A Comparative Analysis of House Prices and Bubbles in the U.K. and New Zealand

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Utilising a dynamic and forward-looking present value model, our analysis investigates whether bubbles exist in the New Zealand and U.K. housing markets by constructing an implied fundamental (real) price series based on what house prices 'should be' given expectations of household real disposable income and comparing these prices with actual prices. The analysis also investigates the type of behaviour driving revealed deviations from fundamental value. While we find evidence of bubbles in both markets they occur in different time periods and would appear to be driven by different behaviour. The results suggest that U.K. house price deviations from their implied fundamental value are driven by an overreaction to future income with price dynamics only coming into predominance when prices are well above or below this value. In contrast, New Zealand deviations from fundamental value appear to be driven by price dynamics alone.

Keywords: Real house prices; Real disposable income; Fundamentals; Present value; Time-varying risk; Bubbles
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1. Introduction

Much media and professional attention is given to the state of the housing sector in the economy. In particular commentators focus on how house prices are changing over time and whether the observed price dynamics are sustainable, or indeed, whether a 'bubble' exists that will eventually peak. This interest is well warranted given the importance of housing in the wider economy. In many economies residential housing is a major asset in household portfolios (Englund *et al.*, 2002; Flavin and Yamashita, 2002) hence actual and expected changes in the market value of housing will impact on actual, as well as perceptions of future, household wealth. Such portfolio effects can be considerable and have been reported as having a greater impact on the economy than those resulting from changes in the value of financial assets. For example, wealth effects on household consumption patterns tend to be greater for housing than for financial assets (Case *et al.*, 2005; Benjamin *et al.*, 2004) and the negative effects of house price busts on the growth of the economy not only have twice as large an impact as those from stock market busts but last twice as long (Helbling and Terrones, 2003).

Further, prolonged departures of house prices from their 'affordable' range (relative to average household income) can result in static market conditions due to existing homeowners being reluctant or unable to move up the property ladder. Such market conditions, particularly when the supply of new housing is constrained, would tend to close-up the supply of lower-cost housing for first-time buyers.

In fact, much of the attention given to house prices is driven by the negative impact that rapid and unsustainable changes in house prices would have on the general economy not only in terms of consumption and output effects but also on the accessibility of households to this important source of wealth.

The aim of this paper is twofold. First, we compare what we term *fundamental* house prices with *actual* house prices for the U.K. and New Zealand ranging over a 35 year period from 1970 through 2005. The measurement of fundamental prices is based on the present value of household expectations of their future real income stream. Thus, akin to the traditional 'affordability' studies (Gyourko and Linneman, 1993; Bogdon and Can, 1997), we consider the house price – household income relationship but do so in terms of measuring what house prices 'should be' given expectations of household real disposable income and compare these with actual prices at each point in time. We are able therefore to identify periods where there are significant prolonged departures from this implied fundamental value and where a bubble can be said to exist.

Second, we analyse deviations from fundamental value over the sample period by investigating the type of behaviour which might drive any revealed house price bubble components of the departures from fundamental value. In particular we ask: are bubbles driven by an *overreaction* by households to the expected future value of real income, or driven by price alone - a *band-wagon* or *momentum* effect, whereby agents tend to buy after price increases and sell after price decreases? Such distinctions are important not least because of the policy implications regarding the economy-wide management of such bubbles, which of course may differ according to the type of behaviour predominant in driving house price bubbles.[1]

As indicated above we investigate both the U.K. and New Zealand house prices. An analysis for the U.K. is conducted by Black *et al*. (2006), while Fraser *et*

[1] For example, bubbles driven solely by the overreaction hypothesis may be managed by the authorities' ability to 'talk-up' or 'talk-down' expectations.

al. (2008 forthcoming) investigate the New Zealand housing market. No effort however is made to compare the results of these countries. The current paper provides such comparison and is motivated by several reasons, which, when viewed collectively, identify New Zealand as unique in comparison with other OECD countries and, as a result, a paragon to which compare and contrast international experiences.

Arguably the most important of these in the current context is that New Zealand households hold a disproportionately high percentage of their assets in housing (Claus and Scobie, 2001) and has experienced a relatively high number of housing peaks in recent years (van den Noord, 2006). Further, not only is the probability of reaching another peak if interest rates were to increase substantially greater in New Zealand (van den Noord, 2006) but the economy is particularly vulnerable to higher interest rates (The Economist 2006a, 2006b). Such features along with the fact that the New Zealand economy is recognised as being one of the most liberal in the world (Bollard *et al*., 1996), can provide policy-makers with an international exemplar of house price dynamics where household portfolios are particularly sensitive to changes in housing wealth. Further these portfolios have been constructed against a background of rapid structural change from a highly interventionist to what is now a relatively liberal economic system[2] and one where migration issues have historically impacted on the pricing process.

The remainder of the paper is organised as follows. In section 2 we summarise the empirical framework used to measure fundamental house prices, while section 3 contains a discussion of the data and some preliminary results. The

[2] The New Zealand economy is unusual in the extent to which and speed with which it evolved from a highly interventionist economy to one of the most liberal in the world. Starting in 1984, New Zealand began to institute a series of policies which rapidly shifted the economy away from extensive state ownership and regulatory control.

empirical results and modelling of the deviations from fundamental value are discussed in the following section, while concluding remarks are contained in a final section.

2. Empirical Framework: Fundamental House Prices v. Actual House Prices

The fundamental value of housing is computed based on the present value of expected real disposable income. While traditional theory suggests that within a present value model, housing rents rather than disposable income might be an appropriate income variable, recall that the objective here is to measure fundamental prices according to households' expectations regarding their ability to pay. Hence we wish to measure the income growth expected by households after taxes and inflationary pressures in the economy (on which they base their current consumption and investment spending patterns) and be able to capture the extent to which actual prices deviate from this implied 'sustainable' price.[3] Given the present value model utilised also incorporates a non-constant discount rate and focuses on expectations of future income, the analysis is dynamic and forward-looking in nature - arguably a necessary requirement for an analysis of prices that play such a pivotal role in the behaviour of households and thus the overall state of the economy. While the dynamic model and associated empirical framework are discussed in full in the Appendix to this paper, the empirical analysis is based on the following expression as a measurement of the (log) price-income ratio:

$$pq_t = \frac{k-f}{(1-\mu)} + \sum_{j=0}^{\infty} \mu^{j+1} E_t^c \Delta q_{t+j+1} - \alpha \sum_{j=0}^{\infty} \mu^{j+1} E_t^c \sigma_{t+j+1}^2 \quad (1)$$

[3] It is also well known that no satisfactory data exist on rental income for New Zealand and the U.K. over the period under consideration (see for example Hawksworth, 2004).

where μ and k are linearization constants; f is the constant real-risk free component of real required returns; $E_t^c \Delta q_{t+j+1}$ is the conditional expectation of changes in (log) income (q_t);[4] $E_t^c \sigma_{t+j+1}^2$ is the conditional expectation of the variance of house price returns (σ_t^2); and α is the coefficient of relative risk aversion (*CRRA*) of agents. Hence we follow the work of Merton (1973, 1980) and model the time-varying required return as the product of the *CRRA* and the expected variance of returns.

In order to utilize (1) to find the implied or fundamental house price, p_t^*, we use a 3-variable vector autoregression (VAR) *in* pq_t, Δq_t, *and* σ^2_t, to forecast real income growth and housing return variance and, from this, construct a measure of the fundamental house price-disposable income ratio, pq_t^*. Finally, from the fundamental price-income ratio pq_t^* we can generate the (log) of fundamental house prices as:

$$p_t^* = pq_t^* + q_t \tag{2}$$

where p_t^* denotes the (log) fundamental measure of house prices.

A formal test of whether the actual and implied fundamental price are significantly different from zero is conducted by restricting the VAR coefficients and constructing a Wald test with degrees of freedom equal to the number of restrictions imposed – in this case, three.

Given the above, we can identify the sign, size and significance of any deviations of actual house prices from their fundamental value (as warranted by real disposable income). Deviations from fundamental value are then modelled as a function of how far real disposable income is from trend, resulting in the construction

[4] It is convention to use upper case letters to denote the level of variables and lower case to denote their natural logarithm.

of a price series which captures expectations regarding future income *plus* any over/under estimation as to what future income might be. The difference between this latter price and the actual price is the component of bubbles driven by price dynamics (momentum behaviour). We are therefore able to separate out the components of house price deviations from fundamental value into those due to agents' overreaction to future income and to those due to movements in price.

3. Data

Data on New Zealand house prices were sourced from Quotable Value New Zealand's Residential Sales Summary quarterly publications and the Reserve Bank. The period analysed is 1970:1 through to 2005:4. This index measures average prices of freehold house sales adjusted for the quality mix of sales in each period. U.K. house prices, which track the price changes of a representative house from 1972:4 through 2005:4, were collected from the *Nationwide* database. Macroeconomic data were obtained from various sources: for New Zealand this was the *New Zealand Reserve Bank* and *Statistics New Zealand* while relevant U.K. macroeconomic data were sourced from the *Office of National Statistics*. All housing data were deflated, thus providing prices in real terms.[5]

[5] Due to data limitations it was not possible to perform the analyses at the city level. It is acknowledged that the conclusions which hold at the country level do not necessarily hold for all cities within the country.

4. Empirical Results

4.1. Fundamental v. Actual Prices

Figures 1 and 2 plot the actual and computed fundamental (warranted by real disposable income growth) residential house prices over the sample period for New Zealand and the U.K. respectively.

Figure 1: New Zealand Actual (P_t) and Fundamental (P_t^*) Real Residential House Prices as Warranted by Real Disposable Income

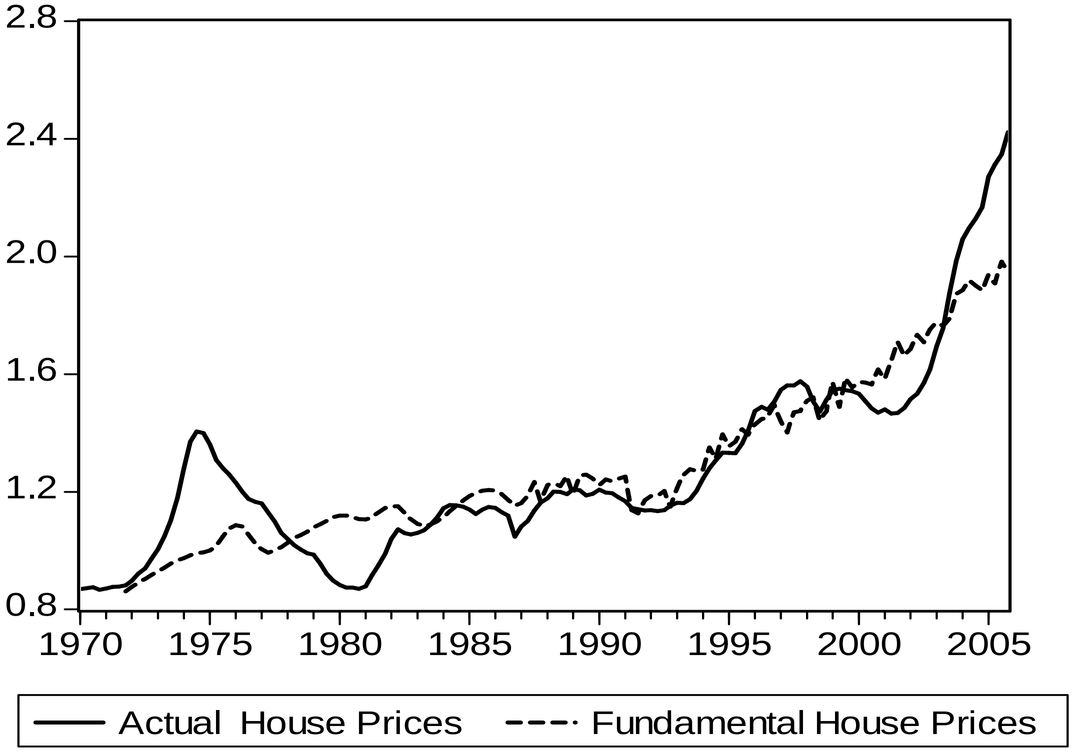
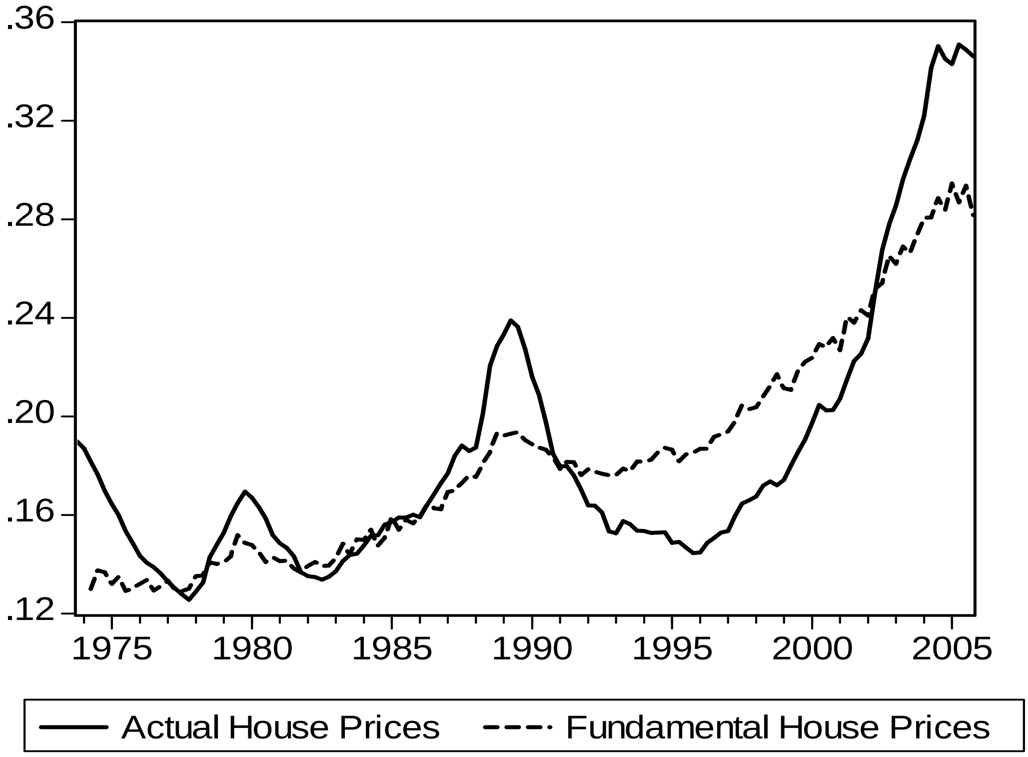


Figure 2: U.K. Actual (P_t) and Fundamental (P_t^*) Real Residential House Prices as Warranted by Real Disposable Income



In both cases we were able to convincingly reject the hypothesis that the difference between each of the two price series was statistically insignificant (not reported). Disparities between the actual and fundamental price in the New Zealand housing market are particularly noticeable in the early 1970s and 1980s and from 2000 to date. By the end of the time period, actual prices are 24.73 percent higher than that warranted by real disposable income, there being a steep rise in house prices following on from an undervaluation, the trough of which occurred in 2001. For the U.K., the overvaluation at the end point was also high at 22.87 percent, although this dramatic rise had stabilized and fallen slightly from the price of four quarters previously. Two other periods of overvaluation can be identified for the U.K., occurring in 1979Q4 (13.92 percent) and in 1989Q2 (23.86 percent). During these periods U.K. house prices were well above those supported by expectation of household disposable income

However, unlike other studies using international housing data, there is no evidence of a large overvaluation in the mid-late 1980s in the New Zealand market (see e.g., Fraser *et al*., 2008 forthcoming; Hawksworth, 2004; Ayuso and Restoy, 2003) – in fact from the late 1980s to 2000, New Zealand house prices would appear to be quite close to fundamental value and, if anything, tending to lie at, or just below, this value. Therefore, while New Zealand house prices peaked three times over the period, such price behaviour appeared to be warranted by forecasts of household real disposable income. This is consistent with results contained in Bourassa *et al.* (2001) who point to only modest bubbles in the housing markets of Auckland, Christchurch and Wellington and would tend to suggest that the market took some time to recover from the dramatic decline in prices at the end of the 1970s and early 1980s.

Importantly, the New Zealand economy during the late 1970s and early 1980s was in the final stages of high state intervention and was performing poorly. Related to the poor economic performance, New Zealand was also experiencing net external migration: during 1977 through 1981 it averaged approximately 0.66 percent, this from a population of approximately 3.2m. Notably, the three years from 1973 to 1975 had above average excess of arrivals to New Zealand (New Zealand Official Yearbook, 1984), a feature that Bourassa *et al.* also find important over different time periods. Further, the dip in New Zealand house prices in the late 1990s to 2001 was shorter lived than those reported for the U.K., where so-called 'negative housing equity' is evident from 1992 through 2001 with the turning point being in 1996, thus indicating a period where U.K. house prices were well below the fundamental price.

The propensity of both markets to experience 'negative housing equity' at some points (although not at the same points) over the period of interest does however imply that deviations from fundamental value over periods of undervaluation are unlikely to have been driven by an explosive bubble due to *extraneous* factors (that is factors other than those related to fundamentals): such an explosive bubble cannot be negative as this would imply a negative expected asset price at some date in the future and violate free disposability (see for example Diba and Grossman, 1988; Campbell *et al*., 1997, p. 259). However, while a zero price floor puts a limit on how far prices can fall, as Farlow (2004), p. 12, explains, it does not exclude the possibility that real payoffs in debt-backed housing can go below zero, with the New Zealand experience of negative equity in the late 1970s and late 1999 to 2003 and the U.K. one in the 1990s demonstrating this.

Hence while discussions above would tend to preclude the existence of an explosive bubble due to non-fundamental factors as being the driving force of deviations from fundamental value, it does not preclude the existence of a type of bubble which could be both negative and in the process of collapsing. An interesting question therefore is how can we interpret what drives deviations of house prices from their fundamental present value?

4.2. Deviations from Fundamental Value: Fundamentals v. Price Dynamics

Froot and Obstfeld (1991, p. 1180) posit that deviations in asset prices from fundamental values can be explained by the presence of a particular type of bubble that depends exclusively on aggregated values of the fundamental: here, this is real disposable income. They call such bubbles 'intrinsic', being non-linear deterministic functions of the fundamentals of asset value alone.

In common with explosive bubbles, intrinsic bubbles rely on bounded rationality and self-fulfilling expectations, but such expectations are driven by a *non*-linear relationship between prices and the fundamentals themselves, rather than factors extraneous to the asset value. Further, unlike explosive bubbles, such bubbles do not continuously diverge but periodically revert toward their fundamental value. Hence the 'bubble' element in house prices is constant if the fundamental is constant but will change in a non-linear way along with the level of fundamentals: if the fundamental is persistent then so is the bubble and prices will exhibit persistent deviations from fundamental present value (see for example, Cuthbertson, 1996, p. 163). This captures the idea that asset prices overreact to news on fundamentals: for a given innovation in (log) fundamentals and the belief that the relevant price function is non-linear, the expected change in the asset price will, for some time, deviate from the present value or fundamental price (Froot and Obstfeld, 1991, p. 1193).

Essentially, the existence of an intrinsic bubble violates the transversality condition that the expected asset price goes to zero as time goes to infinity. However, agents will eventually learn that their expectations regarding fundamental realizations are unreasonable, and therefore are not forever stuck on a path along which fundamental price ratios eventually explode (Froot and Obstfeld, 1991, p. 1190). At the heart of such an argument is the concept of arbitrage, which in housing markets is impeded by the fact that the asset is heterogeneous, is traded in a highly segmented market where information on fundamentals can be costly, does not have close substitutes and experiences relatively high and lumpy transaction costs, all of which would imply that any correction toward 'true' value can be a relatively prolonged process.

Alternatively, prolonged deviations from fundamental value can be due to so-called band-wagon or momentum behaviour driven by price alone, whereby agents buy after price increases and sell after price decreases (see evidence from stock markets e.g. Shiller, 1984; Kyle, 1985; DeLong *et al.,* 1990; Daniel *et al.,* 1998; Barberis *et al.*, 1998; Hong and Stein, 1999; Lui *et al*., 1999). Such behaviour occurs when a price rise or fall is expected to continue to rise or fall: hence in an 'up' market buyers will pile in pushing prices up even further encouraging other buyers to do likewise, while in a 'down' market price falls lead to falling demand, discouraging buyers as they fear prices will fall further, leading to slowing demand even further. Given that housing tends to be demand determined over the business cycle (due to relatively high supply constraints) this, along with the impediments to arbitrage cited above, can lead to 'inefficient' pricing of real estate being perpetuated for relatively long and often uncertain periods when compared to financial assets. As Farlow (2004) argues, this is particularly relevant to residential real estate, as housing markets tend to be short on the aggressive intervention of 'efficient' arbitrageurs.

In an attempt to distinguish between the competing hypotheses described above, we focus on the intrinsic argument and its implications. To consider this we begin with a comparison of price deviations from fundamental present value with a series that represents periods when real disposable income was either above or below its long term trend – the 'disposable income gap' – and which is depicted in Figures 3 and 4. Essentially, if the intrinsic explanation of price deviations being due to overreaction to fundamentals has some value then we should see some evidence of this by considering the association between house price deviations from the implied fundamental value and income deviations from trend.

Figure 3: New Zealand Real (logged) House Price Deviations from Fundamental Value $(p_t - p_t^*)$ and the Real Disposable Income Gap (log real disposable income (q_t) demeaned and detrended)

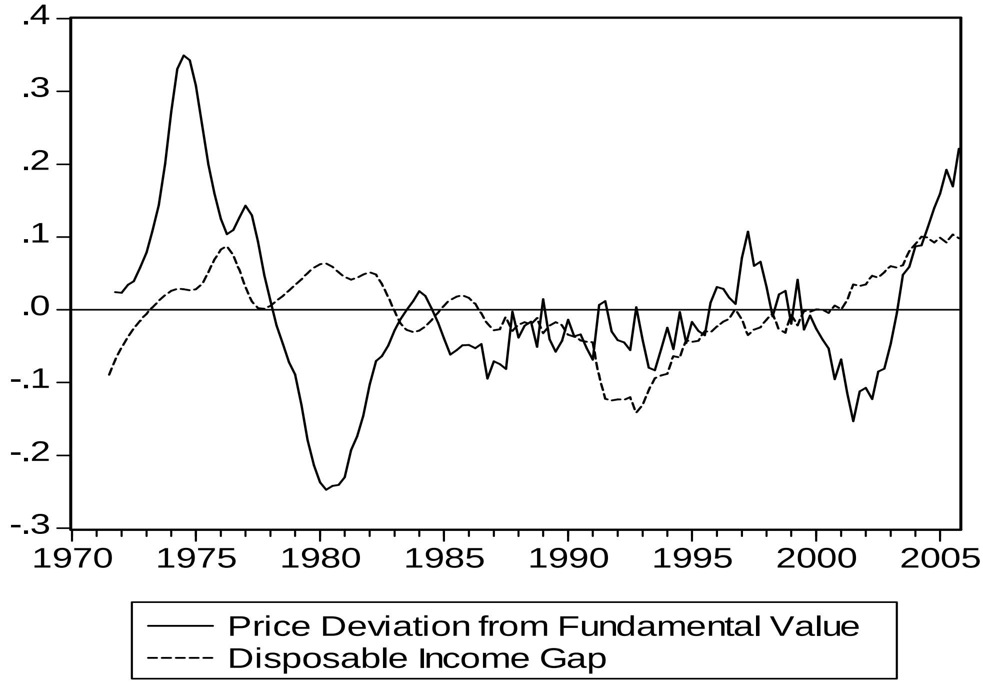
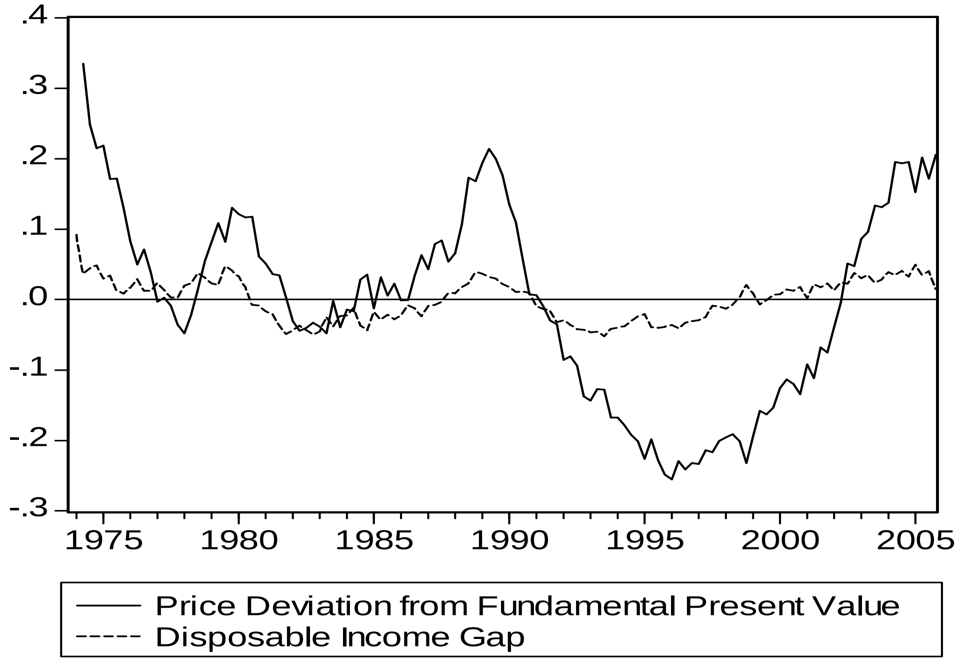


Figure 4: U.K. Real (logged) House Price Deviations from Fundamental Value $(p_t - p_t^*)$ and the Real Disposable Income Gap (log real disposable income (q_t) demeaned and detrended)



With the notable exception of the periods around 1980 and 2000, inspection of Figure 3 indicates that for New Zealand there is some evidence that positive (negative) price deviations from the present value fundamental price increase (decrease) when real disposable income is rising (falling) toward or above its long-term trend value and ability to pay is or expected to be relatively high (low). Since 1993, real income has gradually risen from below to above its long term trend and, with the exception of the fall in house prices in around 1999, this has been associated with an upward trajectory in house prices culminating in the dramatic overvaluation since 2003.

However, the evidence from the U.K., displayed in Figure 4, appears to be stronger both in terms of the time path of deviations from fundamental value and the 'ability to pay' and turning points. During the early-to-mid 1980s U.K. house prices appeared to be near their fundamental present value as real disposable income was close to trend value before rising well above trend in the late 1980s. Similarly, when in the mid 1990s negative price deviations from fundamental had peaked, real disposable income had already began to rise toward trend value. This pattern appears to be consistent throughout the whole time period and supports the view that housing costs relative to the ability to pay is an important factor in U.K. housing price paths (see for example, Himmelberg *et al.*, 2005), with the evidence being less convincing for New Zealand.

Intrinsic behaviour also implies that deviations from fundamental value will be more highly correlated with real income than with prices themselves, again suggesting that the dominant driving force for these is fundamentals rather than activities due to price dynamics. We report the relevant New Zealand and U.K. correlations in Table 1.

Table 1

*Summary Statistics on Price Deviations from Fundamental Value**

	Corr(deviations,income)	*Corr(deviations,house prices)*
New Zealand	0.155 (t=1.845)	0.442 (t=5.725)
U.K.	0.636 (t=9.288)	0.447 (t=5.631)

*Deviations denotes (logged) actual real house prices less (logged) fundamental house prices $(p_t - p_t^*)$. Income denotes (log) demeaned and detrended real disposable income (q_t) and house prices, the (log) of actual real house prices (p_t). Corr(.) denotes the correlation coefficient. The t-statistic is calculated as $(corr\sqrt{n-2})/(\sqrt{1-corr^2})$, where *corr* is the correlation coefficient and $corr^2$ is the squared correlation coefficient.

For New Zealand, we find that both pairs of variables depict a positive relationship but only the association between deviations from fundamental value and house prices is unambiguously significant at least at the 5 percent level of significance. The U.K. experience however is somewhat different. Here we find that while both correlations are significantly different from zero depicting a positive relationship, the association between deviations from fundamentals and house prices is less than that reported for deviations from fundamentals and real disposable income. Hence, U.K. house prices on average appear to be more sensitive to fundamentals than price dynamics with the converse being the case for New Zealand.

While such features imply that, *on average*, there are differences in the sensitivity of New Zealand and UK house prices to rational and irrational activities, it does not inform about the *extent* to which, over the sample period, bubbles are rational, due to fundamentals, or irrational due to price dynamics associated with momentum trading and the implied lack of aggressive arbitrageurs.

To investigate this further we begin with the suggestion that (in levels):

$$P_t = P_t^* + B_t \tag{3}$$

where P_t^* is the present value fundamental price as denoted by equation (A2) and B_t is an intrinsic bubble driven exclusively by fundamentals such that $B_t = E(B_{t+1})/(1+\rho_{t+1}^*)$, where ρ_{t+1}^* is the real discount rate and is a solution to equation (3) but one which violates the transversality condition imposed on the present value relationship (equation (A2)) that the expected price goes to zero as time goes to infinity.

How then might we empirically measure the extent of any intrinsic bubble inherent in house prices? Assuming that real disposable income follows an autoregressive process with drift, we hypothesize that the intrinsic bubble is a non-linear function of the deviations of real disposable income from trend, thus

$$B_t = cQ_{d,t}^{\lambda} \tag{4}$$

where c is a constant (c >0), $Q_{d,t}$ denotes real disposable income deviations from trend and λ (λ >1) is the exponent that permits the bubble to grow in expectation at rate $1+\rho_{t+1}$.

Substituting (3) into (4) and dividing through by P_t^*, re-arranging, taking logs of each side and using a first order Taylor series expansion allows us to specify a log-linear regression of the form:

$$p_t - p_t^* = b_t = c' + \lambda' q_{d,t} + \varpi_t \tag{5}$$

where lower case letters denote logs and ϖ_t is an error term measuring the element of the deviations from present value that is *not* attributable to an intrinsic bubble.[6] The fitted values of (5) permits the construction of a series that mimics the path a bubble might take in response to whether income is above/below trend. When the bubble

[6] As we are decomposing the bubble into its component parts, by definition $P_t - P_t^* = B_t = cQ_{d,t}^{\lambda}$ is non-zero.

series, B_t, is combined with P_t^*, we have a present value price which includes a bubble price which can then be compared to actual prices, P_t .

The (heteroskedasticity and autocorrelation robust) regression results, are shown in Table 2.

Table 2

Regression of Deviations from Present Value on Income*

$$p_t - p_t^* = c' + \lambda' q_{d,t} + \varpi_t$$

	c'	λ'	R^2	*Unit Root Test (ADF)* (ϖ_t)
New Zealand	-0.0007 (0.020)	0.332 (0.363)	0.024	-1.415
U.K.	5.72E05 (0.009)	3.053 (0.329)	0.405	-1.986

$p_t - p_t^*$ denotes (logged) house price deviations from present value, $q_{d,t}$ is demeaned and detrended real disposable income and ϖ_t is the error term of the regression. c', λ' are the parameters of interest with the figures in parenthesis below the coefficient estimates being Newey-West standard errors. R^2 denotes the coefficient of determination and *ADF*, the augmented Dickey-Fuller test statistic. Critical values for the ADF statistics with an intercept and trend removed are: 1% -2.584; 5% -1.943; 10% -1.615.

Notably, for both counties, the constant term, which is insignificantly different from zero implies a value of *c* close to unity. For New Zealand, the slope coefficient is clearly insignificantly different from zero and the regression only explains 2.4 percent of movements in these deviations. In contrast, the U.K. results show the slope coefficient as being highly significant, indicating that the sensitivity of the deviations from fundamental value to a one-percentage change in income deviation from trend to be c. 3 percent, and the regression explains 40 percent of movements in these deviations.

According to the unit root test statistics, the part of deviations from present value not explained by the regression (the residual series, ϖ_t) is non-stationary for New Zealand but (marginally) stationary, hence mean-reverting, for the U.K. at the 5 percent level of significance. Further investigation of the New Zealand model residuals indicated that around 1975, 1980 and 2001, the residuals were significantly different from zero, implying that outwith these periods i.e. 1982 through 2000, fundamentals had a more important role to play in explaining the path of actual house prices than in the remaining parts of the sample. In contrast, the U.K. model residuals indicated that between 1993 and 2001, these were significantly different from zero, implying that over this period fundamentals had a less important role to play in explaining the path of actual house prices than in the remaining part of the sample.

Figures 5 and 6 depict three price series (in levels): the actual house price series, P_t, the fundamental (present value) house price series, P_t^*, and the present value house price series plus the bubble component $(P_t^* + B_t)$ for New Zealand and the U.K. respectively.

Figure 5: New Zealand Actual (real) House Prices (P_t), Fundamental (Present Value) House Prices (P_t^*), and Fundamental House Prices with an Intrinsic Bubble $(P_t^* + B_t)$

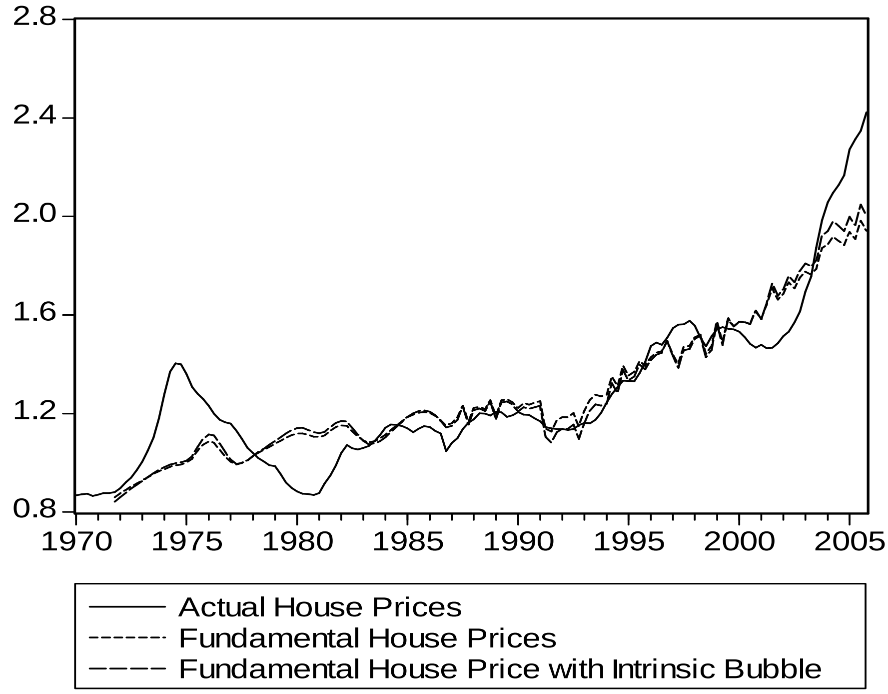
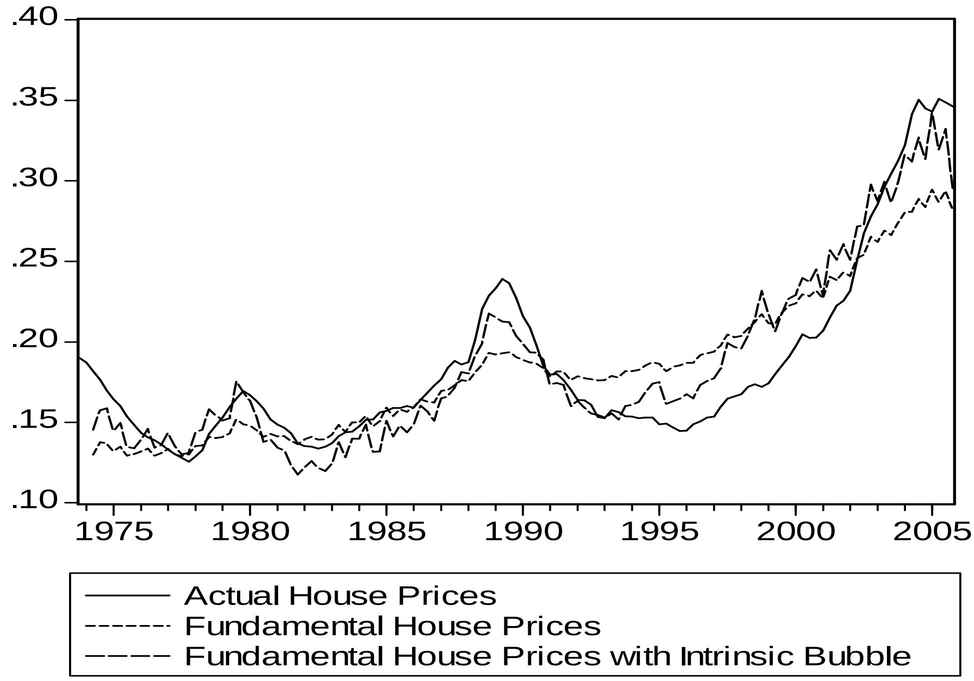


Figure 6: U.K. Actual (real) House Prices (P_t), Fundamental (Present Value) House Prices (P_t^*), and Fundamental House Prices with an Intrinsic Bubble ($P_t^* + B_t$).



Interestingly, and in accordance with the above discussion, for New Zealand, the fundamental price with the inclusion of the intrinsic bubble component does not appear to make a significant difference to the ability of the present value model to track actual prices particularly in periods when over/under valuation is greatest – for example the 1970s, early 1980s and early 2000. While the present value model alone would predict that house prices were 24.73 percent overvalued at the end of the sample, with the inclusion of an intrinsic bubble component this only reduces to 20.89 percent thus suggesting much of the overvaluation is due to price dynamics rather than an overreaction to fundamentals.

In contrast, for the U.K., the price with the bubble component appears to track actual prices quite well with the exception of the period between 1993 and 2001 and also from early 2005 – periods when actual house prices were well below or well above their fundamental value. Levin and Wright (1997) also note that the 1990s saw a period of what they term a negative speculative component in house prices in almost all regions of the U.K. While the inclusion of an intrinsic bubble component into the U.K. present value price reduces the overvaluation at the end of the sample from c. 23% (without an intrinsic bubble) to c. 17%, this gap was closed completely in the first quarter of 2005, indicating that at the end of the sample period price momentum had gained pace.

5. Concluding Remarks

This paper compares and contrasts U.K. and New Zealand real house prices with fundamental real house prices from the early 1970s through 2005. Prolonged deviations from fundamental value - or bubbles - can have considerable household portfolio effects which can lead to changes in household consumption patterns, growth of the economy and the accessibility of households to housing wealth. In New Zealand, this situation is exacerbated due to the composition of household asset portfolios. It is therefore crucial that policy makers identify the existence and causes of rapid, and perhaps unjustified, changes in house prices.

Utilising a dynamic and forward-looking present value model, our analysis investigates whether bubbles exist in the New Zealand and U.K. housing markets by constructing an implied fundamental (real) price series based on what house prices 'should be' given expectations of household real disposable income and comparing these with actual prices. The analysis also investigates the type of behaviour driving revealed deviations from fundamental value.

While we find evidence of bubbles in both markets they occur in different time periods and would appear to be driven by different behaviour. The results suggest that U.K. house price deviations from their implied fundamental value are driven by an overreaction to future income with price dynamics or momentum behaviour only coming into predominance when prices were well above or below this value. In contrast, New Zealand deviations from fundamental value appear to be driven by price dynamics alone, indicative of the predominance of band-wagon or momentum effects.

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Appendix: **The Fundamental Price-Income Model**

The model described in the empirical framework section above has the following present value expression for the real value of household property, V_t:

$$V_t = \gamma E_t \sum_{i=1}^{\infty} \left(\frac{1}{\prod_{j=1}^{i} (1+\rho^*_{t+j})} \right) Y_{t+i} \tag{A1}$$

where V_t is a constant proportion, γ, of the expected value of future real disposable income, Y_t, discounted at the real discount rate, ρ_t^*. Assuming the relationship between the real house price index P and market capitalization V, and the relationship between the value of all income, Y, and income covered by the house price index, are constant, then equation (A1) is re-written as:

$$P_t = E_t \sum_{i=1}^{\infty} \left(\frac{1}{\prod_{j=1}^{i} (1+\rho^*_{t+j})} \right) Q_{t+i} \tag{A2}$$

where $P_t = \beta' V_t$, and, defining $\beta = \beta'(\gamma)$ and $Q_t = \beta Y_t$.

We define the time stream of realized discount rates, ρ_t, to satisfy:

$$P_t = \sum_{i=1}^{\infty} \left(\frac{1}{\prod_{j=1}^{i} (1+\rho_{t+j})} \right) Q_{t+i} \tag{A3}$$

Given the discussion of (A2) above, (A3) is a particular solution to $P_t = (P_{t+1} + Q_{t+1})/(1+\rho_{t+1})$, and it follows that:

$$1+\rho_{t+1} = (P_{t+1} + Q_{t+1})/P_t \tag{A4}$$

where P_t is the real price at the end of period t, and Q_{t+1} is real disposable income measured during $t+1$. Taking logs and using lower case letters to represent the logs of their upper-case counterparts, we can write:

$$r_{t+1} = ln(1+exp(q_{t+1} - p_{t+1})) + p_{t+1} - p_t \tag{A5}$$

where r is defined as $ln(1+\rho)$ and the term $(q-p)$ can be viewed as the economy-wide income-price ratio. The first term in (A5) can be linearized using a first-order Taylor's approximation and (A5) can be written as:

$$r_{t+1} = -(p_t - q_t) + \mu(p_{t+1} - q_{t+1}) + \Delta q_{t+1} + k \tag{A6}$$

where k and μ are linearization constants:

k = -lnμ - (1-μ). $\overline{(q-p)}$

μ = 1/(1 + exp$\overline{(q-p)}$)

where $\overline{(q-p)}$ is the sample mean of (q-p) about which the linearization was taken. Clearly, 0 < μ < 1 and in practice is close to 1.

Empirically, it is common that both p and q are I(1) so that the variables are transformed to ensure stationarity. Denote by pq_t the (log) price-income ratio, $p_t - q_t$, and rewrite equation (A6) as:

$$pq_t = k + \mu pq_{t+1} + \Delta q_{t+1} - r_{t+1} \tag{A7}$$

After repeated substitution for pq_{t+1}, pq_{t+2},… on the right-hand side of (A7), we get:

$$pq_t = \frac{k(1-\mu^i)}{(1-\mu)} + \sum_{j=0}^{i-1} \mu^{j+1} \Delta q_{t+j+1} - \sum_{j=0}^{i-1} \mu^{j+1} r_{t+j+1} + \mu^i pq_{t+i} \tag{A8}$$

Letting i $\rightarrow \infty$ and assuming that the limit of the last term is 0, results in the following alternative form of (A8):

$$pq_t = \frac{k}{(1-\mu)} + \sum_{j=0}^{\infty} \mu^{j+1} \Delta q_{t+j+1} - \sum_{j=0}^{\infty} \mu^{j+1} r_{t+j+1} \tag{A9}$$

Hence, if $q_t \sim I(1)$ then $\Delta q_t \sim I(0)$ and, assuming that $r_t \sim I(0)$ (recall that it is the real discount rate), then pq_t will be I(0) and we have the model linearized and expressed in terms of stationary variables. Finally, taking conditional expectations of both sides:

$$pq_t = \frac{k}{(1-\mu)} + \sum_{j=0}^{\infty} \mu^{j+1} E_t^c \Delta q_{t+j+1} - \sum_{j=0}^{\infty} \mu^{j+1} E_t^c r_{t+j+1} \tag{A10}$$

where E_t^c are conditional expectations and we interpret r_{t+j+1} as investors' required return.

In order to use (A10) to generate a series for pq^*_t, the price-income ratio implied by the model and from it the implied or fundamental house price, p^*, we need to obtain empirical counterparts to the terms on the right-hand side involving expectations. For the first of these, the expectation of disposable income growth, we incorporate disposable income growth into a *3*-variable VAR model (see below) while for the second we assume a time-varying risk premium, which we also include in the empirical VAR. Here we follow the work of Merton (1973, 1980) on the intertemporal CAPM, and model the time-varying risk premium as the product of the coefficient of relative risk aversion, α, and the expected variance of returns, $E_t^c \sigma_t^2$.[7] The equation for the price-income ratio then becomes:

$$pq_t = \frac{k-f}{(1-\mu)} + \sum_{j=0}^{\infty} \mu^{j+1} E_t^c \Delta q_{t+j+1} - \alpha \sum_{j=0}^{\infty} \mu^{j+1} E_t^c \sigma_{t+j+1}^2 \tag{A11}$$

[7] We also experimented with measures of conditional variance derived from various specifications of GARCH-type models of housing returns. However, the results were very similar to those reported below.

where f is the constant real-risk free component of real required returns. In this case, we forecast both real income growth and the housing return variance using a 3-variable VAR in $\mathbf{z}_t = (pq_t, \Delta q_t, \sigma^2_t)'$. The empirical VAR is written in compact form as:

$$\mathbf{z}_{t+1} = \mathbf{A}\mathbf{z}_t + \boldsymbol{\varepsilon}_{t+1} \tag{A12}$$

where $\mathbf{A}$ is a (3x3) matrix of coefficients and $\boldsymbol{\varepsilon}$ is a vector of error terms. We assume a lag length of 1 for ease of exposition. If, in the empirical application, a longer lag length is required, the companion form of the system can be used.

Forecasts of the variables of interest $j+1$ periods ahead are achieved by multiplying $\mathbf{z}_t$ by the $j^{\text{th}}+1$ power of the matrix $\mathbf{A}$:

$$\mathbf{z}_{t+j+1} = \mathbf{A}^{j+1}\mathbf{z}_t \tag{A13}$$

The equation from which we compute the fundamental price-income ratio (and hence the fundamental house price) is:

$$pq_t^* = \frac{k-f}{1-\mu} + (\mathbf{e}_2' - \alpha\mathbf{e}_3')\mathbf{A}(\mathbf{I} - \mu\mathbf{A})^{-1}\mathbf{z}_t \tag{A14}$$

where $\mathbf{e}_2' \mathbf{A}^{j+1}\mathbf{z}_t = E_t^c \Delta q_{t+j+1}$ and $\mathbf{e}_3' \mathbf{A}^{j+1}\mathbf{z}_t = E_t^c \sigma^2_{t+j+1}$ where e_2' and e_3' are, respectively, the second and third unit vectors. Hence the fundamental value of the price-income ratio is generated by a combination of the present value model and the forecasting assumptions.

Therefore pq_t* provides a measure of the fundamental house price series once we have estimated the VAR coefficients and the constants μ, k, and f. Given that we wish to generate a series for real house prices that is warranted by (predicted) income growth, we generate (the log of) fundamental house prices as:

$$p_t^* = pq_t^* + q_t \tag{A15}$$

Equation (A14) can also be used to derive tests of how far actual house prices deviate from their fundamental value as warranted by real disposable income. This is simply a test of $pq_t = pq_t^*$ for all t. Since $pq_t = e_1'\mathbf{z}_t$ where $\mathbf{e}_1'$ is the first unit vector, we can write (A14), after transforming the variables to deviations from their means to remove the constant term, as:

$$\mathbf{e}_1'(\mathbf{I} - \mu\mathbf{A}) = (\mathbf{e}_2' - \mathbf{e}_3')\mathbf{A} \tag{A16}$$

This restriction is linear in the elements of $\mathbf{A}$ (denoted a) and in the present case simply amounts to:

$$\begin{aligned} \mu a_{11} - \alpha a_{31} + a_{21} &= 1; \\ \alpha a_{32} - a_{22} + \mu a_{12} &= 0; \\ \alpha a_{33} - a_{23} + \mu a_{13} &= 0. \end{aligned} \tag{A17}$$

and can be tested with a standard Wald test which is asymptotically χ^2–distributed with 3 degrees of freedom.