t+j+1} - \Delta c_{t+j}),$$

which is equation (1) in the text.
References


Table 1
Cointegration tests and long-run estimates


(i) Cointegration tests

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(ii) Estimates of cointegrating parameters

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(ii) Estimates of cointegrating parameters

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Notes: This table reports residual based tests for cointegration based on the OLS estimates of the parameters in the cointegrating regressions and Johansen’s (1991) trace and λ -max tests for the number of cointegrating relations. ADF(4) is the adjusted Dickey-Fuller (1981) t-statistic from the cointegrating regression, including four lags of the first-differences of the OLS residuals. PP and Zτ are the Phillips-Perron (1988) and Phillips-Ouliaris (1990) t-statistics, respectively. In each case, the autocovariance function is truncated at four lags. The critical values are taken from Hamilton (1994), table B.8. Johansen’s test statistics are based on a VAR with four lags and the critical values are from Osterwald-Lenum (1992) table 1. In the DOLS regressions, the number of leads and lags of changes in the right-hand side variables is k=4 and the standard errors are based on the Newey-West estimator (Newey and West, 1987) with eight lags. The first-order autocorrelation coefficient of the residuals from the DOLS regressions is denoted AR(1).
### Table 2
Estimates of vector error correction models conditional on DOLS estimates.

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<td>[0.99]</td>
<td>[0.07]</td>
<td>[0.04]</td>
<td>[0.40]</td>
<td>[0.54]</td>
<td>[0.01]</td>
</tr>
</tbody>
</table>

| $\bar{R}^2$ | 0.230        | 0.187        | -0.034               | 0.175                | 0.254        | 0.127        | 0.155                | 0.166                |
| s.e.       | 0.007        | 0.013        | 0.018                | 0.020                | 0.007        | 0.014        | 0.014                | 0.020                |
| sc(4)      | 0.370        | 0.484        | 0.973                | 0.777                | 0.239        | 0.597        | 0.758                | 0.214                |
| Reset      | 0.717        | 0.642        | 0.307                | 0.103                | 0.631        | 0.945        | 0.665                | 0.138                |
| ARCH       | 0.447        | 0.734        | 0.018                | 0.248                | 0.291        | 0.548        | 0.056                | 0.053                |
| Normality  | 0.910        | 0.755        | 0.137                | 0.001                | 0.980        | 0.381        | 0.081                | 0.001                |
| Skewnwss   | 0.704        | 0.476        | 0.530                | 0.756                | 0.880        | 0.179        | 0.403                | 0.820                |
| Kurtosis   | 0.844        | 0.845        | 0.068                | 0.000                | 0.901        | 0.812        | 0.047                | 0.000                |

**Notes:** In each equation, the sums of the estimated coefficients on the lags of the variables are reported, together with the $t$-statistic for the sum. $t$-statistics are shown in parentheses. Also shown is the associated $p$-value in square brackets for the estimated error correction coefficient ($ec$) which is constructed from the dynamic ordinary least squares (DOLS) estimates reported in table 1. Significant coefficients at the five percent level are highlighted in bold face. The adjusted $R$-squared statistic and the standard error of estimate (s.e.) are given. Also shown are the $p$-values for, respectively: an $F$-test for absence of serial correlation of order four ($sc(4)$), based on regression of residuals on initial regressors and four lagged residuals; a reset $F$-test for heteroskedasticity based on regression of squared residuals on a constant and fitted values and their squares and cubes; an $F$-test for fourth-order ARCH effects based on regression of squared residuals on lagged squared residuals; the Jarque-Bera test for normality and a $z$-test for symmetry and absence of excess kurtosis.
### Table 3
Decomposition of forecast error variance

<table>
<thead>
<tr>
<th></th>
<th>( \Delta c_{t+1} - E_t(\Delta c_{t+1}) )</th>
<th>( \Delta y_{t+1} - E_t(\Delta y_{t+1}) )</th>
<th>( \Delta a_{p,t+1} - E_t(\Delta a_{p,t+1}) )</th>
<th>( \Delta a_{w,t+1} - E_t(\Delta a_{w,t+1}) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. 1977:4 – 2004:3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( j )</td>
<td>( P )</td>
<td>( T )</td>
<td>( P )</td>
<td>( T )</td>
</tr>
<tr>
<td>1</td>
<td>60.65</td>
<td>39.35</td>
<td>100.00</td>
<td>0.00</td>
</tr>
<tr>
<td>2</td>
<td>59.65</td>
<td>40.35</td>
<td>99.44</td>
<td>0.56</td>
</tr>
<tr>
<td>3</td>
<td>56.75</td>
<td>43.25</td>
<td>98.51</td>
<td>1.49</td>
</tr>
<tr>
<td>4</td>
<td>59.42</td>
<td>40.58</td>
<td>98.32</td>
<td>1.68</td>
</tr>
<tr>
<td>6</td>
<td>57.46</td>
<td>42.54</td>
<td>97.85</td>
<td>2.15</td>
</tr>
<tr>
<td>8</td>
<td>57.75</td>
<td>42.25</td>
<td>97.72</td>
<td>2.28</td>
</tr>
<tr>
<td>12</td>
<td>57.73</td>
<td>42.27</td>
<td>97.07</td>
<td>2.93</td>
</tr>
<tr>
<td>( \infty )</td>
<td>57.55</td>
<td>42.45</td>
<td>96.88</td>
<td>3.12</td>
</tr>
<tr>
<td>( j )</td>
<td>( P )</td>
<td>( T )</td>
<td>( P )</td>
<td>( T )</td>
</tr>
<tr>
<td>1</td>
<td>67.38</td>
<td>32.62</td>
<td>100.00</td>
<td>0.00</td>
</tr>
<tr>
<td>2</td>
<td>65.43</td>
<td>34.57</td>
<td>99.56</td>
<td>0.44</td>
</tr>
<tr>
<td>3</td>
<td>56.79</td>
<td>43.21</td>
<td>99.26</td>
<td>0.74</td>
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<tr>
<td>4</td>
<td>59.53</td>
<td>40.47</td>
<td>98.19</td>
<td>1.81</td>
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<td>6</td>
<td>57.73</td>
<td>42.27</td>
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<td>1.96</td>
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<tr>
<td>8</td>
<td>57.86</td>
<td>42.14</td>
<td>97.72</td>
<td>2.28</td>
</tr>
<tr>
<td>12</td>
<td>56.95</td>
<td>43.05</td>
<td>96.89</td>
<td>3.11</td>
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<tr>
<td>( \infty )</td>
<td>56.83</td>
<td>43.17</td>
<td>96.80</td>
<td>3.20</td>
</tr>
</tbody>
</table>

**Notes:** The table reports the percentage contribution of the permanent shocks together \( (P) \) and the transitory shock \( (T) \) to the \( j \)-step ahead forecast error variance in the growth of each series, respectively. Horizons are in quarters. In the estimated VEC models, labor income is weakly exogenous and the number of lags is three.
### Table 4 Long-horizon regressions

<table>
<thead>
<tr>
<th>Regressand $ca_{a,y_t}$</th>
<th>Forecast Horizon (in quarters)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>8</th>
<th>12</th>
<th>16</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel A. Excess Returns to Housing</strong></td>
<td>1982:3-2004:3</td>
<td>0.202</td>
<td>0.720</td>
<td>1.161</td>
<td>1.999</td>
<td>2.647</td>
<td>3.144</td>
<td>3.986</td>
<td>4.605</td>
<td>3.967</td>
<td>3.781</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.76)</td>
<td>(1.35)</td>
<td>(1.41)</td>
<td>(1.71)</td>
<td>(1.93)</td>
<td>(2.31)</td>
<td>(3.29)</td>
<td>(3.34)</td>
<td>(1.18)</td>
<td>(0.92)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.006]</td>
<td>[0.017]</td>
<td>[0.035]</td>
<td>[0.072]</td>
<td>[0.094]</td>
<td>[0.102]</td>
<td>[0.118]</td>
<td>[0.102]</td>
<td>[0.049]</td>
<td>[0.027]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.84)</td>
<td>(1.19)</td>
<td>(1.25)</td>
<td>(1.51)</td>
<td>(1.59)</td>
<td>(1.75)</td>
<td>(2.02)</td>
<td>(1.32)</td>
<td>(-0.73)</td>
<td>(-0.93)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[-0.005]</td>
<td>[0.032]</td>
<td>[0.067]</td>
<td>[0.133]</td>
<td>[0.156]</td>
<td>[0.145]</td>
<td>[0.128]</td>
<td>[0.010]</td>
<td>[0.006]</td>
<td>[0.022]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.64)</td>
<td>(1.77)</td>
<td>(1.97)</td>
<td>(1.93)</td>
<td>(1.91)</td>
<td>(1.76)</td>
<td>(1.08)</td>
<td>(-1.30)</td>
<td>(-0.95)</td>
<td>(-0.26)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.026]</td>
<td>[0.041]</td>
<td>[0.060]</td>
<td>[0.073]</td>
<td>[0.073]</td>
<td>[0.057]</td>
<td>[0.009]</td>
<td>[0.027]</td>
<td>[0.023]</td>
<td>[-0.009]</td>
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<tr>
<td></td>
<td></td>
<td>(2.32)</td>
<td>(2.39)</td>
<td>(2.29)</td>
<td>(2.00)</td>
<td>(1.88)</td>
<td>(1.68)</td>
<td>(0.94)</td>
<td>(-1.41)</td>
<td>(-0.79)</td>
<td>(-0.18)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[0.046]</td>
<td>[0.075]</td>
<td>[0.092]</td>
<td>[0.107]</td>
<td>[0.094]</td>
<td>[0.066]</td>
<td>[0.005]</td>
<td>[0.038]</td>
<td>[0.018]</td>
<td>[-0.014]</td>
</tr>
</tbody>
</table>

**Notes:** Panel A reports the results of the OLS regression of the excess return on the Residential Investment Property Index for houses over $h$ quarters on $ca_{a,y_t}$. Panel B reports the results of the OLS regression of the excess return on the ASX200 accumulation index over $h$ quarters on $ca_{a,y_t}$. In each case, the return over $h$ quarters is defined as $\Pi_{0}^{h}(1+r_{t+i})-1$, where $r_i$ is the return in excess of the rate on 3-month bank accepted bills. A constant is included in all regressions. For each regression, the estimated coefficient on $ca_{a,y_t}$ is reported together with the Newey-West $t$-statistic (calculated with four lags) directly below in parentheses. The adjusted R-squared statistic from the regression is shown in square brackets. The coefficients in $ca_{a,y_t}$ are the DOLS estimates for the samples that end in 2004:3 and 1998:3, respectively, shown in table 1.
Figure 1. Ratios of Components of Wealth to Total Wealth.

Notes: Total wealth (W) is defined as the sum of human wealth (labor income (Y) is used as its proxy), financial wealth (AF) and non-financial wealth (AN). The figure shows each component of wealth as a proportion of total wealth.
Figure 2. The DOLS cointegrating residual $ca_0a_ny$ for 1976:4-2004:3.
Figure 3. Responses of series to a one-standard error transitory shock


Notes: In the estimated VEC models, the number of lags is three and labor income is specified to be weakly exogenous.
Figure 4. The transitory component of each series. Sample and estimation period is 1977:4 – 2004:3.

Notes: The transitory component in each series is the difference between the actual series and its Beveridge-Nelson permanent component. The permanent component is calculated from the VEC model which is estimated with three lags and under the restriction that labor income is weakly exogenous.
Figure 5. The transitory component of each series. Sample period is 1977:4 – 2004:3. Estimation period is 1977:4 – 1998:3.

Notes: The transitory component in each series is the difference between the actual series and its Beveridge-Nelson permanent component. The permanent component is calculated from the VEC model which is estimated with three lags and under the restriction that labor income is weakly exogenous. The VEC model is estimated with data from 1977:4 to 1998:3; this end-of-estimation date is shown by the vertical line.
Footnotes

* This paper was begun while the first author was with the School of Economics at the University of New South Wales. We are grateful to two anonymous referees for their very helpful comments and to seminar participants at Latrobe University, the University of Victoria, the University of Wollongong, Sydney University and the Reserve Bank of Australia. Financial support from the Australian Research Council Grant no.’s DP0558678 and DP0877219 is gratefully acknowledged.

1 Other studies that have addressed this issue following the approach of Lettau and Ludvigson include; Fernandez-Corugedo, Price and Blake (2003) for United Kingdom, Pichette and Tremblay (2003) for Canada, Hamburg, Hoffman and Keller (2005) for Germany and Chen (2006) for Sweden.

2 Lettau and Ludvigson’s finding is broadly consistent with the predictions of the permanent income hypothesis. Increases or decreases in future wealth that are expected to be transitory have only a modest effect on permanent income and hence on consumption.

3 Evidence that U.S. household asset wealth is dominated by equity market returns is reflected in the very high correlation between quarterly fluctuations in household net worth and movements in equity returns (Lettau and Ludvigson, 2004).

4 Australia experienced rapid increases in house prices in the late 1980s and again in 2002 and 2003.

5 The importance of the wealth effect on consumption in Australia has previously been investigated by Tan and Voss (2003). However, their analysis is conducted in a single-equation framework which, as they note, assumes all of the adjustment to changes in wealth occurs through consumption changes and is likely to over-estimate the wealth effect on consumption.

6 Strictly speaking with time-varying real asset returns the approximate Euler equation for consumption growth is \( E_t \Delta c_{t+1} = \mu + \theta E_t r'_{t+1} \) for \( j = af \) or \( an \); however log consumption will be close to a random walk with drift for small \( \theta \) i.e. when the inter-temporal elasticity of substitution is small.

7 The econometric analysis was also conducted with total household final consumption expenditure excluding household expenditure on both rent and other dwelling services and consumer durables. Using this measure of consumption gives results that are very similar to those reported for total consumption excluding rent and other dwelling services so that in both cases exactly the same inferences are drawn. The full set of results for consumption excluding both rent and consumer durables is available on request.

8 A test of the null hypothesis that the wealth share contains a unit root against the alternative that the wealth share is stationary around a constant mean is not rejected for each wealth component on the basis of the Adjusted Dickey-Fuller (ADF) and Phillips-Perron (PP) tests pointing to potential parameter instability in the long-run relation.

9 On the basis of the ADF and PP tests, the null of a unit root in each series cannot be rejected at standard significance levels so there may exist a cointegrating relationship between consumption, labor income, financial and non-financial wealth.
Davidson and MacKinnon (1993) argue that this procedure has low power to reject the null hypothesis of no cointegration. If this is the case then actually rejecting the null would seem to provide very strong evidence of cointegration.

The DOLS standard errors are corrected for heteroskedasticity and serial correlation using the Newey and West (1987) estimator.

The ratio of the log of total consumption to the log of total consumption excluding expenditure on rent and other dwelling services has declined steadily since 1997 bringing into question the assumption of a constant proportional relationship between the series over the full sample.

The DOLS coefficient estimates imply long-run MPC’s out of wealth (at the mid-point of the sample – 1990:3) of 0.0064 for financial wealth and 0.0119 for non-financial wealth.

Hansen uses the fully modified cointegration estimator to perform the $SupF$ test while we employ DOLS.

When total household consumption excluding both expenditure on consumer durables and on rent and other dwelling services is used as the consumption measure, the $SupF$ statistic also gives a break date of 1998:3 where it reaches its maximum value of 65.31.

As a practical matter Gonzalo and Ng (2001) recommend constraining statistically insignificant error correction coefficients in estimated $\alpha$ to zero before constructing $\alpha_\perp$ because the long-run impact matrix of the $\epsilon_i$’s (which depends on $\alpha_\perp$) can be very sensitive to small variations in estimated $\alpha$. We follow this recommendation with respect to labor income but not to financial wealth in order to leave its effects unrestricted. However, the reported results are practically unchanged when both labor income and financial wealth are specified as weakly exogenous.

Alternatively, the contemporaneous interactions among the series in the orthogonal VEC model (re-parameterized to a model in levels of the series) is given by $H^{-1}G X_t$. Consumption potentially depends on contemporaneous labor income, financial wealth and non-financial wealth because the matrix $G$ is in general not lower triangular.

One-standard error bands around the impulse responses are not shown in figure 3 because the figures would appear too cluttered. One-standard error bands were calculated by taking the estimated coefficients in the VEC models (both for the short-run dynamics and the long-run relation) to form the data generating process which was then bootstrapped 1000 times. For the full sample model, the response of non-financial wealth to the transitory shock is statistically significant up to horizons of ten quarters. The response of financial wealth is statistically insignificant at all forecast horizons. The consumption response is statistically significant up to horizons of three quarters while the labor income response is statistically significant up to horizons of ten quarters. Similar inferences apply to the impulse responses for the sub-sample. The impulse responses with one-standard error bands for both the full sample and sub-sample models are available on request.

For the ordering of the variables chosen here, the source of the transitory shock can be attributable to fluctuations in non-financial wealth only if the other variables in the VEC model are weakly exogenous, that is, only if the error correction term does not appear in the equations for growth in labor income, consumption and financial wealth. To see this,
let $C(1)$ and $\Gamma(1)$ denote the long-run impact matrix of the reduced form shocks ($\varepsilon_i$'s) and the orthogonal shocks ($\nu_i$'s), respectively. The relationship between them is $\Gamma(1) = C(1)G^{-1}H$. Using the results in Fisher and Huh (2007), one can establish that the last column of $C(1)$ will be a column vector of zeros and $G^{-1}H$ will be lower triangular provided growth in labor income, consumption and financial wealth are weakly exogenous. It then follows that the last column of $\Gamma(1)$ is a column vector of zeros so that the orthogonal innovation in non-financial wealth has no long-run impact on any of the variables; it only has a transitory effect. However, unlike for labor income and financial wealth, consumption growth in all the estimated VEC models is not weakly exogenous. Therefore it is not possible to identify the transitory shock exclusively with fluctuations in non-financial wealth.

Formally, $C(1) = I + \sum_{i=1}^{\infty} C_i L^i = \beta_\perp \gamma \alpha_\perp^t$ where $L$ is the lag operator, $\gamma = (\alpha_\perp \Psi \beta_\perp)^{-1}$ and $\Psi = I - \sum_{i=1}^{k-1} \Pi_i$. Note that the permanent component here is the multivariate version of the Beveridge-Nelson permanent component under cointegration. In the actual estimation, the vector of initial permanent components is obtained from the VEC model by forecasting ahead 108 periods beginning in 1977:4 so that the forecast horizon corresponds to the end of the sample and then subtracting off the deterministic portion of the forecast.

The predictive content of $cay$ (not $cay_a,v$) for stock returns was first investigated by Lettau and Ludvigson (2001) for the United States and subsequently by other researchers for other countries. Among those studies are; Fernandez-Corugedo, Price and Blake (2003) for the United Kingdom, Fisher and Voss (2004) for Australia and Ioannidis et al. (2006) for Australia, Canada and the United Kingdom.

The Real Estate Institute of Australia provides a Residential Investment Property Index for houses for each major Australian city. The indexes incorporate both capital value and net rental income before taxes. An Australia-wide index is formed by taking a weighted average of the city indexes. The weights are calculated as the ratio of the state population, which is concentrated in the major city, to the Australia-wide population.

The quarterly excess return on stocks of minus 55% in 1987:4, which corresponds to the stock market crash in October of that year, is a highly influential observation. This observation is set to zero through a regression of excess returns on a dummy variable which takes the value of one in 1987:4 and zero otherwise.

The results for returns are very similar to those for excess returns and are available on request.

In the long horizon regressions, the estimated coefficient on $cay_a,v$ is expected to be positive. If the representative household expects the returns on housing and stocks to increase in the future, it will temporarily increase consumption above the long run trend it shares with labor income and the two wealth components. Thus, $cay_a,v$ rises in anticipation of an increase in returns implying a positive coefficient.