

Prices, Rents and Speculative Bubbles in the Sydney Housing Market*

Eden Hatzvi
ehatzvi@hotmail.com

and

Glenn Otto
g.otto@unsw.edu.au

School of Economics
UNSW
Sydney, 2052
Australia

June 2007

Abstract

In this paper we examine whether standard asset pricing theory can explain the behaviour of residential property prices in Sydney. Using price and rent data for LGAs in Sydney, we find little evidence that a rise in price-rent ratios anticipates future growth in rents. Rather changes in price-rent ratios are most likely driven by changing expectations about future discount factors; in particular the long-term real interest rate or real housing returns. However there are some important geographic differences in the behaviour of house prices and returns across Sydney LGAs. We find that a significant amount of the variability in property prices in the outer western regions of Sydney cannot be accounted for by economic fundamentals. Therefore we cannot completely rule out the possibility that property prices in some outer Sydney LGAs are affected by a rational speculative bubble.

Keywords: price-rent ratio, present-value model, discount factor, property prices, speculative bubble, excess returns to housing

JEL Classification: G12, R31

* Financial support from the Australian Research Council Grant No. DP0558678 is gratefully acknowledged. We wish to thank seminar participants at the RBNZ and Victoria University Wellington for their comments and suggestions.

1. Introduction

The behaviour of residential property prices in Sydney is an issue of perennial interest. Aggregate prices for established houses in Sydney rose sharply in the four years leading up to 2003-2004 but have subsequently fallen. However informal evidence suggests that changes in house prices across the city have not been uniform, with recent declines in prices being larger in the outer western regions. Despite the interest in house prices and the considerable commentary about them in the press, there has been little formal analysis of the recent behaviour of house prices in Sydney. The aim of this paper is to provide some empirical evidence on property prices in Sydney with the ultimate objective of identifying the main factors that influence their behaviour.

The framework we use to interpret Sydney property prices is asset pricing theory (Cochrane, 2001). Houses and apartments are durable assets that provide a flow of rents or utility services to their owners over time. Thus current house prices should reflect expectations of future discounted rents or utility services¹. Property prices will rise and fall with changes in buyers and sellers expectations about future discount factors and rental or utility-service flows. Asset pricing theory admits only one other possibility as a driver of prices – a rational speculative bubble. Under a rational bubble house prices can rise independently of expected future fundamentals. A buyer will pay a price for a property that is greater than its fundamental or fair value, simply because they expect to be able to sell it for an even higher price in the future. Over time the expected price of a property always exhibits positive growth².

For some commentators the sharp rise in Sydney house prices in the years leading up to 2004 was *prima facie* evidence of a speculative bubble or at least irrational exuberance in property markets (Economist, 2003; Gittins, 2003a; 2003b). However formal empirical evidence of bubbles in asset markets has been hard to find, in part because it is usually possible to argue that some economic fundamental has not been taken into account by the researcher (Flood and Hodrick, 1990). An advantage of the asset pricing

¹ It is sometimes suggested that asset pricing models assume a fixed supply of residential property and therefore only allow for fluctuations in demand. However changes in housing supply should influence expectations of future rents and this will in turn feedback onto current prices.

² With a stochastic bubble the actual price of a property may fall despite a continual rise in the expected price.

model used in this paper is that it implies a relatively small set of fundamental influences on property prices.

Studies that analyse residential property markets from an asset pricing perspective typically fall into two categories. The first approach focuses on returns or excess returns to housing and examines their predictability (Hamilton and Schwab, 1985; Guntermann and Smith, 1987; Case and Shiller, 1989; 1990; Mean, 2000). The existing evidence suggests that excess returns to housing are time-varying and predictable, both by their own lags and by macroeconomic variables such as interest rates and the ratio of house price to rents. Previously the predictability of excess returns to an asset has been taken as evidence of market inefficiency; however it is now clear that this is not necessarily the case. Excess returns will be predictable if there are predictable variations in the risk premium (Cochrane, 2001; 2006).

A second group of papers use a present value relation linking house prices to economic fundamentals; typically discounted future expected rents (Meese and Wallace, 1994; Clayton, 1996; Ayuso and Restoy, 2003; 2006; Grimes and Aitken, 2007). The simplest and most restrictive present value model for houses implies that the price of a house should equal the present discounted value of the future stream of rents (either explicit or implicit). Furthermore when the discount rate is constant and there are no bubbles we expect to observe a common trend in house prices and rents.

This basic version of the present value model cannot provide an adequate explanation for the Sydney data, since a key feature of the residential property market is the marked rise in the ratio of prices to rents – the price-rent ratio. Figure 1 illustrates this rise in the price-rent ratio using data for established houses over the period 1982 to 2005³. From the mid-1990s to around 2004 annual price-rent ratios roughly doubled, from about 20 to 40. At the peak of the recent Sydney housing boom buyers were willing pay up to 40 times the annual market rent on a house. While ratios have fallen somewhat since their peak, they still remain well above the levels of the early 1990s. In order to account for these changes in the price-rent ratio we use a present value model that allows for a time-varying stochastic discount factor (Campbell and Shiller, 1988; Cochrane, 1992).

³ The quarterly data for this figure are produced by the Real Estate Institute of Australia (REIA). The price series measures the median established house price and the rent series is the median annual rent on a three bedroom house.

Section 2 of the paper begins with a general asset pricing formula linking house prices to their expected, discounted payoffs. This formula is then used to derive testable models for both the expected excess returns to housing and for the price-rent ratio. Predictions of the models are tested using quarterly data on property prices, rents and returns for Local Government Areas (LGAs) of Sydney from 1991 to 2006. The definitions of the data series and some summary statistics for each LGA are presented in Section 3.

Section 4 presents our empirical findings on the predictability of excess housing returns in Sydney. The evidence suggests that excess housing returns across Sydney regions are time-varying and predictable. Furthermore the variables that forecast excess returns to housing include real and nominal interest rates and the price-rent ratio, which we argue are likely to be correlated with the state of the economy and hence with the aggregate risk premium.

The results obtained from testing the predictions of the present value relation for the price-rent ratio are reported in Section 5. The evidence suggests that changes in price-rent ratios are most likely driven by changing expectations about future discount factors. However we also find that the ability of the present value model to explain variation in the price-rent ratio differs across LGAs. In those LGAs that cover the outer western areas of Sydney about 50 percent of the variation in price-rent ratios is unexplained by fundamentals. This finding points to a possible role for speculative bubbles in influencing house prices in these LGAs. To investigate this further we compare the behaviour of price-rent ratios in outer western areas to an average of LGAs in the inner region, where the evidence indicates no bubble exists. These comparisons are reported in Section 6. Section 7 concludes.

2. House Prices and Rents in an Asset Pricing Framework

According to asset pricing theory the price of an asset should equal its expected discounted payoff. In the case of a house its price should satisfy the following relationship,

$$P_t^h = E_t[M_{t+1}(P_{t+1}^h + R_{t+1}^h)] \quad (1)$$

where P_t^h is the house price at time t , R_t^h is the rent (possibly implicit) on a house at time t , M_{t+1} is the stochastic discount factor and E_t is the expectation operator conditional on information at time t .

Excess Returns

Defining the gross one-period return on a house as $(1 + r_{t+1}^h) \equiv \frac{P_{t+1}^h + R_{t+1}^h}{P_t^h}$ allows (1) to

be re-written in terms of the returns;

$$1 = E_t[M_{t+1}(1 + r_{t+1}^h)] \quad (2)$$

Following Cochrane (2001) this formula can be transformed into a statement about excess returns to housing,

$$E_t(er_{t+1}^h) = \frac{-Cov_t[M_{t+1}, (1 + r_{t+1}^h)]}{E_t M_{t+1}} \quad (3)$$

where $er_{t+1}^h = r_{t+1}^h - r_{t+1}^f$, r_{t+1}^f is the risk-free real interest rate, which satisfies

$(1 + r_{t+1}^f) = 1 / E_t M_{t+1}$. The expected excess return on a house depends on the conditional covariance of its return with the stochastic discount factor. This covariance is a measure of the risk premium on housing and will be negative on average since housing is a risky asset. The covariance can differ between properties and it can also vary over time.

Notice that if the covariance term on the right hand side of (3) varies over time then so will expected excess returns.

Tests of the efficient market hypothesis that require excess returns at time $t+1$ to be unpredictable using information available at time t are consistent with (3) only when the conditional covariance term is constant over time. However because M_{t+1} measures the growth in the marginal utility of wealth it is likely to vary with the state of the economy. Therefore variables that can predict the state of the economy will predict the risk premium and excess returns to housing.

Previous studies have examined the predictability of housing returns or the capital gain component for the US (Guntermann and Smith, 1987; Case and Shiller, 1989; 1990) and the UK (Meen, 2000). The evidence indicates that housing returns are serially correlated and also predictable by a number of macroeconomic variables including; interest rates,

real income and the ratio of house prices to rent. In Section 4 we examine the predicability of excess returns to residential property in the Sydney market. Equation (3) provides a basis for choosing variables that might predict excess returns and for interpreting their predictability (or otherwise).

A Present Value Model

Following Cochrane (1992) equation (1) can be iterated forward to obtain an equation for the price of a house;

$$P_t^h = E_t \sum_{i=1}^T \left(\prod_{k=1}^i M_{t+k} \right) R_{t+i}^h + E_t \left(\prod_{k=1}^T M_{t+k} \right) P_{t+T}^h \quad (4)$$

then if the transversality condition $\lim_{T \rightarrow \infty} E_t \left[\left(\prod_{k=1}^T M_{t+k} \right) P_{t+T}^h \right]$ is imposed to rule out rational bubbles we obtain;

$$P_t^h = E_t \sum_{i=1}^{\infty} \left(\prod_{k=1}^i M_{t+k} \right) R_{t+i}^h \quad (5)$$

Equation (5) states that the current price of a house is equal to the expected present-discounted value of future rents.

Given our focus is on the price-rent ratio, we divide both sides of (5) by R_t^h to obtain

$$\frac{P_t^h}{R_t^h} = E_t \sum_{i=1}^{\infty} \left(\prod_{k=1}^i M_{t+k} \right) \frac{R_{t+i}^h}{R_t^h} \quad (6)$$

or

$$\frac{P_t^h}{R_t^h} = E_t \sum_{i=1}^{\infty} \left(\prod_{k=1}^i M_{t+k} G_{t+k}^R \right) \quad (7)$$

where $G_{t+1}^R = \frac{R_{t+1}^h}{R_t^h}$ is gross rent growth. Equation (7) now explains the current price-rent ratio in terms of expectations of future rent growth and future discount factors.

The non-linearity of equation (7) makes it difficult to empirically test. Cochrane derives a log-linear approximation to (7) using a Taylor expansion. Re-write (7) as

$$\frac{P_t^h}{R_t^h} = E_t \sum_{i=1}^{\infty} \exp \left(\sum_{k=1}^i (g_{t+k}^R - m_{t+k}) \right) \quad (8)$$

where $g_t^R = \log(G_t^R)$ and $m_t = -\log(M_t)$. Assuming that the growth rates of rent and the discount factors are stationary, we can take a first-order Taylor expansion of the right-

hand side of (8) around $E(g^R)$ and $E(m)$. This yields the following approximate present value relation for the price-rent ratio,

$$\frac{P_t^h}{R_t^h} \cong \frac{\Omega}{1-\Omega} + \frac{1}{1-\Omega} E_t \sum_{i=1}^{\infty} \Omega^i (\tilde{g}_{t+i}^R - \tilde{m}_{t+i}) \quad (9)$$

where $\tilde{g}_t^R = g_t^R - E(g)$, $\tilde{m}_t = m_t - E(m)$ and $\Omega = \exp(E(g) - E(m))$ ⁴. The first term on the right-hand side of (9) indicates the value of the price-rent ratio in a world of certainty with constant rent growth and a constant discount rate⁵. The second right-hand side term explains variations in the price-rent ratio around its mean as due to changing expectations about rent growth and discount rates. The price-rent ratio increases when rent growth rates are forecast to rise (above their mean) and/or discount rates are forecast to decline. The approximate present-value relation (9) is what we use to try and explain the behaviour of price-rent ratios in the Sydney housing market.

A standard approach to testing present value models is to use the VAR methodology proposed by Campbell and Shiller (1987)⁶. Ayuso and Restoy (2003) use this approach in their analysis of aggregate house prices in Spain. While the Campbell and Shiller methodology can provide a formal statistical test of equation (9), we have chosen not to use it in this paper for a number of reasons. First the restrictions imposed by present value models are frequently rejected by the data. While such rejections tell us there is something wrong with the model, they do not provide much guidance about the reasons for the failure. Nor do they indicate whether the models' inability to match the data in a statistical sense is an economically importance rejection. Second while we believe that our data on house prices and rents are of relatively of good quality compared to that used in many previous studies, the data are for regions rather than individual properties and will almost surely contain some measurement error. This may create problems for formal statistical tests. Finally the Campbell and Shiller test may perform poorly if one of the variables in the present value model is very persistent (Hodrick, 1992). Figure 1 suggests that this is likely to be the case for price-rent ratios in Sydney.

⁴ Cochrane (1992) uses a second-order Taylor expansion which would produce an additional term in (9) that measures covariance of rent growth with the discount rate.

⁵ This is just the classic Gordon (1962) growth model for stock prices.

⁶ This is a generalisation of the Hansen-Sargent methodology which is applied to the study of house prices by Meese and Wallace (1994) and Clayton (1996).

To evaluate the ability of equation (9) to explain the behaviour of price-rent ratios in Sydney we focus on two basic predictions of the model. The first of these follows from the fact that variations in the current price-rent ratio should reflect anticipated future changes in the growth of rents or in discount factors. If this is correct then the price-rent ratio must predict future growth in rents and/or the discount factor⁷. Notice that if \tilde{g}_t^R and \tilde{m}_t are unpredictable then this test would fail, however in that case the price-rent ratio would just fluctuate randomly around its mean. Furthermore in deriving equation (9) the existence of a rational speculative bubble is ruled out by the imposition of a transversality condition. Therefore if we find that fluctuations in the price-rent ratio do not predict rent growth or a reasonable proxy for the stochastic discount factor, then we would have some support for the view that speculative bubbles are an important influence on house prices.

While tests of predictive content provide evidence about what variables cause changes in the price-rent ratio, they do not necessarily give us an estimate of the contribution to the variation in the price-rent ratio that any particular variable makes. Thus we might be interested in having an estimate of how much of the variation in the price-rent ratio is due to predictable changes in rent growth. Cochrane (1992) suggests a variance decomposition for equation (9) that can be used to answer such questions.

Variance Decomposition

Multiply both sides of (9) by $[\frac{P_t^h}{R_t^h} - E(\frac{P^h}{R^h})]$ and take unconditional expectations to get,

$$E[\frac{P_t^h}{R_t^h} - E(\frac{P^h}{R^h})] \frac{P_t^h}{R_t^h} \cong \frac{1}{1-\Omega} E\{[\frac{P_t^h}{R_t^h} - E(\frac{P^h}{R^h})] \sum_{i=1}^{\infty} \Omega^i (\tilde{g}_{t+i}^R - \tilde{m}_{t+i})\} \quad (10)$$

or

$$V(\frac{P_t^h}{R_t^h}) \cong \frac{1}{1-\Omega} \sum_{i=1}^{\infty} \Omega^i \left(\text{cov}(\frac{P_t^h}{R_t^h}, \tilde{g}_{t+i}^R) - \text{cov}(\frac{P_t^h}{R_t^h}, \tilde{m}_{t+i}) \right). \quad (11)$$

⁷ Engle, Mark and West (2007) use a similar strategy to evaluate conventional models of the nominal exchange rate. They argue that examining forecasting ability may be robust to omitted fundamentals whereas Campbell and Shiller's test is likely to be quite sensitive to this form of misspecification.

Equation (11) shows that the variance of the price-rent ratio can be approximated by the covariances between the current price-rent ratio and future rent growth rates and the current price-rent ratio and future stochastic discount factors. To make (11) operational we can replace the population moments by their sample analogues and truncate the sum of the covariances at some point. The estimates of the summed covariances provide a measure of the percentage of variation in the price-rent ratio that is due to rent growth relative to changes in the discount factor.

Discount Factors

One final issue concerns the measurement of the (unobserved) stochastic discount factor M_t . One choice is to set $M_t = (1 + r_t^h)^{-1}$, the ex-post real return on housing. This choice satisfies equation (2) by definition so that equation (9) now becomes an (approximate) identity (Campbell and Shiller, 1988). If we rule out speculative bubbles then it must be true that a rise in the price-rent ratio is associated with higher future rent growth and/or a fall in returns to housing. Conversely if variation in rent growth and housing returns is found to contribute little to the variance of the price-rent ratio, this provides indirect evidence of a rational bubble.

Asset pricing theories suggest other choices for the stochastic discount factor⁸. For example the CAPM suggests the using the return to the market portfolio, while more traditional approaches to discounting suggest the use of the real interest rates. We employ three other choices for M_t , the real mortgage rate, the real bond rate and the real equity returns. These variables reflect returns on other assets and should influence the returns to and consequently the price of housing.

3. Data and Summary Statistics

House Prices and Rents

We use quarterly data on median house prices and median weekly rents for Local Government Areas (LGAs) in metropolitan Sydney. The source of the price and rent data

⁸ In an optimal consumption framework $M_t = \frac{\beta u'(c_{t+1})}{u'(c_t)}$ implying that we can approximate \tilde{m}_t by some

function of consumption growth (or possibly wealth growth). This is not feasible in the current context as we do not have data on consumption at the LGA level.

is the NSW Department of Housing's quarterly *Rent and Sales Reports*. Data on rents are derived from information provided when renters and landlords lodge bonds with the Office of Fair Trading. Price data is based on title information provided by the Department of Lands. For most LGAs we have rent and price data for the period 1991:1 to 2006:3. In total we have data for 36 LGAs.

The data on rents is disaggregated into houses and units and also by the number of bedrooms. We construct three series for rents – for apartments, for houses and an aggregate rent series. When aggregating (for example to get overall rent for apartments from data on one and two bedroom apartments) we use weights from the 2001 Census - which indicates the number of one and two bedroom apartments in each LGA.

Data on sales prices are reported by housing title (strata and non-strata) and for aggregate sales. Strata title includes townhouses, terraces, villas, flats and units while non-strata title includes, separate houses and multi-unit dwellings with Torrens title. The data allow us to construct measures of aggregate property prices and for two disaggregated series – roughly houses and apartments. In constructing price-rent ratios; sale prices for strata titles are used as the denominator for apartment rents, sale prices for non-strata titles for house rents and aggregate sale prices for aggregate rents⁹.

Figure 2 shows aggregate price-rent ratios for three Sydney LGAs; Randwick, Manly and Penrith. Consistent with the aggregate Sydney data in Figure 1, price-rent ratios are relatively flat in the period 1991-96 after which there is steady growth until about 2001. There is acceleration in growth until 2003-04, after which price-rent ratios have declined, although generally not to pre-1996 levels. A broadly similar pattern for price-rent ratios is repeated across all Sydney LGAs.

The return to housing in each LGA is computed using the following formula,

$$(1 + r_t^h) \equiv \frac{P_t^h + R_t^h}{P_{t-1}^h}.$$

Other Series

Mortgage rates are measured using the standard variable mortgage rate for banks, while the bond rate is the 10-year government bond rate. Stock returns are based on the

⁹ Most of the results in this paper are based on data that is aggregated over houses and apartments.

S&P/ASX 200 accumulation index. Finally to compute real rent growth and real returns we use the CPI for Sydney.

Summary Statistics

Table 1 provides a list of the 36 LGAs used in this study. LGAs are classified into three groups - an inner, middle and outer ring - based on their distance from the Sydney CBD. Reported in the table are various summary statistics based on aggregated data (i.e. houses and apartments) for each LGA. Across the Sydney LGAs quarterly real rent growth averaged about 0.16 percent during the period 1991-2006, with the highest growth occurring in the inner ring and the lowest in the outer ring. Average real price growth was about five times that of real rents and was highest in the outer ring (0.95 percent per quarter) and lowest in the inner ring (0.76 percent per quarter). The quarterly real return to houses and apartments in Sydney averaged a little over 2 percent and was about one-quarter of a percent higher in the outer ring of LGAs. The final three columns of the table report the mean, minimum and maximum values of the quarterly price-rent ratio.

Although our main interest lies with the time series behaviour of the price-rent ratio, it is informative to examine initially the cross-section features of the data. Figure 3 presents a scatter-plot of average real returns to residential property against the average price-rent ratio for each LGA. The data indicate a clear negative relationship – high price-rent ratios are associated with relatively low real returns. By comparison Figure 4 plots real rent growth rates against the average price-rent ratio for each LGA. There is a relatively weak positive relationship between the two series, suggesting that variations in price-rent ratios across LGAs are not primarily driven by differences in rent growth.

Finally the cross-section data can be used to estimate an unconditional (or steady-state) version of equation (9). Taking unconditional expectations of both sides of (9) gives,

$$E\left(\frac{P^h}{R^h}\right) \cong \frac{\Omega}{1 - \Omega} \quad (12)$$

where $\Omega = \exp(E(g) - E(m))$. $E(g)$ can be estimated by average real rent growth in each LGA and we use the quarterly average of the real bond rate (0.01057) to estimate $E(m)$. Figure 5 plots the mean price-rent ratio for each LGA and also the steady-state

value that is implied by the right-hand side of (12). Aside from sampling error the two lines should be equal, however the model-based estimate tends to over-estimate the sample average. The degree of over-estimation by the steady-state present value model is largest for the LGAs in the inner ring.

4. Are Excess Returns to Housing Predictable?

If risk premia are time-varying and predictable then equation (3) implies that excess returns to housing will also be predictable. We begin by testing for evidence of serial correlation in excess housing returns. Excess returns are regressed on 4 lags of excess returns, a constant, 3 seasonal dummies and a GST dummy¹⁰. The main results from this regression model are presented in the first two columns of Table 2. Using a 5 percent significance level, there is some evidence of seasonality although only in about 20 percent of LGAs. There is stronger evidence that excess returns are serially correlated. In about 70 percent of LGAs the lagged values of excess returns are statistically significant. One interesting feature of the results is that the nature of the serial correlation apparently differs across LGAs. Excess returns in the inner region LGAs typically display negative serial correlation. This can be seen by computing the sum of the coefficient estimates on the four lags of excess returns. The sum and its associated t-statistic are reported in column 2. For example in Woollahra the sum is -0.60 and its t-statistic is -2.36. In contrast for LGAs in outer Sydney excess returns tend to be positively serially correlated. For example in Penrith the coefficient sum is 0.89 and its t-statistic is 8.99. The different dynamics of excess returns are clearly evident in Figure 6, which plots excess returns for Randwick and Penrith¹¹.

The results from the serial correlation test indicate that excess returns to housing are time-varying. Thus we now examine whether they are predictable by economic variables. While there are a large number of candidate regressors we limit our “fishing expedition” to the following; the price-rent ratio, the real bond rate and the nominal bond rate and the inflation rate¹². The results in columns 3 and 4 of Table 2 are based on a regression of excess returns on the four lags of both the price-rent ratio and the real bond rate. In

¹⁰ The dummy variable for introduction of the GST takes the value 1 in 2000:3 and zero elsewhere.

¹¹ One possible explanation for the different patterns is that the median house price in Randwick is subject to greater variation due to compositional changes in the type of houses sold.

¹² The decision to include inflation as a separate regressor is based on Brunnermeier and Julliard (2007).

general at least one of these variables and in most cases both are significant predictors of excess returns. The only exceptions are the LGAs of Ryde and Warringah.

In terms of the estimated effects; a rise in the price-rent ratio or a rise in the real interest rate anticipates a future fall in excess returns to housing. Columns 5, 6 and 7 show the effect of allowing for separate effects from the nominal bond rate and the inflation rate.

One question that emerges from these results is whether the variables used as regressors reference risks in the residential property market. The key assumption is that property prices and interest rates are likely to be positively correlated with economic conditions. When times are good owners will accept a low return on their property, but in bad economic times they require a higher return to hold the asset.

5. What do Price-Rent Ratios Predict?

We now turn to the issue of whether observed movements in the price-rent ratios in the various LGAs of Sydney predict future changes in local rent growth and variations in future discount factors.

Econometric Model

The following regression model provides a simple framework for testing the predictive content of the price-rent ratio;

$$x_t = \mu + \sum_{i=1}^k \alpha_i x_{t-i} + \sum_{i=1}^k \beta_i \frac{P_{t-i}^h}{R_{t-i}^h} + \omega_t \quad (13)$$

In equation (11) x indicates the variable that the present value model implies should be forecast by the price-rent ratio. Our five choices for x are; the growth rate of real rents, real returns to housing, the real mortgage rate, the real 10 year bond rate and real equity returns.

The present value model (9) predicts that if a particular choice of x is relevant we should find that lags of the price-rent ratio in (13) are jointly significant¹³. Furthermore the sign on β_i is predicted to be positive for real rent growth and negative for the variables measuring the stochastic discount factor. However rather than requiring each

¹³ Strictly speaking the price-rent ratio could predict rent growth and the discount factor but not Granger-cause them. This would arise where the only variables used by agents to predict rent growth and the discount factors were their own lags. One solution would be to follow the empirical literature on share prices and dividends and use long-horizon regressions. However in the current context we believe the use of an ADL model like (13) will produce more reliable results.

β_i to be a particular sign we focus on the sum of the (k) β_i s and its statistical significance. Finally we also compute the long-run or steady-state response of x to the price-rent ratio; $\frac{\sum \beta_i}{1 - \sum \alpha_i}$. These steady-state values indicate how useful the price-rent ratio is at predicting long-term movements in x . In the steady-state (13) becomes

$$x = \frac{\mu}{1 - \sum \alpha_i} + \left[\frac{\sum \beta_i}{1 - \sum \alpha_i} \right] \frac{P^h}{R^h} \quad (14)$$

so the slope coefficient measures the change in the long-run forecast long-run response of x to a (persistent) change in the price-rent ratio. When this number is close to zero the price-rent ratio must have relatively little long-run predictive power for x . Thus even if we observe a persistent rise in the price-rent ratio we would not predict a very large change in the future value of x .

Empirical Results

The results presented in this section are for $k=6$. We have chosen a relatively large value for k to ensure that dynamics in the price-rent ratio series are adequately modelled and that the residuals are serially uncorrelated. Table 3 reports the p-value for an F-test of the joint significance of the β_i s, the sum of the estimated values of the β_i s and the t-statistics for the statistical significance of the sum. In response to the question of which of the x variables are predicted by median price-rent ratios in the LGAs, we document four main findings.

Result #1: An increase in the price-rent ratio does not anticipate future increases in the growth rate of real rents.

In about two thirds of LGAs the lags of the price-rent ratio are not statistically significant in explaining the growth rate of rents. In that third of LGAs where lags of the price-rent ratio are jointly significant, the sum of the estimated coefficients on the lags on the price-rent ratio is almost always statistically significant and of the wrong sign. There is really only one LGA (Fairfield) which could be said to provide reasonable statistical support for the present value model (9) with respect to rents.

Cochrane (1992) emphasises that it is only predictable changes in real rent growth that should produce variation in the price-rent ratio. If real rent growth is unpredictable its future behaviour will not affect current house prices and we should not find evidence of

Granger-causality. Thus one explanation for our results is that the growth rate of real rents is not predictable. This does not seem to be the case. We estimate an AR(6) model for real rent growth in each LGA and test the joint significance of the six lags. Figure 7 shows the p-value associated with the relevant F-test. For most LGAs the growth rate of rent is predictable by its own lags. Since rent growth is predictable it should produce variations in the price-rent ratio – our Granger-causality tests suggest it does not in two-thirds of LGAs and in the remaining one-third any effect is generally of the wrong sign.

Where houses and apartments are owner-occupied there is no explicit rental payment, rather there will be an unobserved utility flow to the owner-occupier of the house. It is conceivable that market rents may provide an imperfect proxy for the flow of services to owner-occupied housing. It is difficult to formally test this possibility in the current situation, although to explain the behaviour of price-rent ratios in Sydney growth of utility flows from home ownership must have been expected to grow much faster than rents.

Result #2: An increase in the price-rent ratio predicts declining real returns to housing.

When real housing returns are used in (13) we are testing an identity rather than a specific asset pricing model. It is therefore reassuring to find that an increase in the price-rent ratio forecasts declining real returns to housing in all LGAs. These findings are consistent with the cross-section averages in Figure 3. The economic content to this finding arises from the fact that equation (9) is derived from imposing a no-bubbles condition. Thus if price-rent ratios did not predict either rents or housing returns it would have suggested a possible role for bubbles in determining house prices. The finding that price-rent ratios do forecast returns is evidence against the speculative bubble explanation for Sydney property prices.

Result #3: An increase in the price-rent ratio predicts declining real interest rates.

Across virtually all LGAs we find strong evidence that price-rent ratios are useful in forecasting future movements in the (ex-post) real mortgage rate and the 10 year bond rate. Furthermore the sign of the effect is consistent with our theory - increases in price-rent ratios anticipate future declines in real interest rates. Based on the magnitude of the t-statistics the price-rent ratio seems to be slightly better at forecasting the real bond rate than the real variable mortgage rate.

Result #4: An increase in the price-rent ratio does not predict declining real equity returns.

For a majority of LGAs there is evidence that price-rent ratios do forecast real equity returns. However it is also evident from Table 3 that there is no systematic pattern to the sum of the estimated coefficients on lags of the price-rent ratio. In addition the sum is never statistically significant.

What emerges from the prediction tests is that Sydney property prices appear to respond to anticipated future movements in long-term real interest rates. This raises the question as to whether there are systematic differences across LGAs in the response of price-rent ratios to changes in the long-term interest rates. If property prices in some locations responded more to expected changes in real rates this could explain differences in the level of house prices across Sydney. We examine this by looking at the magnitude of the long-run coefficients on the price-rent ratio in the model for the real bond rate.

What are the Long-Run Effects?

The (absolute value) of the long-run coefficients are reported in Figure 8 for each LGA. With a few exceptions there are not large differences across LGAs in the estimated long-run coefficients. Coefficient estimates appear to be somewhat above average for five LGAs - North Sydney, Lane Cove, Willoughby, Strathfield and Ashfield. The average effect across Sydney is 0.016. This implies that a rise in the quarterly price-rent ratio by 10 percentage points (from 90 to 100) predicts a decline in future real bonds rates of about 0.16 percentage points. Reversing this - if the RBA could engineer a credible expected fall in real bond rates of 0.50 basis points – this would be associated with an increase in the quarterly price-rent ratio by about 30 percentage points (or in the annual price-rent ratio by about 7.5 percentage points).

Further evidence of the ability of the price-rent ratio to predict the real bond rate in the long-run is provided by Figure 9. This graph plots the long-run predictions for the real bond rate using equation (14) and price-rent ratios in three LGAs - Randwick, Manly and Penrith against the actual value of the real bond rate. While the real bond rate is more variable than its predictions, the predicted values do track the downward trend in the real bond rate over the sample period.

Decomposing the Variance of the Price-Rent Ratio

The above results suggest that changes in price-rent ratios in Sydney are driven by changing expectations about future housing returns or future real interest rates. To measure the relative contributions of that various fundamentals make to the variance of the price-rent ratio we use the decomposition given in equation (11). For a given choice of x we compute the following ratio for each LGA,

$$\frac{100}{1 - \hat{\Omega}} \sum_{i=1}^{20} \hat{\Omega}^i \left(\text{cov}\left(\frac{P_t^h}{R_t^h}, x_{t+i}\right) \right) \left[\text{var}\left(\frac{P_t^h}{R_t^h}\right) \right]^{-1} \quad (15)$$

where $\Omega = \exp(E(g) - E(m))$ with $E(g)$ estimated by average real rent growth in each LGA and the quarterly average of the real bond rate (0.01057) used to estimate $E(m)$. We consider the contributions of real rent growth, real returns to housing and the real bond rate. Table 4 reports the percentage of the sample variance of price-rent ratios in Sydney LGAs that is accounted for by each variable.

The first column shows the contribution that real rent growth makes to the variance of the price-rent ratio. The estimated contribution of real rent growth to the variance of the price-rent ratio is typically small and frequently negative. This is consistent with our earlier finding that a rise in the price-rent ratio does not predict higher growth in real rents. The negative numbers (to the extent they are significant) imply that rises in the price-rent ratio are actually predicting lower real rent growth.

The contribution of the real bond rate to the variance of the price-rent ratio is provided in column 4. Estimated contributions range from 37 percent for North Sydney to 5 percent in Willoughby. The difference in contributions across LGAs is interesting, given that we do not see much cross-section variance in the long-run estimates in Table 8. In general the contribution from the real bond rate tends to be highest for inner ring LGAs. However even then, less than a quarter of the variance in the price-rent ratio can be attributed to changing expectations about future real interest rates.

When real returns to housing are used in equation (15) we find a much greater proportion of the variance of the price-rent ratio is accounted for. This is not unexpected. In light of the low or negative contributions of real rent growth we expect the contribution of real returns to be 100 percent or (even higher). The total contribution from rents and returns is reported in column 3. It is evident that for inner ring LGAs the

estimates are close to 100. There does not appear to be much variation in price-rent ratios in inner ring LGAs that is not accounted for by fundamentals.

However this is not the case for most of the outer ring LGAs. Here the contributions of fundamentals are generally less than 50 percent. There seems to be some tendency for the contribution of real returns to decline with distance from the CBD. For the inner ring of LGAs real returns and rents explain on average 100 percent of the variance of price-rent ratios. This figure falls to about 70 percent for the middle ring and to 52 percent for the outer ring of LGAs.

The results for the outer ring of LGAs are interesting. What they imply is that in these outer ring of LGAs a reasonably large proportion of the variation in price-rent ratios cannot be explained by future rent growth or even by future housing returns. According to the present value relation the only remaining source of variation in the price-rent ratio is a rational bubble.

6. Is There a Speculative Bubble?

In this section we investigate in more detail the question of a speculative bubble in outer Sydney property prices. While the variance decomposition suggests there is unexplained variation in the price-rent ratio in some LGAs it is possible that these results are affected by non-stationarity in the data. Although the price-rent ratio should in theory be a stationary series, it is evident that in our particular sample period it does exhibit some persistent trends. This is not necessarily a problem for the regression based tests if at least one of our fundamentals \tilde{g}_t^R or \tilde{m}_t exhibits a common trend to the price-rent ratio. However it may invalidate the calculation of the unconditional variance of the price-rent ratio used in (15).

One potential solution is to look at differences in the behaviour of price-rent ratios across LGAs. Consider versions of equation (9) for two LGAs denoted 1 and 2 and then subtract the present value model for 2 from 1;

$$\frac{P_{1t}^h}{R_{1t}^h} - \frac{P_{2t}^h}{R_{2t}^h} \cong \frac{\Omega_1}{1-\Omega_1} - \frac{\Omega_2}{1-\Omega_2} + \frac{1}{1-\Omega_1} E_t \sum_{i=1}^{\infty} \Omega_1^i (\tilde{g}_{1t+i}^R - \tilde{m}_{t+i}) - \frac{1}{1-\Omega_2} E_t \sum_{i=1}^{\infty} \Omega_2^i (\tilde{g}_{2t+i}^h - \tilde{m}_{t+i}) \quad (16)$$

Since rent growth is almost certainly a stationary series and \tilde{m}_t is common to both LGAs we can write (16) as

$$\frac{P_{1t}^h}{R_{1t}^h} - \frac{P_{2t}^h}{R_{2t}^h} \cong \mu - \left[\frac{\Omega_1}{(1-\Omega_1)^2} - \frac{\Omega_2}{(1-\Omega_2)^2} \right] \tilde{m}_t + \omega_t \quad (17)$$

where ω_t is a stationary error term. Equation (17) implies that if $\Omega_1 \cong \Omega_2$ differences in the price-rent ratios for the two LGAs should be roughly stationary. However one thing that would definitely cause large and persistent differences between price-rent ratios in LGAs is if there was a speculative bubble in one LGA but not in the other.

The results in Table 4 imply that in inner ring LGAs variation in price-rent ratios is fully explained by economic fundamentals. Based on this finding we compute an average price-rent ratio for the nine LGAs in the inner ring and view it as a bubble-free series. Figure 10 shows the differences between the price-rent ratio for each inner ring LGA and the mean price-rent ratio for the inner ring. While Woollahra looks a little different to the other LGAs, there are no obvious trends in these differences.

Turning to the outer ring LGAs we find a very different picture emerges. Figure 11 presents the differences between the price-rent ratios in four western Sydney LGAs – Liverpool, Fairfield, Blue Mountains and Blacktown – and the average price-rent ratio for the inner ring LGAs. Notice that in the initial half of the sample the differences in the price-rent ratios appear to be relatively stationary. However in the latter half of the sample there is a pronounced upward trend in the differences, followed by a decline in the differences from about 2004. Over a period of 5 years price-rent ratios in these four LGAs move from being about 10 units below the average for the inner region to being 10-20 units above the inner region average by 2004. Something caused this (relative) rise in price-rent ratios and in the absence of other fundamental explanations we view this as providing some support for a speculative bubble.

5. Conclusions

The results in this paper suggest that a partial explanation of the recent boom in Sydney property prices lies with lower long-term real interest rates. During the second half of the 1990s it appears that buyers and sellers of residential property came to expect a relatively persistent fall in real interest rates. This led to an upward re-valuation of the flow of rents (or utility services) associated with houses and apartments and drove up market prices (relative to rents). At the same time there seems to be little evidence that buyers and sellers were expecting any (short or medium term) increase in the growth rate

of rents. Just as future dividend or earnings growth explains little of the variation in stock prices, we find that real rent growth explains little of the variation in residential property prices.

The idea that expected real interest rate changes drive house prices is a simple and theoretically appealing story. Unfortunately some of our empirical results also suggest that it is incomplete. At most only about a quarter of the variation in Sydney price-rent ratios seems to be due to expected variation in real interest rates. In explaining the remaining variation we find that our story varies with location. For properties that are close to the CBD almost all of the variation in the price-rent ratio can be explained by expected variation in future returns to housing. An economic interpretation of this finding is that there was a decline on the risk premium on houses and apartments leading to a bidding-up of the property prices and a lowering of expected (excess) returns. While this conclusion leaves unanswered the question of what drives the risk premium, at least it rules out any influence on house prices from speculative bubbles.

Finally when we consider property in the outer western suburbs of Sydney even appealing to a declining risk premium leaves about half of the variation in price-rent ratios unaccounted for. According to our model the only remaining explanation is a rational speculative bubble.

Figure 1: Median Price-Rent Ratio for Established Houses in Sydney (1982-2005)

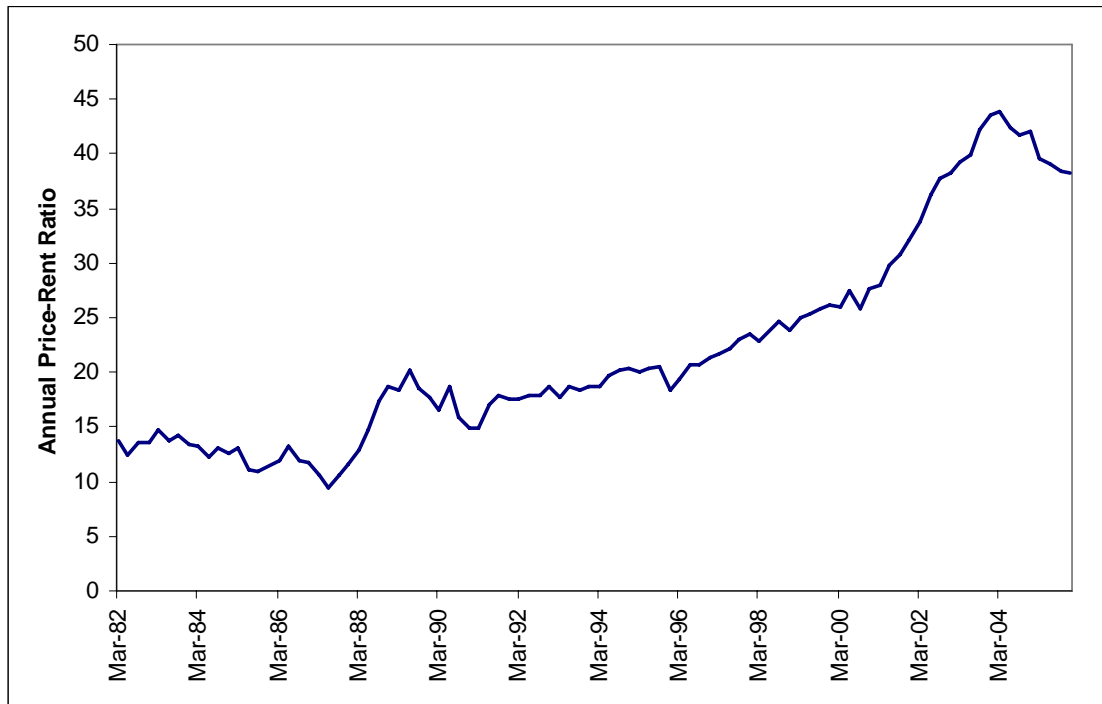


Figure 2: Median Price-Rent Ratios in 3 Sydney LGAs (1991-2006)

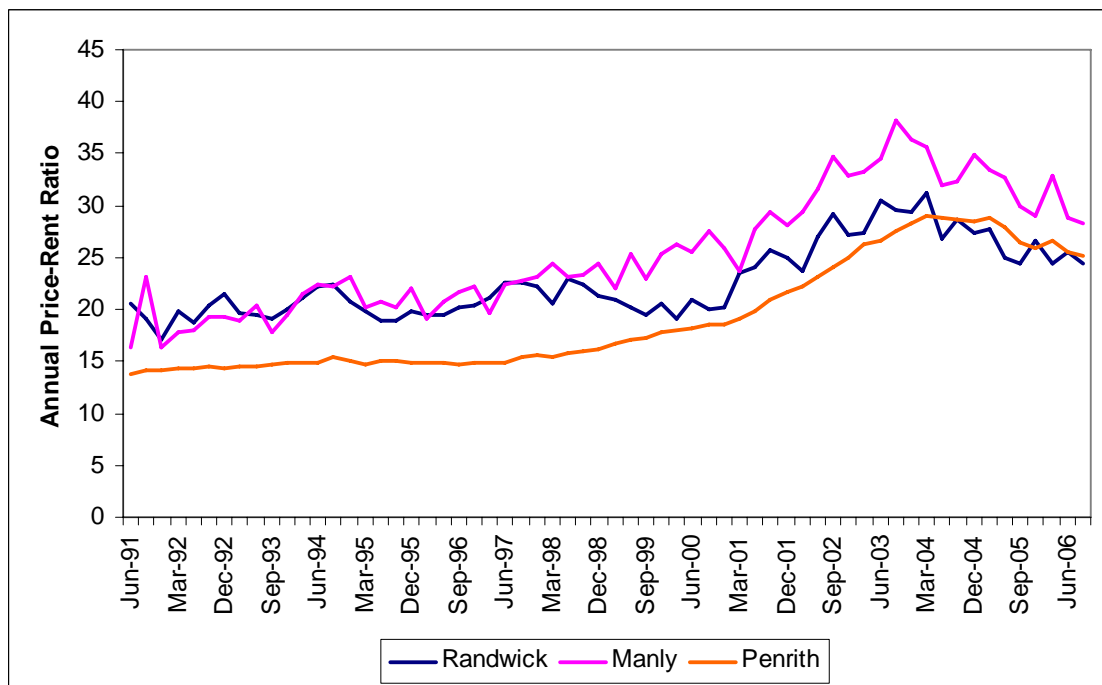


Table 1: Summary Statistics for LGAs in Sydney

LGA	Sample	Real Rent Growth % per qtr	Real Price Growth % per qtr	Real Return % per qtr	P-R Ratio Mean quarterly	P-R Ratio Min quarterly	P-R Ratio Max quarterly
Inner Ring							
Ashfield	91:1-06:3	0.21	1.04	2.33	79.9	55.0	115.4
Botany	91:1-06:3	0.20	0.69	1.96	84.2	50.6	128.9
Lane Cove	91:3-06:3	0.16	0.45	1.61	87.9	57.6	122.7
Leichhardt	91:2-06:3	0.41	1.21	2.33	92.4	64.0	140.1
Marrickville	91:1-06:3	0.36	1.73	2.96	86.4	47.3	132.5
North Sydney	91:3-06:3	0.43	0.47	1.59	91.0	70.5	114.3
Randwick	91:2-06:3	0.29	0.59	1.70	90.5	68.3	125.1
Waverley	91:1-06:3	0.52	0.89	2.04	89.6	63.2	135.8
Woollahra	91:1-06:3	0.12	-0.21	0.71	113.1	75.9	163.5
Average		0.30	0.76	1.91	90.6	61.4	130.9
Middle Ring							
Auburn	91:1-06:3	0.16	1.14	2.32	90.5	59.0	139.8
Bankstown	91:1-06:3	-0.04	0.85	2.04	89.2	62.8	137.9
Burwood	92:4-06:3	0.24	0.85	1.92	95.3	71.4	134.1
Canterbury	91:2-06:3	0.09	0.76	2.01	83.2	56.0	132.1
Hurstville	91:2-06:3	0.03	0.77	1.88	93.7	67.4	139.3
Kogarah	91:2-06:3	0.09	0.61	1.71	92.7	72.5	134.8
Ku-ring-gai	91:3-06:3	0.07	0.62	1.50	117.0	90.4	161.5
Manly	91:1-06:3	0.56	1.64	2.66	101.5	58.0	152.9
Parramatta	91:1-06:3	-0.02	0.75	1.96	87.0	63.3	128.6
Rockdale	91:2-06:3	0.13	0.72	1.92	85.4	64.0	127.9
Ryde	91:1-06:3	0.10	0.96	2.08	92.6	63.3	139.9
Strathfield	91:1-06:3	0.08	0.57	1.65	93.5	58.7	120.0
Willoughby	94:3-06:3	0.29	0.69	1.75	95.5	75.9	126.6
Average		0.14	0.84	1.95	93.6	66.4	136.6
Outer Ring							
Baulkham Hills	91:1-06:3	0.05	0.67	1.69	100.8	77.9	147.3
Blacktown	91:1-06:3	-0.07	0.96	2.31	78.9	56.3	127.0
Blue Mountains	91:1-06:3	0.11	0.94	2.14	88.7	64.3	136.0
Campbelltown	91:1-06:3	-0.11	0.95	2.43	72.3	46.1	113.6
Fairfield	91:1-06:3	-0.06	0.86	2.13	83.4	60.0	135.2
Gosford	91:1-06:3	0.09	1.00	2.17	89.3	64.0	134.3
Hawkesbury	91:1-06:3	-0.04	0.95	2.22	83.6	58.4	127.3
Holroyd	91:1-06:3	0.01	0.82	2.05	85.1	62.0	128.3
Hornsby	91:1-06:3	0.08	0.57	1.65	94.5	74.2	130.8
Liverpool	91:2-06:3	0.08	1.61	2.91	83.7	42.5	136.9
Penrith	91:1-06:3	-0.02	0.96	2.35	76.4	54.8	116.2
Sutherland	91:1-06:3	0.12	0.72	1.85	91.6	68.3	133.0
Warringah	91:3-06:3	0.34	1.35	2.50	89.3	54.8	126.0
Wyong	91:2-06:3	0.04	0.93	2.90	83.5	63.2	134.8
Average		0.04	0.95	2.24	85.8	60.5	130.5
Overall Average		0.16	0.85	2.03	90.0	62.7	132.7

Figure 3: Real Returns verses the Price-Rent Ratio

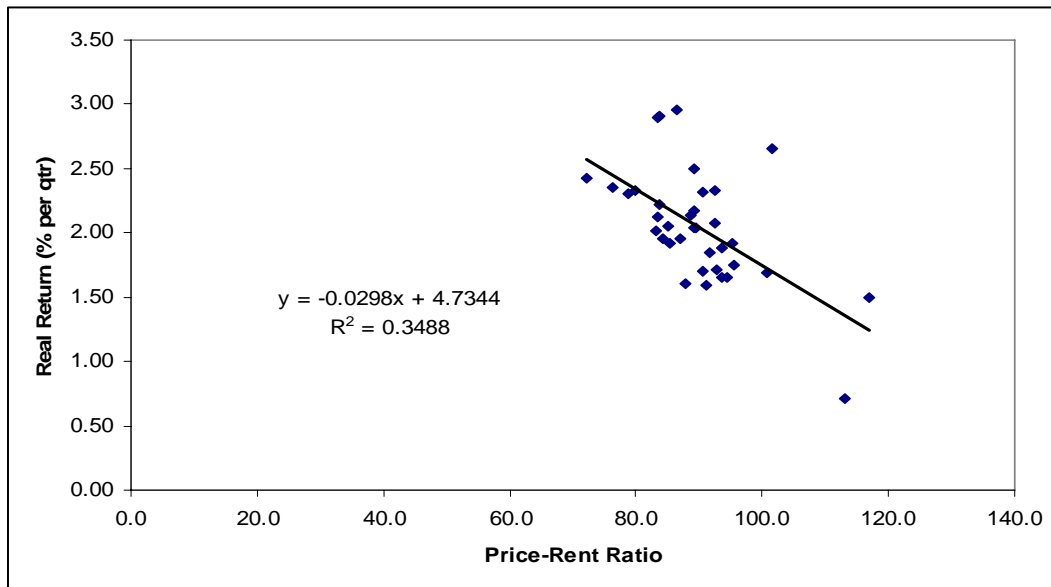


Figure 4: Price-Rent Ratio verses Real Rent Growth

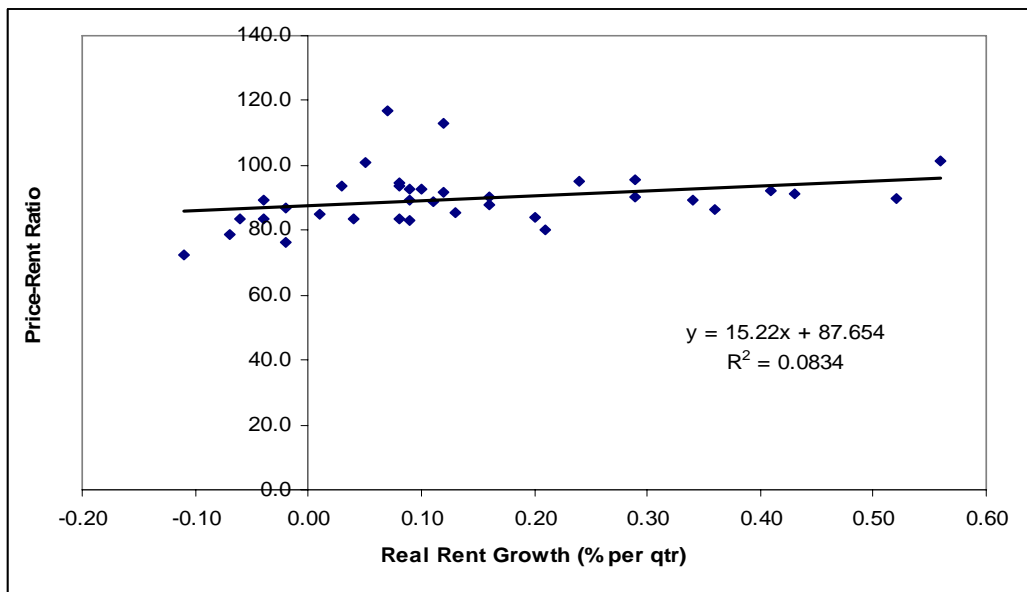


Figure 5: Mean and Steady-State Price-Rent Ratios

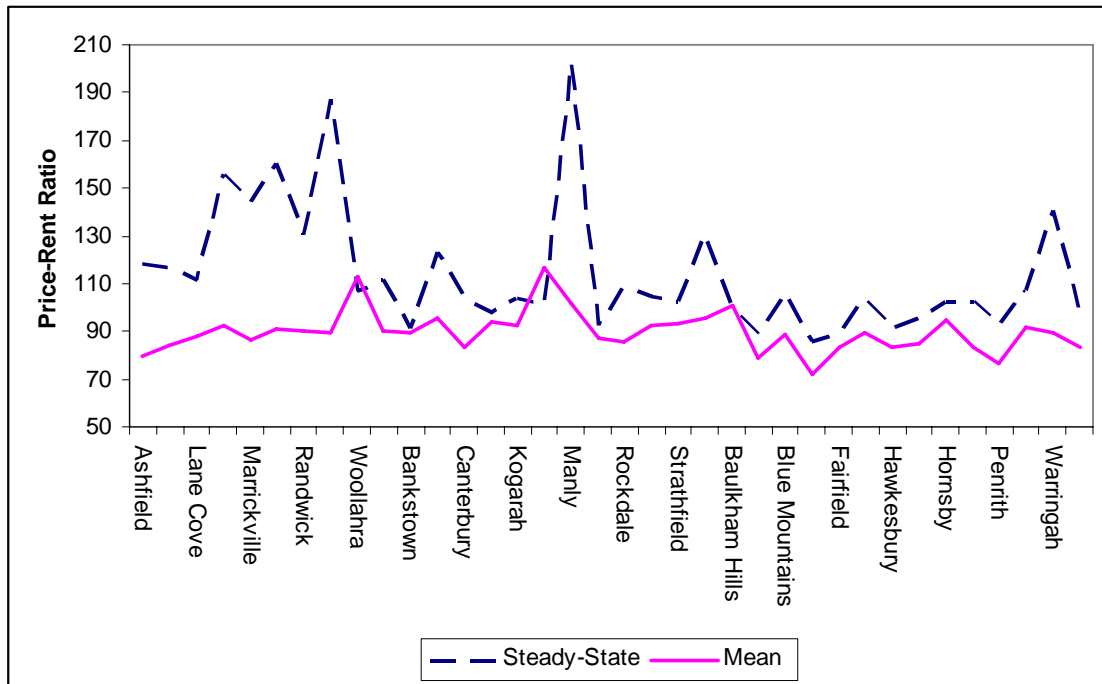


Table 2: Excess Returns to Housing – How Predictable?

LGA (Inner Ring)	Seas. Dum.	Lagged Excess Returns	Price- Rent Ratio	Real Bond Rate	Price- Rent Ratio	Nominal Bond Rate	Inflation Rate
<i>Ashfield</i>							
Joint Sig. (p-value)	0.3058	0.0257	0.0222	0.1033	0.0017	0.0062	0.3373
Coeff. Sum	-	-0.8934	-0.1068	-2.1587	-0.2632	-12.6562	0.1924
t-statistic	-	(-2.862)	(-1.583)	(-1.084)	(-2.758)	(-2.595)	(0.089)
\bar{R}^2	-	0.095	-	0.097	-	-	0.153
<i>Botany</i>							
Joint Sig. (p-value)	0.4441	0.0020	0.0032	0.5332	0.0000	0.0098	0.5733
Coeff. Sum	-	-0.7457	-0.0795	-3.0412	-0.1630	-10.7253	1.6821
t-statistic	-	(-2.086)	(-1.548)	(-1.228)	(-2.246)	(-1.861)	(0.726)
\bar{R}^2	-	0.187	-	0.147	-	-	0.229
<i>Lane Cove</i>							
Joint Sig. (p-value)	0.0782	0.0018	0.0003	0.2104	0.0000	0.0105	0.9392
Coeff. Sum	-	-1.0956	-0.2000	-4.1783	-0.5747	-25.4889	1.8842
t-statistic	-	(-3.348)	(-2.170)	(-1.725)	(-3.630)	(-3.139)	(0.720)
\bar{R}^2	-	0.263	-	0.214	-	-	0.270
<i>Leichhardt</i>							
Joint Sig. (p-value)	0.0002	0.6559	0.0312	0.0000	0.0224	0.0000	0.0001
Coeff. Sum	-	-0.0192	-0.0959	-3.1318	-0.1100	-5.0452	2.4915
t-statistic	-	(-0.063)	(-3.181)	(-3.158)	(-3.218)	(-3.010)	(2.828)
\bar{R}^2	-	0.065	-	0.213	-	-	0.289
<i>Marrickville</i>							
Joint Sig. (p-value)	0.0606	0.0023	0.0767	0.0629	0.0141	0.0264	0.0718
Coeff. Sum	-	-0.4450	-0.0659	-0.7377	-0.1301	-7.0954	-0.2024
t-statistic	-	(-1.470)	(-1.743)	(-0.489)	(-2.885)	(-2.662)	(-0.137)
\bar{R}^2	-	0.116	-	0.118	-	-	0.145
<i>North Sydney</i>							
Joint Sig. (p-value)	0.2514	0.2192	0.0001	0.0000	0.0000	0.0014	0.0006
Coeff. Sum	-	-0.6088	-0.2082	-3.6360	-0.3082	-8.5139	2.7594
t-statistic	-	(-1.871)	(-3.772)	(-3.592)	(-3.871)	(-3.595)	(2.763)
\bar{R}^2	-	0.082	-	0.212	-	-	0.240
<i>Randwick</i>							
Joint Sig. (p-value)	0.4757	0.0888	0.0010	0.0154	0.0001	0.0000	0.0126
Coeff. Sum	-	-0.5375	-0.1692	-3.5492	-0.1634	-4.4771	3.5237
t-statistic	-	(-1.872)	(-3.151)	(-3.088)	(-2.757)	(-2.150)	(2.873)
\bar{R}^2	-	0.058	-	0.180	-	-	0.285
<i>Waverley</i>							
Joint Sig. (p-value)	0.0009	0.0081	0.0007	0.0357	0.0000	0.0000	0.1544
Coeff. Sum	-	-0.3344	-0.1572	-4.1418	-0.3283	-15.848	0.3897
t-statistic	-	(-1.090)	(-2.551)	(-2.116)	(-4.456)	(-4.776)	(0.275)
\bar{R}^2	-	0.243	-	0.273	-	-	0.443
<i>Woollahra</i>							
Joint Sig. (p-value)	0.3021	0.0012	0.2910	0.0014	0.2117	0.1206	0.0005
Coeff. Sum	-	-0.5993	-0.0879	-1.9849	-0.1984	-9.8822	-0.3451
t-statistic	-	(-2.363)	(-1.700)	(-0.815)	(-2.117)	(-1.744)	(-0.160)
\bar{R}^2	-	0.138	-	0.153	-	-	0.158

Table 2 continued

LGA (Middle Ring)	Seas. Dum.	Lagged Excess Returns	Price- Rent Ratio	Real Bond Rate	Price- Rent Ratio	Nominal Bond Rate	Inflation Rate
<i>Auburn</i>							
Joint Sig. (p-value)	0.1936	0.0674	0.0148	0.0000	0.0000	0.0000	0.0000
Coeff. Sum	-	-0.1239	-0.0737	-4.1279	-0.1548	-12.1261	3.3079
t-statistic	-	(-0.425)	(-2.872)	(-3.383)	(-4.723)	(-5.238)	(3.087)
\bar{R}^2	-	0.175	-	0.322	-	-	0.4121
<i>Bankstown</i>							
Joint Sig. (p-value)	0.0186	0.0000	0.0000	0.0002	0.0000	0.0000	0.0146
Coeff. Sum	-	0.6874	-0.0360	-1.5644	-0.0540	-3.6131	1.0123
t-statistic	-	(6.209)	(-3.702)	(-3.644)	(-4.573)	(-4.135)	(2.160)
\bar{R}^2	-	0.365	-	0.375	-	-	0.444
<i>Burwood</i>							
Joint Sig. (p-value)	0.3354	0.5257	0.0551	0.6550	0.0015	0.1506	0.8070
Coeff. Sum	-	-0.2720	-0.1537	-2.5624	-0.2330	-9.1318	0.4038
t-statistic	-	(-1.088)	(-2.914)	(-1.289)	(-3.965)	(-3.179)	(0.188)
\bar{R}^2	-	-0.035	-	-0.034	-	-	-0.040
<i>Canterbury</i>							
Joint Sig. (p-value)	0.0003	0.3393	0.0525	0.0124	0.0019	0.0046	0.0009
Coeff. Sum	-	-0.0519	-0.0488	-0.7507	-0.1057	-5.910	-0.8312
t-statistic	-	(-0.146)	(-1.313)	(-0.652)	(-2.335)	(-2.484)	(-0.760)
\bar{R}^2	-	0.365	-	0.425	-	-	0.522
<i>Hurstville</i>							
Joint Sig. (p-value)	0.3776	0.0229	0.0009	0.0197	0.0000	0.0000	0.0691
Coeff. Sum	-	-0.1384	-0.0616	-1.5168	-0.1288	-7.4492	-0.0607
t-statistic	-	(-0.556)	(-1.845)	(-1.209)	(-3.287)	(-3.128)	(-0.045)
\bar{R}^2	-	0.102	-	0.1499	-	-	0.267
<i>Kogarah</i>							
Joint Sig. (p-value)	0.6562	0.0003	0.0153	0.1627	0.0111	0.0682	0.0784
Coeff. Sum	-	-0.8744	-0.0765	-0.9260	-0.1310	-4.2973	-0.3785
t-statistic	-	(-1.913)	(-1.467)	(-0.526)	(-1.966)	(-1.390)	(-0.251)
\bar{R}^2	-	0.103	-	-	-	-	0.167
<i>Ku-ring-gai</i>							
Joint Sig. (p-value)	0.5992	0.0000	0.0014	0.3878	0.0000	0.0668	0.3255
Coeff. Sum	-	-0.0399	-0.0505	-1.3652	-0.0794	-4.1972	0.5784
t-statistic	-	(-0.150)	(-1.573)	(-1.230)	(-2.125)	(-1.902)	(0.510)
\bar{R}^2	-	0.133	-	0.092	-	-	0.130
<i>Manly</i>							
Joint Sig. (p-value)	0.0192	0.0767	0.0032	0.2841	0.0000	0.0586	0.4803
Coeff. Sum	-	-0.5133	-0.0823	-1.3701	-0.1600	-7.8404	-0.1044
t-statistic	-	(-1.676)	(-1.844)	(-0.932)	(-2.994)	(-2.457)	(-0.066)
\bar{R}^2	-	0.0192	-	0.036	-	-	0.086
<i>Parramatta</i>							
Joint Sig. (p-value)	0.9232	0.0274	0.0014	0.0001	0.0001	0.0010	0.0049
Coeff. Sum	-	0.4349	-0.0599	-2.0395	-0.1041	-6.0790	0.9126
t-statistic	-	(2.450)	(-2.714)	(-2.210)	(-4.100)	(-4.080)	(1.022)
\bar{R}^2	-	0.049	-	0.242	-	-	0.295
<i>Rockdale</i>							
Joint Sig. (p-value)	0.0003	0.0626	0.0016	0.0400	0.0039	0.0016	0.0110
Coeff. Sum	-	0.2719	-0.0624	-1.8201	-0.1277	-6.5364	0.5175
t-statistic	-	(1.221)	(-2.034)	(-1.949)	(-3.459)	(-3.819)	(0.571)
\bar{R}^2	-	0.187	-	0.257	-	-	0.318

<i>Ryde</i>							
Joint Sig. (p-value)	0.4954	0.2513	0.3213	0.4333	0.0449	0.0025	0.6795
Coeff. Sum	-	-0.4984	-0.0599	-1.4122	-0.1258	-6.7772	-0.2258
t-statistic	-	(-1.080)	(-1.271)	(-1.260)	(-2.591)	(-3.625)	(-0.219)
\bar{R}^2	-	0.031	-	-0.012	-	-	0.009
<i>Strathfield</i>							
Joint Sig. (p-value)	0.2636	0.0060	0.0000	0.5421	0.0000	0.0084	0.4158
Coeff. Sum	-	-0.8639	-0.4672	-0.4378	-0.5131	-3.6984	-2.5804
t-statistic	-	(-4.453)	(-3.061)	(-0.188)	(-3.677)	(-1.397)	(-0.936)
\bar{R}^2	-	0.288	-	0.402	-	-	0.433
<i>Willoughby</i>							
Joint Sig. (p-value)	0.2573	0.1062	0.0097	0.0124	0.0013	0.0159	0.0440
Coeff. Sum	-	-0.8502	-0.1095	-0.6536	-0.1995	-7.0471	-0.8023
t-statistic	-	(-1.661)	(-1.526)	(-0.377)	(-2.425)	(-2.363)	(-0.491)
\bar{R}^2	-	0.098	-	0.188	-	-	0.162

Table 2 continued

LGA (Outer Ring)	Seas. Dum.	Lagged Excess Returns	Price- Rent Ratio	Real Bond Rate	Price- Rent Ratio	Nominal Bond Rate	Inflation Rate
<i>Baulkham Hills</i>							
Joint Sig. (p-value)	0.3740	0.0033	0.0000	0.0363	0.0000	0.0001	0.0307
Coeff. Sum	-	0.5085	-0.0503	-1.6791	-0.0881	-5.2390	0.2543
t-statistic	-	(2.980)	(-2.907)	(-2.061)	(-4.666)	(-3.989)	(0.311)
\bar{R}^2	-	0.080	-	0.204	-	-	0.325
<i>Blacktown</i>							
Joint Sig. (p-value)	0.1672	0.0003	0.0012	0.0000	0.0000	0.0000	0.0001
Coeff. Sum	-	0.7145	-0.0340	-1.7932	-0.0548	-4.5105	1.1849
t-statistic	-	(4.239)	(-2.795)	(-4.218)	(-3.911)	(-4.770)	(2.925)
\bar{R}^2	-	0.263	-	0.274	-	-	0.326
<i>Blue Mountains</i>							
Joint Sig. (p-value)	0.9196	0.0012	0.0045	0.0582	0.0002	0.0013	0.2854
Coeff. Sum	-	0.6720	-0.0354	-1.7600	-0.0713	-5.638	1.0710
t-statistic	-	(4.030)	(-2.183)	(-2.991)	(-3.527)	(-4.001)	(1.692)
\bar{R}^2	-	0.109	-	-0.025	-	-	0.107
<i>Campbelltown</i>							
Joint Sig. (p-value)	0.3146	0.0000	0.0000	0.0000	0.0000	0.1154	0.0000
Coeff. Sum	-	0.6827	-0.0349	-1.3099	-0.0456	-2.7320	0.8917
t-statistic	-	(5.128)	(-3.224)	(-2.172)	(-3.662)	(-2.221)	(1.409)
\bar{R}^2	-	0.263	-	0.338	-	-	0.315
<i>Fairfield</i>							
Joint Sig. (p-value)	0.8984	0.0000	0.0000	0.01791	0.0000	0.0070	0.1503
Coeff. Sum	-	0.8637	-0.0352	-1.9015	-0.0534	-4.1738	1.3610
t-statistic	-	(6.084)	(-2.407)	(-3.272)	(-3.009)	(-3.206)	(2.136)
\bar{R}^2	-	0.339	-	0.294	-	-	0.292
<i>Gosford</i>							
Joint Sig. (p-value)	0.0001	0.0000	0.0000	0.0012	0.0000	0.0036	0.0230
Coeff. Sum	-	0.4860	-0.0399	-1.6954	-0.0740	-5.1813	0.8503
t-statistic	-	(2.747)	(-2.459)	(-3.378)	(-3.397)	(-3.650)	(1.666)
\bar{R}^2	-	0.298	-	0.310	-	-	0.381
<i>Hawkesbury</i>							
Joint Sig. (p-value)	0.1760	0.0000	0.0000	0.0000	0.0000	0.0237	0.0001
Coeff. Sum	-	0.6380	-0.0325	-1.7183	-0.0714	-5.6421	0.8255
t-statistic	-	(2.990)	(-1.676)	(-1.929)	(-2.845)	(-3.060)	(0.932)
\bar{R}^2	-	0.315	-	0.325	-	-	0.364

<i>Holroyd</i>							
Joint Sig. (p-value)	0.2910	0.0427	0.0195	0.0256	0.0016	0.0149	0.0159
Coeff. Sum	-	0.5074	-0.0381	-0.9946	-0.0751	-4.4521	0.2847
t-statistic	-	(2.299)	(-1.874)	(-1.290)	(-3.344)	(-2.948)	(0.301)
\bar{R}^2	-	0.036	-	0.053	-	-	0.128
<i>Hornsby</i>							
Joint Sig. (p-value)	0.1293	0.0006	0.0267	0.1307	0.0022	0.0005	0.4242
Coeff. Sum	-	0.3214	-0.0553	-1.2187	-0.1047	-5.3747	0.0358
t-statistic	-	(1.626)	(-1.775)	(-1.291)	(-3.060)	(-3.459)	(0.043)
\bar{R}^2	-	0.122	-	0.079	-	-	0.193
<i>Liverpool</i>							
Joint Sig. (p-value)	0.0829	0.0001	0.0001	0.0379	0.0000	0.0011	0.0491
Coeff. Sum	-	0.6285	-0.0285	-1.2071	-0.0505	-3.5514	0.6475
t-statistic	-	(4.174)	(-2.166)	(-1.799)	(-3.105)	(-2.972)	(1.086)
\bar{R}^2	-	0.233	-	0.220	-	-	0.281
<i>Penrith</i>							
Joint Sig. (p-value)	0.0532	0.0000	0.0000	0.0000	0.0000	0.0237	0.0004
Coeff. Sum	-	0.8864	-0.0352	-2.0316	-0.0553	-4.2154	1.5073
t-statistic	-	(8.993)	(-3.670)	(-5.421)	(-5.108)	(-5.055)	(4.072)
\bar{R}^2	-	0.480	-	0.539	-	-	0.589
<i>Sutherland</i>							
Joint Sig. (p-value)	0.0038	0.0173	0.0000	0.2156	0.0000	0.0237	0.6204
Coeff. Sum	-	0.5902	-0.0512	-1.7238	-0.1107	-6.6835	0.4882
t-statistic	-	(3.253)	(-2.462)	(-2.037)	(-4.249)	(-4.067)	(0.568)
\bar{R}^2	-	0.228	-	0.202	-	-	0.275
<i>Warringah</i>							
Joint Sig. (p-value)	0.2864	0.9983	0.1821	0.4179	0.0000	0.0014	0.2196
Coeff. Sum	-	-0.0615	-0.0623	-1.0090	-0.1702	-8.2193	0.3201
t-statistic	-	(-0.204)	(-1.812)	(-0.946)	(-3.589)	(-3.605)	(0.318)
\bar{R}^2	-	-0.078	-	-0.096	-	-	-0.043
<i>Wyong</i>							
Joint Sig. (p-value)	0.1853	0.0000	0.0000	0.0106	0.0000	0.0021	0.0685
Coeff. Sum	-	0.7791	-0.0401	-1.8960	-0.0592	-3.9685	1.1281
t-statistic	-	(4.272)	(-2.438)	(-2.984)	(-3.109)	(-3.302)	(1.866)
\bar{R}^2	-	0.303	-	0.363	-	-	0.359

Notes: Each model includes 4 lags of the stochastic regressors. White's (1980) HCCM estimator is used to compute F-statistics and t-statistics.

Table 3: What do House Price-to-Rent Ratios Predict?

LGA (Inner Ring)	Dependent Variable				
	Real Rent Growth	Real Housing Returns	Real Mortgage Rate	Real Bond Rate	Real Stock Returns
<i>Ashfield</i>					
Joint Sig. (p-value)	0.1594	0.0177	0.0008	0.0002	0.1542
Coeff. Sum	-0.1035	-0.0933	-0.0114	-0.0153	-0.0083
t-statistic	(-0.763)	(-1.303)	(-2.766)	(-3.953)	(-0.236)
<i>Botany</i>					
Joint Sig. (p-value)	0.3464	0.2060	0.5057	0.0181	0.0000
Coeff. Sum	-0.0139	-0.0841	-0.0062	-0.0092	0.0055
t-statistic	(-1.090)	(-1.828)	(-2.013)	(-3.095)	(0.251)
<i>Lane Cove</i>					
Joint Sig. (p-value)	0.0012	0.0020	0.0358	0.0002	0.3074
Coeff. Sum	-0.0279	-0.2819	-0.0115	-0.0135	0.0006
t-statistic	(-1.137)	(-2.914)	(-2.581)	(-3.327)	(0.016)
<i>Leichhardt</i>					
Joint Sig. (p-value)	0.0350	0.0238	0.1029	0.0004	0.1136
Coeff. Sum	-0.0177	-0.0689	-0.0078	-0.0107	0.0039
t-statistic	(-1.387)	(-2.331)	(-2.529)	(-3.648)	(0.137)
<i>Marrickville</i>					
Joint Sig. (p-value)	0.5777	0.0143	0.2375	0.0185	0.1444
Coeff. Sum	0.0026	-0.1000	-0.0066	-0.0092	-0.0165
t-statistic	(0.204)	(-2.903)	(-2.389)	(-3.501)	(-0.250)
<i>North Sydney</i>					
Joint Sig. (p-value)	0.2337	0.0003	0.1086	0.1086	0.0312
Coeff. Sum	-0.0006	-0.2192	-0.0151	-0.0184	-0.0165
t-statistic	(-0.018)	(-2.952)	(-2.578)	(-3.231)	(-0.323)
<i>Randwick</i>					
Joint Sig. (p-value)	0.0047	0.0188	0.1245	0.0035	0.0028
Coeff. Sum	-0.0148	-0.1810	-0.0084	-0.0111	0.0186
t-statistic	(-0.786)	(-2.656)	(-2.136)	(-3.021)	(0.531)
<i>Waverley</i>					
Joint Sig. (p-value)	0.0027	0.0615	0.1017	0.0334	0.1679
Coeff. Sum	-0.0661	-0.1753	-0.0087	-0.0114	0.0021
t-statistic	(-2.774)	(-2.830)	(-2.791)	(-3.612)	(0.070)
<i>Woollahra</i>					
Joint Sig. (p-value)	0.0394	0.0002	0.1692	0.0084	0.5145
Coeff. Sum	-0.0180	-0.1450	-0.0050	-0.0070	0.0107
t-statistic	(-0.480)	(-3.933)	(-2.117)	(-3.161)	(0.425)

Table 3: continued

Dependent Variable

LGA (Middle Ring)	Real Rent Growth	Real Housing Returns	Real Mortgage Rate	Real Bond Rate	Real Stock Returns
<i>Auburn</i>					
Joint Sig. (p-value)	0.4482	0.0001	0.0912	0.0047	0.5368
Coeff. Sum	0.0066	-0.0456	-0.0067	-0.0086	-0.0024
t-statistic	(0.999)	(-2.289)	(-2.524)	(-3.164)	(-0.110)
<i>Bankstown</i>					
Joint Sig. (p-value)	0.0543	0.0000	0.0142	0.0057	0.0000
Coeff. Sum	0.0047	-0.0163	-0.0066	-0.0088	0.0086
t-statistic	(0.541)	(-1.884)	(-2.376)	(-2.859)	(0.466)
<i>Burwood</i>					
Joint Sig. (p-value)	0.8311	0.0011	0.2547	0.1852	0.0041
Coeff. Sum	-0.0150	-0.1830	-0.0071	-0.0098	0.0515
t-statistic	(-0.630)	(-2.705)	(-1.937)	(-2.589)	(1.687)
<i>Canterbury</i>					
Joint Sig. (p-value)	0.8410	0.0002	0.0007	0.0000	0.0018
Coeff. Sum	0.0012	-0.0858	-0.0080	-0.0114	0.0113
t-statistic	(0.102)	(-2.186)	(-2.370)	(-3.550)	(0.424)
<i>Hurstville</i>					
Joint Sig. (p-value)	0.8978	0.1978	0.2069	0.0525	0.1624
Coeff. Sum	-0.0050	-0.0790	-0.0060	-0.0089	0.0249
t-statistic	(-0.415)	(-2.641)	(-2.249)	(-3.204)	(1.003)
<i>Kogarah</i>					
Joint Sig. (p-value)	0.1022	0.0298	0.5754	0.1098	0.0000
Coeff. Sum	0.0053	-0.1341	-0.0069	-0.0108	0.0224
t-statistic	(0.223)	(-2.593)	(-1.753)	(-2.801)	(0.820)
<i>Ku-ring-gai</i>					
Joint Sig. (p-value)	0.5982	0.0001	0.0209	0.0002	0.1964
Coeff. Sum	-0.0032	-0.0562	-0.0043	-0.0065	0.0295
t-statistic	(-0.191)	(-2.116)	(-1.642)	(-2.470)	(1.153)
<i>Manly</i>					
Joint Sig. (p-value)	0.8806	0.0145	0.0059	0.0037	0.0015
Coeff. Sum	-0.0076	-0.0938	-0.0071	-0.0099	-0.0018
t-statistic	(-0.404)	(-2.386)	(-2.469)	(-3.544)	(-0.085)
<i>Parramatta</i>					
Joint Sig. (p-value)	0.3786	0.0132	0.1708	0.0228	0.0545
Coeff. Sum	-0.0001	-0.0456	-0.0068	-0.0092	0.0118
t-statistic	(-0.016)	(-2.161)	(-2.327)	(-3.188)	(0.471)
<i>Rockdale</i>					
Joint Sig. (p-value)	0.0136	0.0873	0.0054	0.0036	0.3207
Coeff. Sum	-0.0031	-0.0654	-0.0076	-0.0105	-0.0012
t-statistic	(-0.239)	(-2.099)	(-2.217)	(-3.080)	(-0.036)
<i>Ryde</i>					
Joint Sig. (p-value)	0.1772	0.3480	0.0053	0.0030	0.0034
Coeff. Sum	-0.0016	-0.0684	-0.0062	-0.0096	0.0169
t-statistic	(-0.233)	(-2.111)	(-2.201)	(-3.448)	(0.718)

<i>Strathfield</i>					
Joint Sig. (p-value)	0.0000	0.0000	0.3356	0.1029	0.9831
Coeff. Sum	0.0400	-0.7802	-0.0082	-0.0087	-0.0565
t-statistic	(0.086)	(-5.190)	(-1.326)	(-1.346)	(-0.665)
<i>Willoughby</i>					
Joint Sig. (p-value)	0.9296	0.0027	0.0271	0.0231	0.0128
Coeff. Sum	-0.0245	-0.1711	-0.0073	-0.0120	0.0768
t-statistic	(-0.711)	(-1.976)	(-1.865)	(-3.044)	(1.555)

Table 3 continued **Dependent Variable**

LGA (Outer Ring)	Real Rent Growth	Real Housing Returns	Real Mortgage Rate	Real Bond Rate	Real Stock Returns
<i>Baulkham Hills</i>					
Joint Sig. (p-value)	0.0305	0.0016	0.4677	0.0828	0.0019
Coeff. Sum	0.0031	-0.0386	-0.0048	-0.0071	0.0075
t-statistic	(0.394)	(-2.374)	(-1.794)	(-2.599)	(0.309)
<i>Blacktown</i>					
Joint Sig. (p-value)	0.1518	0.0596	0.1584	0.0067	0.0493
Coeff. Sum	0.0014	-0.0274	-0.0061	-0.0091	0.0241
t-statistic	(0.192)	(-1.607)	(-2.236)	(-3.368)	(1.004)
<i>Blue Mountains</i>					
Joint Sig. (p-value)	0.0012	0.0156	0.0269	0.0006	0.1294
Coeff. Sum	-0.0018	-0.0204	-0.0051	-0.0081	0.0228
t-statistic	(-0.214)	(-1.537)	(-2.149)	(-3.523)	(0.858)
<i>Campbelltown</i>					
Joint Sig. (p-value)	0.0809	0.0092	0.0294	0.0392	0.0197
Coeff. Sum	0.0109	-0.0403	-0.0077	-0.0103	0.0122
t-statistic	(0.931)	(-2.825)	(-2.786)	(-3.363)	(0.455)
<i>Fairfield</i>					
Joint Sig. (p-value)	0.0542	0.0594	0.3552	0.0335	0.0000
Coeff. Sum	0.0135	-0.0289	-0.0054	-0.0084	0.0071
t-statistic	(2.034)	(-2.463)	(-2.141)	(-3.477)	(0.374)
<i>Gosford</i>					
Joint Sig. (p-value)	0.1230	0.0055	0.0626	0.0286	0.0023
Coeff. Sum	0.0013	-0.0237	-0.0073	-0.0098	0.0112
t-statistic	(0.158)	(-1.959)	(-2.468)	(-3.242)	(0.497)
<i>Hawkesbury</i>					
Joint Sig. (p-value)	0.0000	0.5185	0.0917	0.0081	0.0020
Coeff. Sum	0.0131	-0.0324	-0.0065	-0.0093	-0.0002
t-statistic	(1.734)	(-1.707)	(-2.225)	(-3.236)	(-0.009)
<i>Holroyd</i>					
Joint Sig. (p-value)	0.7646	0.1067	0.0166	0.0010	0.1998
Coeff. Sum	-0.0038	-0.0420	-0.0075	-0.0101	0.0177
t-statistic	(-0.481)	(-1.702)	(-2.682)	(-3.738)	(0.672)

<i>Hornsby</i>					
Joint Sig. (p-value)	0.0338	0.0273	0.0000	0.0000	0.0226
Coeff. Sum	-0.0071	-0.0421	-0.0074	-0.0109	0.0191
t-statistic	(-0.649)	(-1.587)	(-2.221)	(-3.014)	(0.642)
<i>Liverpool</i>					
Joint Sig. (p-value)	0.9512	0.3283	0.0015	0.0003	0.0378
Coeff. Sum	-0.0008	-0.0353	-0.0066	-0.0093	0.0104
t-statistic	(-0.096)	(-1.816)	(-2.943)	(-4.135)	(0.472)
<i>Penrith</i>					
Joint Sig. (p-value)	0.1639	0.0014	0.5342	0.0890	0.0092
Coeff. Sum	0.0103	-0.0068	-0.0072	-0.0090	0.0182
t-statistic	(1.200)	(-0.564)	(-1.972)	(-2.425)	(0.627)
<i>Sutherland</i>					
Joint Sig. (p-value)	0.7323	0.1277	0.2505	0.0105	0.0002
Coeff. Sum	-0.0090	-0.0457	-0.0069	-0.0110	-0.0022
t-statistic	(-1.278)	(-2.122)	(-2.194)	(-3.552)	(-0.089)
<i>Warringah</i>					
Joint Sig. (p-value)	0.0533	0.1012	0.3770	0.0112	0.0034
Coeff. Sum	-0.0102	-0.0913	-0.0073	-0.0100	0.0007
t-statistic	(-1.096)	(-1.820)	(-2.160)	(-3.110)	(0.027)
<i>Wyang</i>					
Joint Sig. (p-value)	0.0000	0.1218	0.0000	0.0000	0.0000
Coeff. Sum	0.0011	-0.0158	-0.0045	-0.0071	0.0119
t-statistic	(0.147)	(-1.068)	(-1.801)	(-2.887)	(0.471)

Notes: Each model includes 6 lags of the dependent variable and the house price-to-rent ratio. The above numbers indicate the results of an F-test for the joint significance of the lags of the price-to-rent ratio, the sum of the coefficients on the lags of the price-to-rent ratio and its t-statistic. White's (1980) HCCM estimator is used.

Figure 6: Quarterly Excess Returns for Randwick and Penrith

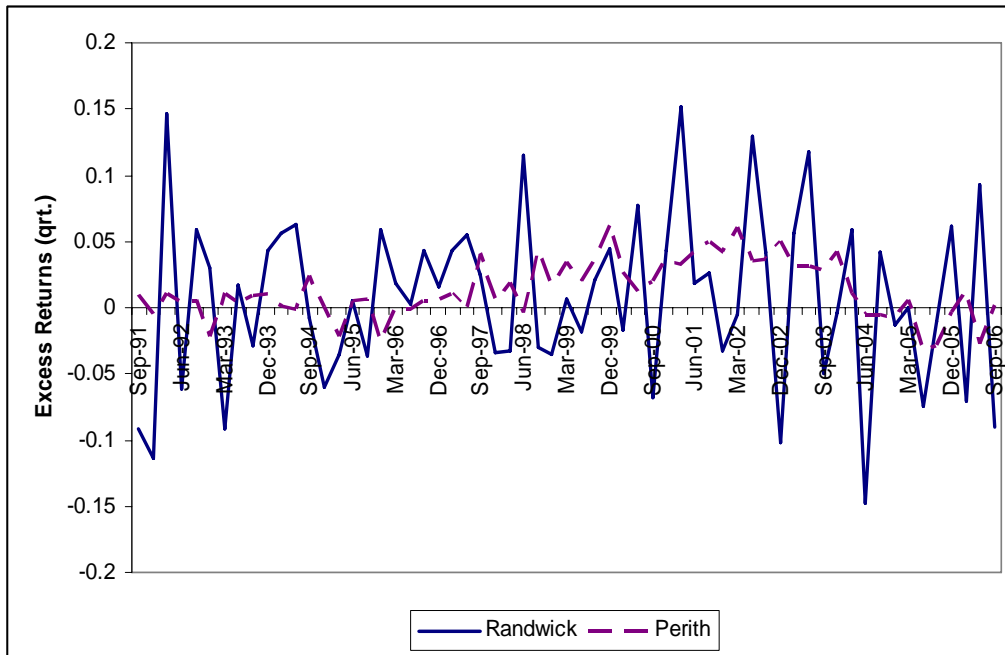


Figure 7: Predicability of Real Rent Growth in LGAs

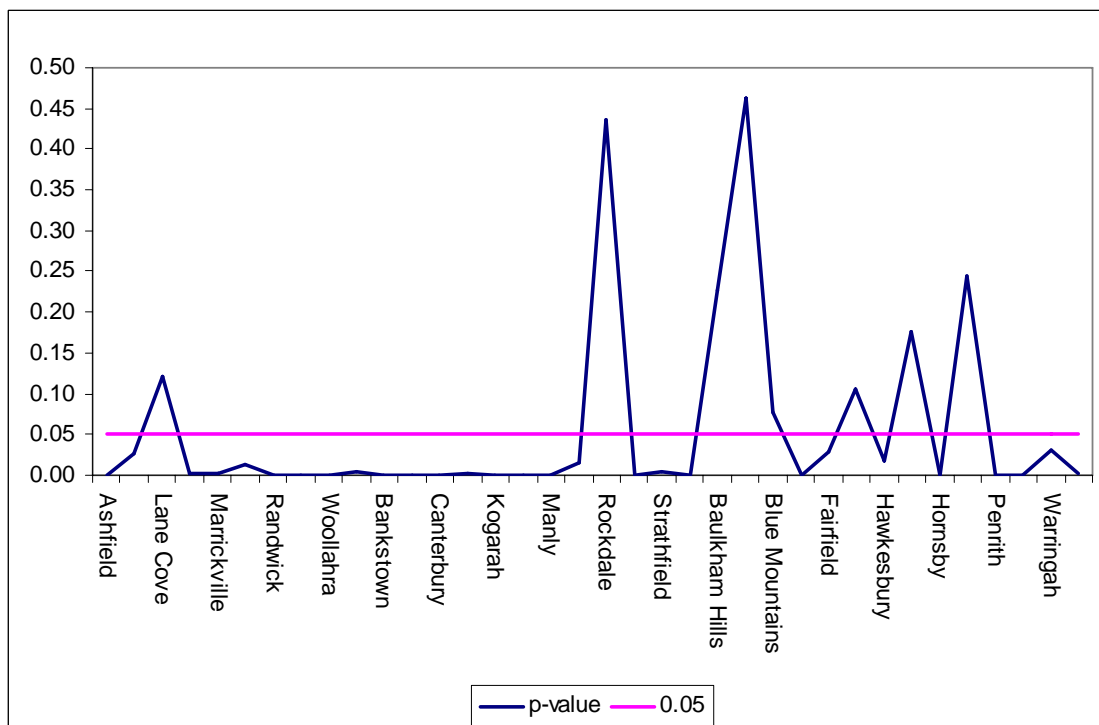


Figure 8: Long-Run Marginal Effect of the Price-Rent Ratio on the Real Bond Rate

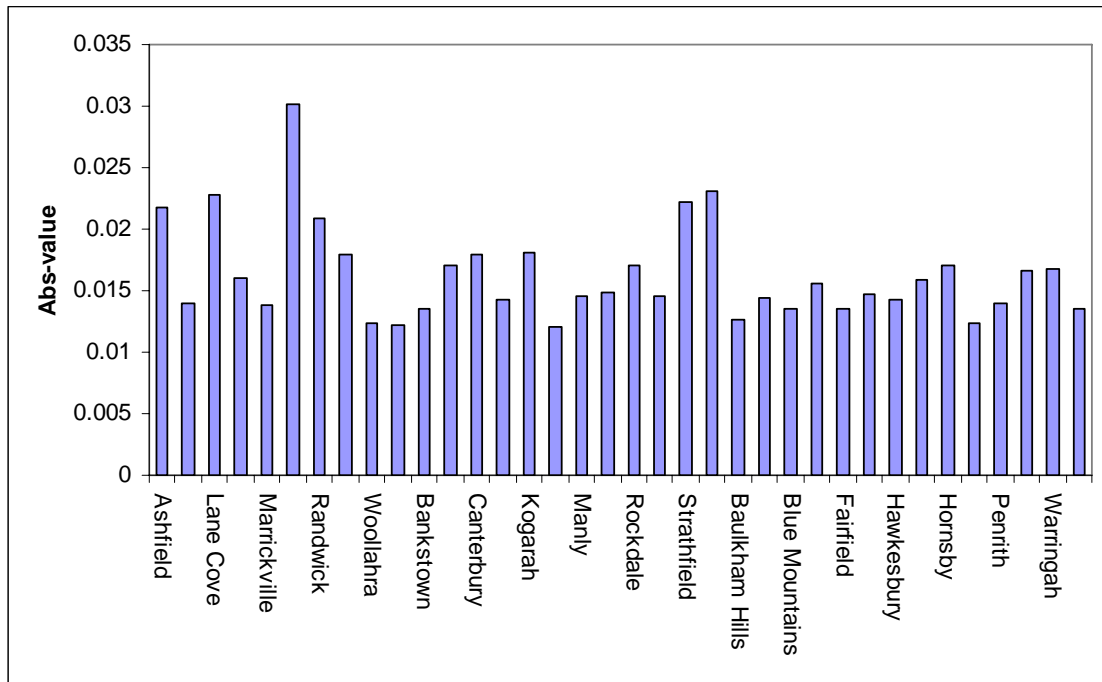


Figure 9: Prediction of the Real Bond Rate Based on Long-Run Estimates for Three LGAs.

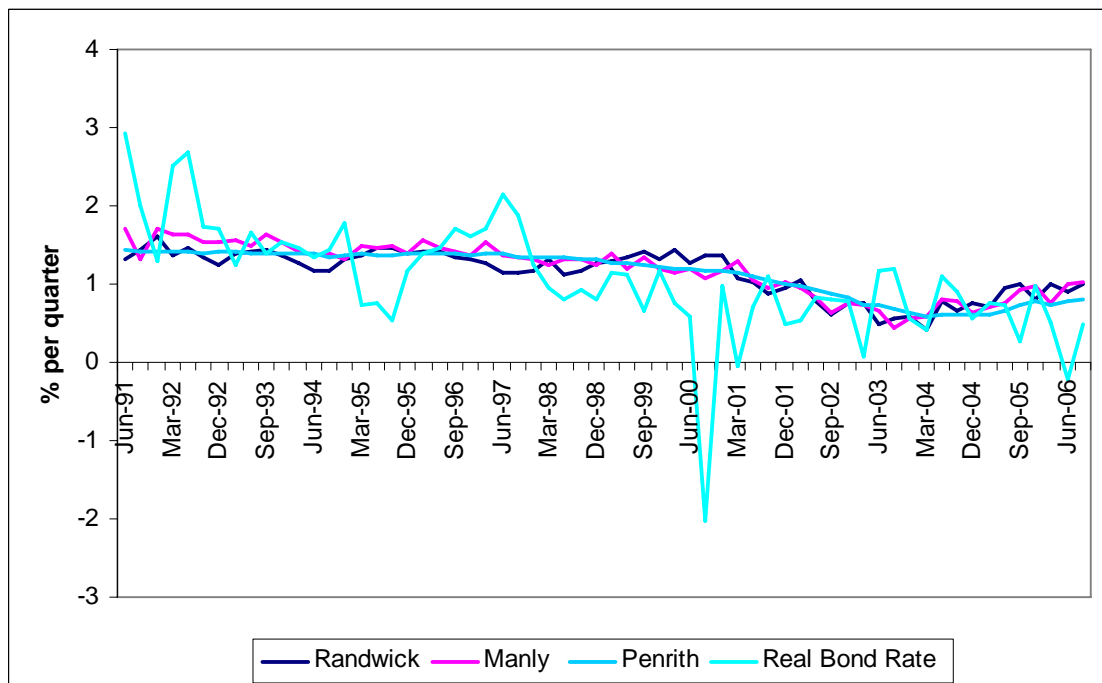


Table 4: Variance Decomposition of the Price-Rent Ratio**Contribution to Variance of Price-Rent Ratio (percent)**

LGA	Real Rent Growth	Real Returns	Total	Real Bond Rate
Inner Ring				
Ashfield	-16.6	92.8	79.2	22.2
Botany	-15.3	113.4	98.1	17.1
Lane Cove	-24.5	127.8	103.3	18.9
Leichhardt	-22.9	118.8	95.9	21.6
Marrickville	-13.2	82.1	68.9	17.3
North Sydney	-24.0	163.4	139.4	36.7
Randwick	-32.7	142.4	109.7	19.7
Waverley	-48.2	190.1	141.9	29.0
Woollahra	-25.4	105.6	80.2	10.6
Average	-24.8	126.3	101.5	21.5
Middle Ring				
Auburn	8.8	62.7	71.5	13.3
Bankstown	2.1	37.6	39.7	8.6
Burwood	-20.1	101.3	81.2	11.9
Canterbury	2.1	74.6	76.7	12.9
Hurstville	-5.2	54.1	48.9	10.8
Kogarah	-0.3	80.5	80.2	16.9
Kur-ring-gai	-8.5	45.2	37.2	7.3
Manly	-9.4	125.7	116.4	25.1
Parramatta	-2.7	58.9	56.2	11.1
Rockdale	-7.2	83.2	75.6	17.0
Ryde	-11.8	65.1	53.3	11.6
Strathfield	8.3	65.1	103.3	14.4
Willoughby	-2.3	116.4	114.1	5.2
Average	-2.6	74.7	71.9	12.8

Outer Ring				
Baulkham Hills	2.7	43.5	46.2	8.7
Blacktown	-2.7	45.2	42.6	7.3
Blue Mountains	-1.1	46.0	45.0	9.2
Campbelltown	6.9	44.6	51.5	7.9
Fairfield	6.9	44.6	51.5	7.1
Gosford	-1.1	45.2	44.0	10.2
Hawkesbury	-1.8	47.5	45.7	10.0
Holroyd	-5.5	58.3	52.8	10.4
Hornsby	-20.9	76.5	55.6	12.3
Liverpool	0	47.8	47.8	9.7
Penrith	2.9	43.1	46.1	9.1
Sutherland	-11.4	69.2	57.8	13.4
Warringah	-18.5	115.8	97.4	24.0
Wyong	-2.0	49.6	47.6	7.9
Average	-3.3	55.5	52.2	10.5

Notes: Entries are the percent of the variance of the log price-rent ratio that is attributable to rent growth, return and real interest rate forecasts. They are computed as

$$\frac{100}{1 - \hat{\Omega}} \sum_{i=1}^{20} \hat{\Omega}^i \left(\text{cov} \left(\frac{P_t^h}{R_t^h}, x_{t+i} \right) \right) \left[\text{var} \left(\frac{P_t^h}{R_t^h} \right) \right]^{-1}$$

Figure 10: Mean Deviations for Price-Rent Ratios in Inner Ring LGAs

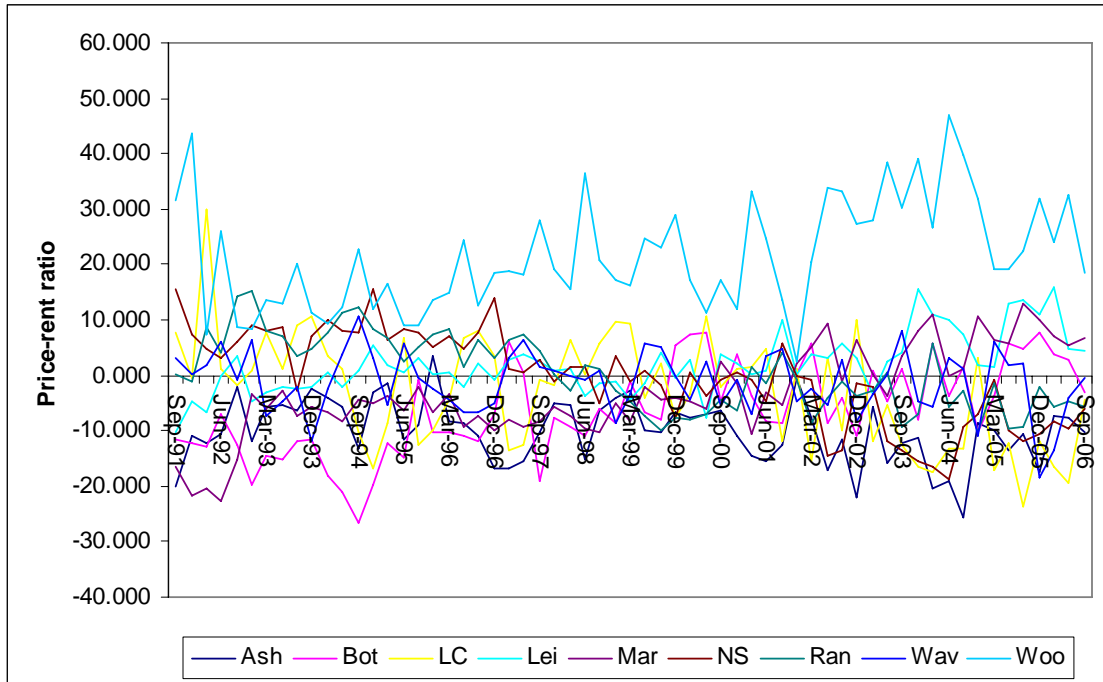
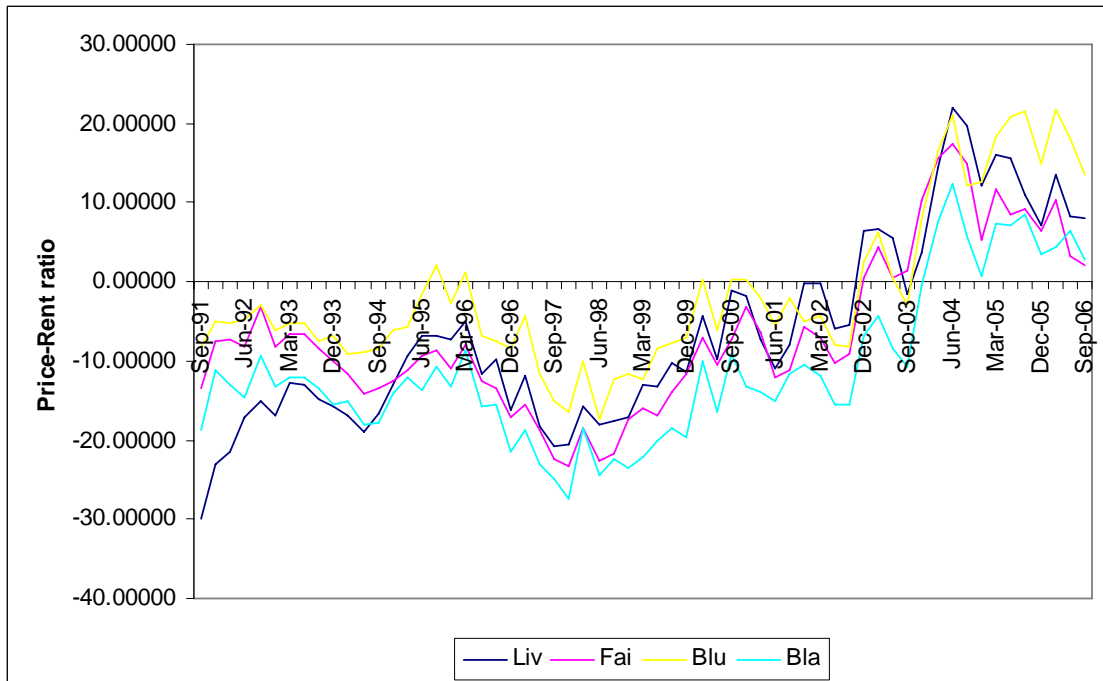


Figure 11: Mean Deviations for Price-Rent Ratios in Four Outer Ring LGAs from Average Price-Rent Ratio for Inner Ring



References

- Ayuso, Juan and Fernando Restoy (2003), "House prices and rents: an equilibrium asset pricing approach," Bank of Spain Working Paper, No. 304.
- Ayuso, Juan and Fernando Restoy (2006), "House prices and rents in Spain: Does the discount factor matter?" Bank of Spain Working Paper, No. 609.
- Brunnermeier, M. K. and C. Julliard (2007), "Money illusion and housing frenzies," mimeo.
- Case, Karl and Robert Shiller (1989), "The efficiency of the market for single-family homes," *American Economic Review*, 79, 125-137.
- Case, Karl and Robert Shiller (1990), "Forecasting prices and excess returns in the housing market," *Journal of the American Real Estate and Urban Economics Association*, 18, 253-273.
- Campbell, John and Robert Shiller (1987), "Cointegration and tests of present value models," *Journal of Political Economy*, 95, 1062-1088.
- Campbell, John and Robert Shiller (1988), "The dividend price ratio and expectations of future dividends and discount factors," *The Review of Financial Studies*, vol. 1, 195-227.
- Clayton, Jim (1996), "Rational expectations, market fundamentals and housing price volatility," *Real Estate Economics*, v24 4, 441-470.
- Cochrane, John (2001), *Asset Pricing*, Princeton University Press, Princeton, New Jersey.
- Cochrane, John (1992), "Explaining the variance of price-dividend ratios," *The Review of Financial Studies*, vol. 5, no. 2, 243-280.
- Cochrane, J.H. (2006), "Financial markets and the real economy," mimeo.
- Engle, C., N.C. Mark and K.D. West (2007), "Exchange rate models are not as bad as you think," *Macroeconomics Annual*, NBER.
- Flood, R. P. and R.J. Hodrick (1990), "One testing for speculative bubbles," *Journal of Economic Perspectives*, vol. 4, no. 2, 85-101.
- Gittins, R. (2003a) "Governor wants a whimper not a bang," *Sydney Morning Herald*, 8 November.
- Gittins, R. (2003b) "Bubble dwellers indulge in retail therapy," *Sydney Morning Herald*, 15 November.

- Gordon, M. (1962), *The Investment, Financing and Valuation of the Corporation*, Irwin, Homewood, IL.
- Guttermann, K.L. and R.L. Smith (1987), "Efficiency of the market for residential real estate," *Land Economics*, vol. 63, no.1 34-45.
- Hamilton, B. and R. Schwab (1985), "Expected appreciation in urban housing markets," *Journal of Urban Economics*, 18, 103-118.
- Hodrick, R. (1992), "Dividend yields and expected stock returns: alternative procedures for inference and measurement," *Review of Financial Studies*, 5, 357-386.
- Meen, G. (2000), "Housing cycles and efficiency," *Scottish Journal of Political Economy*, vol. 47, no. 2, 114-140.
- Meese, Richard and Nancy Wallace (1994), "Testing the present value relation for housing prices: should I leave my home in San Francisco?" *Journal of Urban Economics*, 35, 245-266.
- Shiller, Robert (2005), *Irrational Exuberance*, 2nd edition, Princeton University Press, Princeton, New Jersey.
- The Economist (2003), "The Lucky Country," 8 March 2003.
- White, H. (1980), "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity," *Econometrica*, 48, 817-838.