How does the Official Cash Rate (OCR) Affect the Recent Housing Price in New Zealand?

Song Shi*

School of Economics and Finance (Palmerston North), Massey University

Jyh-Bang Jou

Graduate Institute of National Development, National Taiwan University

David Tripe

School of Economics and Finance (Palmerston North), Massey University

Acknowledgement: The authors would like to thank attendees at seminars at Massey University and the Reserve Bank of New Zealand for comments on earlier versions of this paper.

* Correspondence. Email: s.shi@massey.ac.nz

How does the Official Cash Rate (OCR) Affect the Recent Housing Price in New Zealand?

Abstract

This paper investigates how changes in the retail mortgage rates affected real housing prices in New Zealand during the period 1999-2009. We find that the real interest rate, measured by the real fixed rate, is positively related to the real housing price, after controlling for the effect of real rental rates, unemployment rates and housing credit. There is co-movement between the OCR and mortgage rates, but the co-movement mainly links to short-term mortgage rates. Increases in the OCR thus had little impact on the real housing price during the time period investigated, suggesting that a housing bubble prevailed in the recent New Zealand housing market. We argue that this bubble may stem from the long-term favourable taxation treatment in housing investment.

Keywords: Monetary policy, housing market, OCR, mortgage rates

1. Introduction

The recent subprime crisis has attracted many researchers to investigate the determinants of housing prices, especially to investigate whether the low level of the Federal funds rate during 2002 to 2005 caused the housing bubble, i.e., the housing price growing at a rate much higher than that of the household income. However, most studies focus on the U.S. housing market, even though other countries showed large increases in house prices and subsequent adverse consequences. In this article, we focus on New Zealand, a much smaller country that suffered less from the subprime crises, as compared to the U.S, but where there was still official concern as to the extent of increase in housing prices (Bollard and Smith, 2006).

In this article, we investigate the determinants of the real housing price in New Zealand during 1999-2009. In particular, we focus on investigating whether increases in the official cash rate (OCR), the policy rate set by the Reserve Bank of New Zealand (RBNZ) eight times a year, depress the real housing price. Previous study has examined how this policy rate passes through to retail interest rates. For example, Tripe, McDermott and Petro (2005) found that since the RBNZ introduced the OCR in 1999, key lending interest rates had become more responsive to changes in underlying wholesale rates and RBNZ monetary policy thus became more efficient.[1] More recently, Liu, Margaritis and Tourani-Rad (2008) found that the introduction of OCR increased the pass-through of floating, but not fixed mortgage rates. These previous studies, however, have not explored how the OCR affects real or nominal housing prices. Given that the relationship between the monetary policy and the housing price is so complex, researchers have not yet reached a consensus conclusion regarding the issue which we focus on (PricewaterhouseCoopers, 2009).

[1] Similar findings were also reported in Sethi (2008).

As Shiller (2006) suggests, monetary policy, which has the potential to affect the interest rates and hence the discount rate of households, should affect housing prices. Some evidence for this is evident in research from the USA (Bernanke and Gertler, 1995; Mishkin, 2007), but the effect would be expected to be stronger in New Zealand because of the greater sensitivity of mortgage lending rates to monetary policy rates (reflecting the more frequent repricing of loans). A recent study by Cho and Ma (2006) that analysed the long-run relationship between housing values and interest rates in Korea confirmed this. They found that a long-term negative relationship existed between housing values and interest rates. They further concluded that monetary policy worked very effectively. However, they implicitly assume that long-term market interest rates follow changes of the policy rate immediately.[2] We would expect this effect to apply to short-term rates, but not so immediately to longer term rates.

In this article, we first examine the relationship between the OCR and the two types of mortgage loan available on the New Zealand housing market, i.e., floating-rate loans which allow rates to be changed more or less immediately in response to changes in the underlying cost of funds, and fixed-rate loans, where rates may be fixed for up to five years. We find that the OCR Granger causes the real fixed-rate, but that it does not have as much of an impact on real floating-rates. The real interest rate, both fixed and floating, in turn Granger causes the announced OCR.

We then test the relationship between the real housing price and the real interest rate based on the present value model described by Campbell and Shiller (1988a, b). The model predicts that the real housing price is positively related to the real rental rate, but negatively related to the household's real discount rate. We use both the real fixed-rate and floating-rate to proxy the household's real discount rate. After

[2] See also McDonald & Stokes (2011, forthcoming) who show a relationship between short term interest rates in the United States (the fed funds rate) and nominal house prices.

controlling for the impact of the real rental rate, we find that each of these two proxies exhibits a positive effect on the real housing price. Thus, we reach two conclusions. First, increases in the OCR did not depress housing prices in New Zealand over recent periods, particularly during the 2001 to 2007 period when the OCR increased from 5% to 8.25% per annum. Second, households' real discount rate exhibits a positive effect on real housing prices, thus indicating that the housing bubble in New Zealand was more severe than that in the U.S. where decreases in real interest rates could explain 20% increases in real housing prices (Glaeser et al., 2010). A bubble is identified by an extraordinary escalation in prices which cannot be justified by underlying economic factors, and which cannot therefore be sustained. As Stiglitz (1990) suggests, a bubble exists if the reason that prices are high today is only because the investors believe that selling prices will be high (or higher) tomorrow. We suggest that this bubble may have been facilitated by the long-term favourable taxation treatment in housing investment.

The remainder of this study is organised as follows: Section 2 describes interest-rate setting in New Zealand and the monetary policy process of the RBNZ. Section 3 presents the theoretical framework and econometric tools used in this research. Section 4 describes the data utilised. Section 5 reports the empirical results. Section 6 provides conclusions.

2. Interest rates

The RBNZ currently has an inflation target of 1 to 3% per annum, over the medium term. Adherence to this target provides the basis for its monetary policy. The OCR is the key policy rate for its implementation of monetary policy, and defines the rate banks may earn if they deposit funds with the RBNZ (overnight), or if they borrow from it (on a repo basis), with there being a 50 basis points spread between the borrowing and lending rates. The rate is an overnight rate, and thus affects the rates banks charge each other for overnight borrowing.[3] It provides an anchor for the very short end of the yield curve, with market rates for longer maturities being impacted by the usual range of influences on the shape of the yield curve, and it will have a stronger impact on short term rates than on longer term rates.

The OCR is subject to a regular review process eight times a year, although on one occasion (19 September 2001), it was changed at other than a regular, scheduled review date. This means that, following an OCR review, the dates of which are scheduled 12 months or more in advance, there will not be expected to be any change for another 6 to 7 weeks, and the actual overnight market rate will remain relatively stable accordingly (at more or less the OCR).

Because the OCR is used to try and influence future levels of inflation, one should expect it to be higher at times of higher inflation: real interest rates should be less variable than nominal rates (such as the OCR). In recent times, the OCR reached a maximum of 8.25%, between 26 July 2007 and 24 July 2008, while the lowest rate has been 2.5%, between 30 April 2009 and 10 June 2010, and again since 10 March 2011.

Longer-term interest rates also move to some extent in response to the OCR, although the yield curve developed a negative slope between 2004 and 2009. This reflected an anticipation that the RBNZ would be easing short-term interest rates in response to easing inflation pressures (an outcome which was somewhat delayed, at

[3] For a discussion of the way the process works through banks' liquidity management, see Nield (2006).

least in part because of booming house prices). Longer-term rates did fall significantly between the middle of 2008 and 2009.

3. Methodology

3.1 Present value model

This paper follows the present value model to investigate how the real rental rate and the real interest rate affect the real housing price. Shiller (2006) argued that house prices should be equal to the present discounted value of future rents. His model implies that house prices are positively related to rental rates, but negatively related to the household's discount rate. It is logical to infer that the time-varying discount rates are closely linked to the retail mortgage rates prevailing in the housing market.

A linear present value model with a constant discount rate is written as follows:

$$P_t = E_t\left[\sum_{i=1}^{n}\frac{D_{t+i}}{(1+R)^i}\right] + E_t\left[\frac{P_{t+n}}{(1+R)^n}\right], \quad (1)$$

where P_t is the current asset price at time t, D_t is the dividend or cash flow at time t and R is the constant expected discount rate. On the right-hand side of Equation (1), the first term is called the fundamental value, and the second term the price bubble. When n is sufficiently large, the second term will converge to zero.

Campbell and Shiller (1988a, b) suggest transforming Equation (1) into a log linear present value model with time-varying expected returns, where the logarithmic asset price at time t is written as follows:

$$p_t = \frac{k}{1-\rho} + E_t\left[\sum_{j=0}^{n} \rho^j \left[(1-\rho) d_{t+1+j} - r_{t+1+j}\right]\right] + E_t\left[\rho^j p_{t+j}\right], \quad (2)$$

where $P_t = \ln(P_t)$, $\rho = 1/\left(1+\exp\left(\overline{d-p}\right)\right)$, $\overline{(d-p)}$ is the average log dividend-price ratio, $k = -\log(\rho) - (1-\rho)\log\left(\frac{1}{\rho} - 1\right)$ and $r_{t+1} = \log(P_{t+1} + D_{t+1}) - \log(P_t)$. When the time horizon n increases to infinity, the third term on the right-hand of Equation (2), which is the discounted expected value of asset price, will shrink to zero. Accordingly, the current asset price will become:

$$p_t = \frac{k}{1-\rho} + E_t\left[\sum_{j=0}^{\infty} \rho^j \left[(1-\rho) d_{t+1+j} - r_{t+1+j}\right]\right]. \quad (3)$$

This equation implies that log asset prices are positively correlated to future dividends, but negatively related to future expected returns. Equation (3), which is also referred to as the dynamic Gordon growth model (Campbell and Shiller, 1988a, b), can be rewritten in terms of the log dividend-price ratio, i.e.,

$$d_t - p_t = -\frac{k}{1-\rho} + E_t\left[\sum_{j=0}^{\infty} \rho^j \left[\Delta d_{t+1+j} + r_{t+1+j}\right]\right]. \quad (4)$$

The above dynamic Gordon growth model implies that the dividend-price ratio must be equal to the present discounted value of expected future cash flows and the expected asset's future returns. The model has been successful in describing returns in the stock market and has also been applied to the real estate market, in particular for the study of house price bubbles and volatility over the recent housing price boom.

Recent scholarly works include Campbell et al. (2009), Fraser et al. (2008) and Costello et al. (2011).

We use the standard ADF unit root test to test for the stationarity of all variables. We find that both the real housing price and the real interest rate follow the unit root. Thus, we take the first-order difference for these two series, of which do not follow the unit root. We then take into account of location differences to specify the dynamic relationship among the real house price, the real rent and the real interest rates as follows:[4]

$$\Delta p_{i,t} = \alpha_0 + \beta \Delta d_{i,t} + \lambda \Delta m_t + \psi X + \sum_{j=1}^{11} \phi_j S_j + \varepsilon_{it} \qquad (5)$$

where *p*, *d* and *m* are log prices, log rents and mortgage rates, X is vector of economic variables, a_0 is constant, *i* denotes different cities, *t* denotes the time period, S_j denotes the monthly seasonal dummy variables ($S_j = 1$ for month j, and $S_j = 0$ otherwise), ε_{it} is the white noise, and Δ denotes the first difference.

3.2 Price bubbles

House price bubbles are reflected in people buying houses on the basis of returns from capital gains on houses, rather than from the utility of living in them as homes. The capital gains seem to be earned all too easily, and there is a reluctance to see that these may not continue because they are not readily justifiable by simple efficient-market models. These high prices may persist for some time.

Under the present value model, if a self-fulfilling price bubble does exist, stock prices and dividends will not be cointegrated or the dividend-price ratio will not be stationary. However, a finding of non-cointegration between stock prices and

[4] Following Wheaton and Nechayev (2008), we do not include any lagged price difference variable in Equation (5) because we do not find any significant second-order autocorrelation in our empirical study.

dividends does not necessarily imply a price bubble exists. This is because there may be unobserved factors in market fundamentals causing this non-stationarity. The key question is how we define fundamental values. Nevertheless, finding of this non-cointegration has been widely viewed as a key indicator for asset bubbles. In empirical tests, cointegration and unit root tests between stock prices and dividends give mixed findings depending on the time period studied. Through using the annual US stocks market data from 1871 to 1986, Campbell and Shiller (1987) found stock prices and dividends were not cointegrated. The deviation from prices and dividends was quite persistent, which indicated a bubble exist in the stock market. By taking account of the change of market fundamentals, such as the changes in real interest rates and real rental-price ratio, Shiller (2006) concluded that there was irrational overpricing (a bubble) for U.S. house prices in general and suggested that there might be a huge fall in home prices in the near future. Mikhed and Zemčik (2009) even developed a bubble indicator based on the stationarity between house prices and rents.

In this paper, like many other researchers (Gallin, 2008; Mikhed and Zemčík, 2009; Shiller, 2006) we use a standard present value model to proxy the fundamental values for housing. We found the log rent-price ratio was not stationary over an extended time period since 1994. Moreover log real house prices are positively correlated to real interest rates during the recent time period. The initial results indicated that there was a housing bubble for most New Zealand housing markets over the period 1999-2009.

4. Data Description

This research utilised a rich data set of 528,601 freehold (fee simple) open market transactions of detached or semi-detached houses for six selected cities in New

Zealand between 1994 and 2009. House price movements for the six selected cities were estimated directly from the transaction data by using the repeated sales method at monthly interval, which are unique and not publicly available. The transaction data was supplied by Quotable Value (QV), the official database for all property transactions in New Zealand. The six selected cities are Auckland City, North Shore City, Waitakere City, Manukau City, Wellington City and Christchurch City. We choose these six cities because they accounted for more than 50% of New Zealand housing stock and periodical sales volume. It is important to consider sample sizes when measuring local house price movements by using Case-Shiller (1987) weighted repeated sale (WRS) method. As the repeat sales method uses only repeated sales for index construction, the index is more prone to sample selection bias than other index methods that use all transaction sales data. Previous work indicates that the frequently traded houses (sold more than twice within a period of time) are more likely to be the "starter" houses or houses for opportune buyers (Clapp and Giaccotto, 1992; Haurin and Hendershott, 1991). Previous study also indicates that the repeat sales index is prone to a systematic downward revision due to lagged sales (Clapham et al., 2006). To minimise these two problems, we measure local house price indices over an extended time period from 1994 to 2009. Table 1 illustrates the distribution of house sales and the numbers of dwelling, both of which indicate that we employ a sufficient sample size of repeated sales, and thus minimize the sample selection bias. Note that our study uses real house prices, which are nominal house prices adjusted by the CPI (Consumers Price Index).

QV also produces a house price index but it is on a quarterly basis. The QV index is based on the Sale Price Appraisal Ratio (SPAR) method, which takes the ratios of current sale prices and their previous assessed values to construct an index.

Comparing with the quarterly reported index, our estimated monthly price index will unsmooth the price movement and increase the number of observations in a time series analysis. Another reason to estimate house price movements on a monthly basis is because most the interest rate data are reported on a monthly basis in New Zealand.

<Insert Table 1>

As the repeat sales method is vulnerable to outliers (Meese and Wallace, 1997), we use prior knowledge to eliminate all multiple sales where the second sale price is less than 0.7 or more than 2.5 times the first sale price. Moreover, since the QV data includes building consent information for all the studied cities except Auckland City, we further eliminate the quality changed repeat sales, thus minimizing the constant quality problem faced by the standard repeat sales method.[5] In total, we exclude 15% and 24% of initial pair sales from the final index estimation, depending on various local housing markets. We ended our data set at 2009 because it was the latest year for which we held a complete sale data set.

We obtain monthly rental data for detached or semi-detached houses from the Tenancy Services Division of Department of Building and Housing (DBH) in New Zealand. Under the Residential Tenancies Act, all tenancy bonds must be lodged with the DBH within 23 working days from the tenancy start. The bonds normally amount to two or three weeks of rents payable under the new tenancy. The DBH rental data is transaction based and very comprehensive in terms of recording the market rent settings for all new residential tenancies in New Zealand.

[5] Building consent data is collected for revaluation purposes only where QV is the valuation service provider for the Council. For Auckland City, QV is not the valuation service provider for the council and for that reason there is no building consent data for Auckland City.

We use the monthly median rent for each local housing market, which is almost always equal to the median rent of a 3-bedroom house across all areas studied during the sample period. We use the rental data for houses to proxy the user cost or "imputed rent" of owning for the following reasons. First, we are unable to observe the true user cost of owning a house. Even though we could estimate it (Hendershott and Slemrod, 1983; Himmelberg et al., 2005), we will inevitably introduce measurement errors. Second, the total percentage of rental housing in the New Zealand housing stock is large and also increasing over time. By 2004 rental housing comprised around 30 percent of the national housing stock.[6] Thirdly, the private sector rental houses and the owner-occupied houses tend to substitute for each other, and thus their prices do not differ substantially. The survey by Hargreaves and Shi (2005) shows that on average rental house prices fall between the open-market median and lower quartile house prices.[7]

Finally, we obtain the OCR, the retail residential mortgage lending rates and values of outstanding mortgage loans from the RBNZ. We use a monthly average of OCR for each month. Retail interest rates include floating (or adjustable) rates, and rates fixed for 6 months, 1 year, 2 years, 3 years, 4 years and 5 years. For the whole of the period of this study, fixed rate loans accounted for the majority by value of all housing loans. Note that, at the end of any fixed term period the borrower has the option to choose another fixed term period, or to switch his loan to a floating rate basis. We also use real interest rates in our analysis, which are nominal interest rates adjusted by the CPI.

[6] Although New Zealand has traditionally had a high rate of home ownership, this rate has gradually declined between 1996 and 2006. Analysis of census data from Statistics New Zealand shows that in 1996, 70.7 percent of households owned their dwellings, but it fell to 67.8 percent in 2001 and then to 66.8 percent in 2006.

[7] Where the percentage of rental properties is high, rental houses are not confined to the less expensive suburbs. In fact, rental housing has increased across all established suburbs across all cities in New Zealand.

For the period from 1999 to 2009, for mortgage loans, we use the data for household lending from the RBNZ's data table C5. For analysis including earlier time periods we use the data for total household claims. Unemployment rate data comes from Statistics New Zealand.

5. Empirical Results

Figure 1 shows the real housing price and the real rental rate in Auckland city, the real OCR, the real rate for a floating mortgage loan, and the real rate for a 5-year fixed mortgage loan during 1999 to 2009. We find that the real housing price is positively correlated with these four explanatory variables, with the correlation coefficients being 72.1%, 32.2%, 53.4%, and 1.7%, respectively (although with the less frequent repricing, this last relationship is much weaker). This preliminary result contrasts significantly with the U.S. In the U.S., the rental rate is also positive correlated with the housing price, but the interest rate, no matter whether floating or fixed, is negatively correlated with the housing price (Glaeser et al., 2010).

<Insert Figure 1>

5.1 Co-movement between OCR and retail mortgage rates

We first look at the correlation coefficient between log real OCR changes and log real retail mortgage rate changes. The result is shown in Table 2, which indicates that the OCR is more closely related to the shorter-term mortgage rates. For example, the correlation coefficient between the real OCR and the real floating-rate is 0.75, while it drops gradually to 0.35 between the real OCR and the real 5-year fixed-rate. The result is expected as the short-term interest rate is more directly linked to the overnight cash rate while the long-term interest rate is linked to the corresponding bond yields, linked to the OCR predominantly through expectations for the trend in the OCR.

<Insert Table 2>

We then employ the Granger causality test to see whether changes in the real OCR lead changes in the real retail interest rate or vice versa. We present the result in Table 3, which shows that we reject both hypotheses for longer term rates, that the OCR change does not Granger cause the retail real interest rate change and that the retail real interest rate change does not Granger cause the OCR change, at the 5% significance level. Therefore, it appears that Granger causality runs two-way either from the real OCR change to the real retail interest rate change or from the retail real interest rate change to the OCR change for longer term rates. In contrast the Granger causality runs one-way from the real retail interest rate changes to the real OCR changes for shorter term rates. The result is plausible because of keen market competition between banks. In fact, the announced change of the OCR often provides banks with a good reason to adjust their retail interest rates.[8] On the other hand, banks might change their shorter fixed term mortgage lending rates prior to the OCR announcement because they anticipate the policy change or simply have to follow the preemptive actions of other lenders in changing their mortgage rates. Overall, the result shows that the implementation of monetary policy through changes in the OCR has a direct impact on retail mortgage rates, especially the short-term (floating) mortgage lending rate. The relationship with longer term rates is likely to be an

[8] See Tripe et al (2005), Cottarelli & Kourelis (1994).

indication of the way in which long-term rates predict future shorter-term rates. This is suggesting that the yield curve is acting as a relatively reliable predictor of future rates. If the OCR did not respond to changes in other interest rates it is likely that we would regard the implementation of monetary policy as somewhat erratic.

<Insert Table 3>

5.2 House price dynamics

Table 4 reports the regression results of the house price dynamics based on the present value model specified in Equation (5). It shows that house price changes are positively correlated to changes in the real rental rate and the retail real interest rate, no matter whether floating or fixed. However, the real fixed-rate shows more impact on the housing price than the real floating-rate. For example, 1% increase in the first-order difference of changes of the real floating-rate will significantly (at the 10% level of significance) increase the first-order difference of the housing price by 0.093%. The same change of the first-order difference of the real 1-year fixed rate will significantly (at the 5% level of significance) increase the first-order difference of the housing price by 0.589%.

Our result indicates that households' real discount rate exhibits a positive effect on the real housing price. As shown by Campbell et al. (2009) the link between the level of house prices and real interest rates is more complex than history suggested and changes in risk-free interest rates may not have much impact on house prices. However, our result departs from the results suggested by the standard economic theory such as the present value model, thus indicating that a price bubble might exist.

As compared to the literature, our regression model specified in Equation (5) disregards two sets of factors. The first one is demand fundamentals such as employment and income (Campbell et al., 2009; Wheaton and Nechayev, 2008), and net immigration (PricewaterhouseCoopers, 2009). We argue that the rental rate should reflect fundamental supply and demand factors in the housing market (Campbell et al., 2009). The second one is the credit market terms such as the loan-to-value ratio and approval rates (Glaeser et al., 2010). While the data on these terms can be obtained in the U.S., detailed information on loan terms is not generally published by financial firms in New Zealand.[9] Furthermore, the impacts of these terms on the housing price are still inconclusive. While Khandani, Lo and Merton (2009), and Wheaton and Nechayev (2008) find a pivotal role played by them, Glaeser et al. (2010) find them to be insignificant factors.

<Insert Table 4>

5.3 Bubble indicators

To further investigate the relationship between real house prices and real interest rates, we followed Glaeser et al. (2010) by reporting the results of a series of regressions of the log real house price index on real interest rates and other covariates. The bubble period is then indicated by the positive relationship between real house prices and real interest rates. Since the full breakdown of fixed mortgage rates is not available prior to 1998, we use the floating mortgage rate for this analysis. The results are detailed in Table 5.

[9] There was, however, some recognition of a potential easing of credit standards, as instanced by comments in Reserve Bank of New Zealand (2007), pp 25-26.

<Insert Table 5>

Model 1 (Table 5, column 1) reports the coefficients for the interest rate variables from the results of regression of log real prices on real floating rates including a simple time trend. The time trend is included to correct for any bias from omitted variables that are trending with both interest rates and prices. The results show that for most time periods interest rates are negatively correlated to real house price movements except for a weak effect in 2001 and the period from 2004 to 2007. Since house prices are unit roots in this study, we use the first difference of log real house prices on the first difference of real interest rates. The results are presented under model 2 (Table 5, column 2). Weak bubble effects are found for 1997 and 2001, with stronger effects for 2004 through to 2006. The addition of housing lending data to the analysis (see Table 5, column 3 and 4) does not change the results to any major extent.

For the period 2004 to 2006, policy rates were set low but increased slowly when compared to previous levels. The findings are in line with the self-fulfilling nature of a price bubble. For a price bubble, prices must grow faster than the discount rate in order to compensate for the probability of the bubble bursting. The findings may suggest that the bubble was started by a low policy rate setting with no impact from the slow increase of policy rates over time. Taylor (2007, 2009) argues that the low level of the Federal funds rate was the main reason why the U.S. experienced housing price inflation during the mid-2000s.

5.4 Unemployment and house lending

To address the concern of demand fundamentals and credit market conditions on house prices, we include two further variables - unemployment rate and housing lending data, to equation (5).[10] The idea is to test if this positive relationship between real house prices and real interest rates found in Table 4 changes once we control for those variables. Our hypothesis is that the change in unemployment rate will be negatively correlated to the change of house prices while the change in housing lending will be positively related to the change of house prices, but negatively related to the change of interest rates. The more money that is poured into the housing market, the higher housing prices will be. On the other hand a higher interest rate will dampen the demand for the housing lending. The difficulty is the problem of causation, as it could be either a higher house prices causes increases in housing credit lending or that increased housing lending leads to higher house prices. In this analysis, house lending variable has been estimated by the percentage change of real house lending. The regression model is presented as follows and the results are presented in Table 6.

$$\Delta p_{i,t} = \alpha_0 + \beta \Delta d_{i,t} + \lambda \Delta m_t + \varphi E_t + \delta C_t + \sum_j^{11} \emptyset_j S_j + \varepsilon_{i,t} \qquad (6)$$

where E_t represents the percentage change of unemployment rate at time *t*, C_t represents the percentage change of real house lending at time *t*. All other are same as those defined in equation (5).

<Insert Table 6>

[10] We also tested adding net migration data to equation (5), but the migration variable was not found to be insignificant.

The results show that the change of house lending positively causes price changes and negatively correlates to the short-term interest rate changes up to 1 year. For rates longer than 1 year, both interest rates and housing lending were positively related to house price changes although the impact of interest rates on house prices became statistically insignificant. Thus it appears the household's short-term and long-term discount rates for housing are quite different. An increase in short-term interest rate will cause house prices to drop, while an increase in long-term rates may push house prices up. In other words the longer term rates are likely to contribute to the bubble, while the shorter rates do not. But why should this be the case?

We suggest that the cause may lie in the shape of the yield curve, the mix of fixed and floating rate lending, and the average size of fixed and floating rate loans. During the potential bubble period (2004 to 2006), the yield curve was consistently negatively sloping, with longer term fixed rates consistently cheaper than floating rates. This meant that borrowers who wanted significant amounts of debt were often encouraged to take on fixed rate loans, both to reduce immediate debt servicing costs, and to reduce their exposure to future interest rate increases which might have made their housing financing unviable. We thus saw an increase in the relative proportion of fixed rate lending (as can be seen in Figure 2), while the size of the average fixed rate loan (between $115,000 and $130,000 between 2004 and 2006) was much larger than the size of the average floating rate loan (generally between $50,000 and $55,000 over the same period). Borrowers who had floating rate loans were likely to be much less concerned about the effects of interest rate changes as the amount of their debt meant that the impact was going to be relatively small. The serious borrowing was undertaken at fixed rates, and even though fixed rates increased through this period, this was not enough to put borrowers off, when they perceived that property prices would continue to increase.

Another plausible explanation is that New Zealand has consistently offered favourable taxation treatment toward second and investment home purchases. Investors and second home buyers who hold the asset in long term will pay no tax on capital gain at sale. There is no explicit rule on the minimum length of holding period by the Inland Revenue (tax) Department, but the market generally takes this as 2 years. Therefore households' real long-term discount rates could afford increased long term real interest rates in exchange for no capital gains tax at future sales, especially when people are expecting future capital gains. This might cause a more severe bubble problem for New Zealand than in other countries.

5.5 Hedging effect of mortgage rate changes

Mortgage borrowers have some leeway in choosing between fixed and floating rate loans. If more borrowers choose fixed rates, changes in the floating mortgage rates will have less direct impact on housing prices. This could result in our estimated interest rate impacts on prices being relatively small, as shown in Table 5. Figure 2 shows the ratio of value of floating mortgage to the value of overall mortgage loans over time. Since the RBNZ introduced the OCR in 1999, the proportionate value of floating rate loans dropped from 40% to 12.5% in 2007. However, with continued lowering of the OCR since 2008, floating rates have become more attractive to borrowers. The value of floating rate loans climbed above 25% by the end of 2009, and exceeded 50% by March 2011.

<Insert Figure 2>

As indicated by the literature (see, e.g., Follain (1990)), mortgage choice is endogenously determined with the differential between the fixed and floating rates being the pivotal determinant. To accommodate this endogenous problem we used instrument variables in a two-stage least squares regression. Since the ratio of the value of floating loan to overall mortgage loan is a unit root, we use the percentage change of the ratio in the analysis. The regression model is as follows:

$$\Delta p_{i,t} = \alpha_0 + \beta \Delta d_{i,t} + \lambda \Delta m_t + \varphi E_t + \delta C_t + \theta R_t + \sum_j^{11} \emptyset_j S_j + \varepsilon_{i,t} \quad (7)$$

$$R_t = \tau_0 + \sum_{k=1}^{6} \tau_k I_k \quad (8)$$

where R_t is the change of the ratio at time *t*. The ratio is calculated as the value of floating loan to the overall value of mortgage loan. *k* is representing the various mortgage rates from floating to fixed rates. I_k are instrumental variables representing the differentials between the various mortgage rates. The instrumental variables are believed to be correlated to the mortgage rate choices but uncorrelated to the interest rate changes.

The estimated results are presented in Table 7. The results show the hedging effect as significant in explaining the movement of real house prices. It works like an energy absorber to reduce the overall interest rate's impact on house prices. When interest rates move up, people start to favour fixed rates against the floating rate, particularly as floating rates are likely to move more than fixed rates, which in New Zealand experience has often resulted in the yield curve becoming negative, and thus the ratio of the value of floating-rate loans to overall mortgage lending will drop. At long terms an increase in fixed rates will push up prices in a bubble environment but the decreased proportion of floating rate loans will do the opposite to decrease prices.

As a result our findings suggested the net effect of interest rates on housing prices is much weaker.

This has lent support to some authors' claims of a weak connection between interest rates and housing prices. Glaeser, et al (2010) argue that decreases in the real interest rate could only explain 20% increases in the real housing price, if one allows the interest rate to be mean reverting. Dokko et al. (2011) also follow this argument. By investigating the data of 17 OECD countries, they find that the decrease in the policy rate of these countries is not the main reason for housing price inflation during the mid-2000s. They instead argue that it is more important to prudentially regulate the mortgage market such as implementing the control of the housing market credit lending. One implication of our findings for the monetary policy is since the connection between the interest rate and housing price is weak, policy makers should move the policy rate in a more severe manner in order to influence housing prices.

<Insert Table 7>

Our results indicate that the housing bubble in New Zealand was more severe than in the U.S. While labour income may be taxed at 33% (the highest bracket), no comprehensive capital gains tax has been imposed on housing investment. Until the income tax year starting from April 1, 2011, rental residential property owners could also enjoy tax deductions from depreciation allowances and other costs (including interest), while owner-occupiers could not. This influenced investors' estimation of potential returns, and could also explain why the rate of home ownership declined in the recent years (see footnote 6). While a capital gains tax may be a weapon to prevent the bubble to arise again, it is difficult to implement in practice, as demonstrated by the failure of a series of tax working groups and inquiries (established by successive governments) to lead to any such tax being enacted following their discussions in 1967, 1978, 1982, 1987, 1988, 1989, 2001, and 2009-2010 (Huang and Elliffe, 2011).

6. Conclusions

This paper investigates how changes in the official cash rate (OCR) affect real housing prices in New Zealand during 1999-2009. We find that the announced OCR changes Granger cause the real interest rate changes. We also find that the real interest rate, both fixed and floating, is positively related to the real housing price, after controlling for the effect of real rental rates. Thus, increases in the OCR do not depress the real housing price, indicating that a housing bubble prevails in the recent New Zealand housing market.

We also find that both the quantity of housing lending and the mix of fixed and floating rate lending matter, with the latter also impacted by the slope of the yield curve. This is something that it is not easy for governments or the Reserve Bank to control – intervention at the long end of the yield curve would make the implementation of monetary policy a much more complicated and expensive exercise. Against such a background, the use of a capital gains tax to mitigate some of the excesses of housing price bubbles may be a more attractive option.

One of the limitations in this research has been the relatively short period over which we have been able to undertake it. This has meant that we have not seen as much variation in economic conditions as would be desirable to give our results more robustness, but the other side of this is that there is scope for further research with the passage of time, so that we can observe greater diversity in economic outcomes.

References

Bernanke, B., Gertler, M., 1995. Inside the black box: The credit channel of monetary policy transmission. Journal of Economic Perspectives 9, 27-48.

Bollard, A., Smith, M., 2006. Major global developments in the new millenium. Reserve Bank of New Zealand Bulletin 69, 26-39.

Campbell, J.Y., Shiller, R.J., 1987. Cointegration and tests of present value models. Journal of Political Economy 95, 1062-1088.

Campbell, J.Y., Shiller, R.J., 1988a. The dividend-price ratio and expectations of future dividends and discount factors. Review of Financial Studies 1, 195-227.

Campbell, J.Y., Shiller, R.J., 1988b. Stock prices, earnings, and expected dividends. Journal of Finance 43, 661-676.

Campbell, S.D., Davis, M.A., Gallin, J., Martin, R.F., 2009. What moves housing markets: A variance decomposition of the rent–price ratio. Journal of Urban Economics 66, 90-102.

Case, K.E., Shiller, R.J., 1987. Prices of single-family homes since 1970: New indexes for four cities. National Bureau of Economics Research, Cambridge, MA.

Cho, D., Ma, S., 2006. Dynamic relationship between housing values and interest rates in the korean housing market. Journal of Real Estate Finance and Economics 32, 169-184.

Clapham, E., Englund, P., Quigley, J.M., Redfearn, C.L., 2006. Revisiting the past and settling the score: Index revision for house price derivatives. Real Estate Economics 34, 275-302.

Clapp, J.M., Giaccotto, C., 1992. Repeated sales methodology for price trend estimation: An evaluation of sample selectivity. Journal of Real Estate Finance and Economics 5, 357-374.

Costello, G., Fraser, P., Groenewold, N., 2011. House prices, non-fundamental components and interstate spillovers: The australian experience. Journal of Banking & Finance 35, 653-669.

Cottarelli, C., Kourelis, A., 1994. Financial structure, bank lending rates, and the transmission mechanism of monetary policy. IMF Staff Papers 41, 587-623.

Dokko, J., Doyle, B.M., Kiley, M.T., Kim, J., Sherlund, S., Sim, J., Van Den Heuvel, S., 2011. Monetary policy and the global housing bubble. Economic Policy 26, 237-287.

Follain, J.R., 1990. Mortgage choice. AREUEA Journal 18, 125-144.

Fraser, P., Hoesli, M., McAlevey, L., 2008. House prices and bubbles in New Zealand. The Journal of Real Estate Finance and Economics 37, 71-91.

Gallin, J., 2008. The long-run relationship between house prices and rents. Real Estate Economics 36, 635-658.

Glaeser, E., Gottlieb, J., Gyourko, J., 2010. Can cheap credit explain the housing boom?, NBER Working Paper No. 16230. National Bureau of Economics Research.

Hargreaves, B., Shi, S., 2005. A total returns index for investor housing in New Zealand. Pacific Rim Property Research Journal 11, 253-267.

Haurin, D.R., Hendershott, P.H., 1991. House price indexes: Issues and results. AREUEA Journal 19, 259-269.

Hendershott, P.H., Slemrod, J., 1983. Taxes and the user cost of capital for owner-occupied housing. AREUEA Journal 10, 375-393.

Himmelberg, C., Mayer, C., Sinai, T., 2005. Assessing high house prices: Bubbles, fundamentals and misperceptions. National Bureau of Economic Research, Cambridge, MA.

Huang, C.-C., Elliffe, C., 2011. Hard to argue with benefits of capital gains tax, New Zealand Herald, Auckland, New Zealand.

Khandani, A., Lo, A.W., Merton, R.C., 2009. Systemic risk and the refinancing ratchet effect, NBER Working Paper No.15362. National Bureau of Economic Research.

Liu, M.H., Margaritis, D., Tourani-Rad, A., 2008. Monetary policy transparency and pass-through of retail interest rates. Journal of Banking & Finance 32, 501-511.

McDonald, J.F., Stokes, H.H., 2011, forthcoming. Monetary policy and the housing bubble. Journal of Real Estate Finance and Economics.

Meese, R., Wallace, N., 1997. The construction of residential housing price indices: A comparison of repeated sales, hedonic regression, and hybrid approaches. Journal of Real Estate Finance and Economics 14, 51-74.

Mikhed, V., Zemčík, P., 2009. Testing for bubbles in housing markets: A panel data approach. The Journal of Real Estate Finance and Economics 38, 366-386.

Mishkin, F.S., 2007. Housing and the monetary transmisison mechanism, Working Paper 13518. National Bureau of Economic Research, Cambridge, MA.

Nield, I., 2006. Changes to liquidity management regime. Reserve Bank of New Zealand Bulletin 69, 26-31.

PricewaterhouseCoopers, 2009. New Zealand monetary policy and the residential housing market - a scoping study working paper. Centre for Housing Research, Aotearoa New Zealand, Wellington.

Reserve Bank of New Zealand, 2007. Financial stability review. Reserve Bank of New Zealand, Wellington.

Sethi, R., 2008. The changing transmission mechanism of New Zealand monetary policy, Bulletin, Vol.71, No.2. Reserve Bank of New Zealand, Wellington, New Zealand.

Shiller, R.J., 2006. Long-term perspective on the current boom in home prices. The Economist's Voice 3.

Stiglitz, J.E., 1990. Symposium on bubbles. Journal of Economic Perspectives 4, 13-18.

Taylor, J.B., 2007. Housing and monetary policy, NBER Working Paper No.13682. National Bureau of Economic Research.

Taylor, J.B., 2009. The financial crisis and the policy responses: An empirical analysis of what went wrong, NBER Working Paper No.14631. National Bureau of Economic Research.

Tripe, D., McDermott, J., Petro, B., 2005. A test of the response to a monetary policy regime change in New Zealand. Contemporary Studies in Economics and Financial Analysis 86, 453-467.

Wheaton, W.C., Nechayev, G., 2008. The 1998-2005 housing "bubble" and the current "correction": What's different this time? Journal of Real Estate Research 30, 1-26.

Table 1: Number of Dwellings and Sales, Jan. 1994 – Dec. 2009

Number of Sales	North Shore City	Waitakere City	Auckland City	Manukau City	Wellington City	Christchurch City	Total	
	Dwellings	Dwellings	Dwellings	Dwellings	Dwellings	Dwellings	Dwellings	Sales
1	17,155	15,155	35,581	19,471	13,030	33,098	133,490	133,490
2	11,294	10,929	18,136	13,133	8,061	20,915	82,468	164,936
3	6,105	5,891	8,028	6,662	3,950	10,943	41,579	124,737
4	2,396	2,357	2,962	2,733	1,428	4,524	16,400	65,600
5	790	838	949	899	446	1,529	5,451	27,255
6	209	232	228	309	71	417	1,466	8,796
7	60	51	74	98	12	100	395	2,765
8	8	11	11	24	2	18	74	592
9	3	5	3	12	0	3	26	234
>=10	3	4	0	3	1	4	15	196
Total	38,023	35,473	65,972	43,344	27,001	71,551	281,364	528,601
Percentage*	54.88%	57.28%	46.07%	55.08%	51.74%	53.74%	52.56%	74.75%

Note: The percentages* are indicating for multiple sales.

Table 2: Correlations of real OCR changes and real mortgage rate changes, Apr. 1999 - Dec. 2009

	OCR	Floating	6 months	1 year	2 years	3 years	4 years	5 years
OCR	1.00	0.75	0.68	0.65	0.49	0.44	0.40	0.35
Floating	0.75	1.00	0.81	0.77	0.59	0.55	0.52	0.46
6 months	0.68	0.81	1.00	0.90	0.77	0.72	0.68	0.63
1 year	0.65	0.77	0.90	1.00	0.89	0.83	0.80	0.74
2 years	0.49	0.59	0.77	0.89	1.00	0.93	0.90	0.87
3 years	0.44	0.55	0.72	0.83	0.93	1.00	0.98	0.96
4 years	0.40	0.52	0.68	0.80	0.90	0.98	1.00	0.98
5 years	0.35	0.46	0.63	0.74	0.87	0.96	0.98	1.00

Notes: Variables are transformed in log and then first difference. In total, there are 128 observations.

Table 3: Granger causality tests of real OCR changes and real interest rate changes, Apr.1999-Dec.2009

Direction of causality	Observations	F-Statistic	Prob.	
Floating → OCR	122	3.330	0.005	√
OCR → Floating		1.770	0.112	
6 months → OCR	122	3.853	0.002	√
OCR → 6 months		1.011	0.422	
1 year → OCR	122	4.709	0.000	√
OCR → 1 year		1.373	0.232	
2 years → OCR	122	3.147	0.007	√
OCR → 2 years		1.354	0.240	
3 years → OCR	122	3.091	0.008	√
OCR → years		2.754	0.016	√
4 years → OCR	122	2.922	0.011	√
OCR → years		3.364	0.004	√
5 years → OCR	122	3.007	0.009	√
OCR → 5 years		3.677	0.002	√

Notes: → denotes the direction of Granger causality. √ denotes causality at 5% significance level. 6 lags are included for the test.

Table 4: Fixed effects pool regression with seasonal dummy variables, Apr. 1999 – Dec. 2009

	Floating		6 months		1 year		2 years		3 years		4 years		5 years	
					-		-							
α_0	-0.002		-0.002		0.002		0.003		-0.002		-0.002		-0.002	
Δd_t	0.017		0.017		0.016		0.015		0.015		0.016		0.015	
Δm_t	0.093		0.171		0.589	*	0.571	*	0.583	*	0.475	*	0.514	*
S_1	0.014	**	0.014	**	0.015	**	0.015	**	0.015	**	0.014	**	0.014	**
S_2	0.007	*	0.007	*	0.007	*	0.008	**	0.007	*	0.007	*	0.007	*
S_3	0.003		0.002		0.002		0.003		0.002		0.002		0.002	
S_4	0.004		0.004		0.005		0.005		0.004		0.004		0.004	
S_5	0.005		0.005		0.005		0.005		0.005		0.004		0.004	
S_6	0.001		0.001		0.001		0.002		0.001		0.001		0.001	
S_7	0.005		0.005		0.005		0.006	*	0.005		0.005		0.005	
S_8	0.005		0.005		0.005		0.005		0.004		0.005		0.004	
S_9	0.011	**	0.011	**	0.011	**	0.012	**	0.011	**	0.011	**	0.011	**
S_{10}	0.003		0.004		0.003		0.003		0.002		0.003		0.003	
S_{11}	0.006	*	0.006	*	0.006	*	0.006	*	0.006	*	0.005		0.006	*
R-squared	0.053		0.054		0.060		0.061		0.061		0.058		0.059	

Note: * indicates significance at 0.05 level; ** indicates significance at 0.01 level. The regression model is as follows:

$$\Delta p_{i,t} = \alpha_0 + \beta_j \Delta d_{i,t} + \lambda_j \Delta m_t + \sum_{j=1}^{11} \phi_j S_j + \varepsilon_{it}, \qquad (5)$$

where *p*, *d* and *m* are log prices, log rents and mortgage rates, a_0 is constant, *i* denotes different cities, *t* denotes the time period, *S* denotes the monthly seasonal dummy variables, and ε is white noise. Δ denotes the first difference. The regression is run with a cross-section fixed effect (city dummy variables).

Table 5: Results of real floating interest rate on real housing price, Jan.1994 – Dec.2009 (Coefficients of the interest rate variables only).

Year	**Model 1**		**Model 2**		**Model 3**		**Model 4**	
1994	-2.59	**	-1.98	**	-1.91	**		
1995	-3.29	*	-1.00		0.59			
1996	-1.13	**	-1.12	*	-1.02			
1997	-0.29		0.24		0.06			
1998	-1.60	**	-0.70	**	-0.93	**		
1999	-1.72	*	-1.71	*	-1.60	*	-1.51	
2000	-0.26		-0.21		-0.45		-0.38	
2001	0.17		0.58		0.53		0.52	
2002	-2.32	**	-1.62	**	-1.61	*	-1.70	**
2003	-4.06	**	-2.99	**	-3.06	**	-2.93	**
2004	0.23		0.42		0.95		1.38	
2005	0.75		0.97		0.76		0.68	
2006	3.22	**	0.71		0.62		0.69	
2007	3.64	**	-0.58		-1.40		-1.62	*
2008	-2.03	**	-0.65		-0.59		-0.68	
2009	-0.17		-0.37		-0.33		-0.36	

Note: * indicates significance at 0.10 level; ** indicates significance at 0.05 level. The regression models are defined as follows:

Model 1: log real house price=constant +real floating rate + time trend

Model 2: Δ(log real house price)=constant +Δ(real floating rate)

Model 3: Δ(log real house price)=constant +Δ(real floating rate)+percentage change of real household claims

Model 4: Δ(log real house price)=constant +Δ(real floating rate)+percentage change of real house lending where Δ denotes the first difference.

Table 6: Fixed effects pool regression with additional housing lending data, Apr. 1999 – Dec. 2009

	Floating		6 months		1 year		2 years		3 years		4 years		5 years	
α_0	-0.009	**	-0.009	**	-0.009	**	-0.009	**	-0.009	**	-0.009	**	-0.009	**
Δd_t	0.004		0.004		0.004		0.003		0.003		0.004		0.003	
Δm_t	-0.332		-0.252		0.142		0.209		0.270		0.157		0.223	
E_t	-0.008	**	-0.008	**	-0.009	**	-0.009	**	-0.009	**	-0.009	**	-0.009	**
C_t	1.254	**	1.251	**	1.169	**	1.160	**	1.158	**	1.180	**	1.174	**
S_1	0.013	**	0.013	**	0.013	**	0.014	**	0.013	**	0.013	**	0.013	**
S_2	0.006	*	0.006	*	0.006	*	0.007	*	0.007	*	0.006	*	0.006	*
S_3	-0.001		-0.002		-0.002		-0.001		-0.002		-0.002		-0.002	
S_4	0.002		0.003		0.003		0.004		0.003		0.003		0.003	
S_5	0.005		0.004		0.005		0.005		0.004		0.004		0.004	
S_6	0.003		0.003		0.002		0.002		0.002		0.002		0.002	
S_7	0.007	*	0.006	*	0.006	*	0.007	*	0.006	*	0.006	*	0.006	*
S_8	0.007	*	0.006	*	0.006	*	0.006	*	0.006	*	0.006	*	0.006	*
S_9	0.012	**	0.012	**	0.012	**	0.012	**	0.012	**	0.012	**	0.012	**
S_{10}	0.003		0.003		0.003		0.003		0.002		0.003		0.003	
S_{11}	0.003		0.003		0.004		0.004		0.004		0.004		0.004	
R-squared	0.174		0.174		0.173		0.174		0.174		0.173		0.174	

Note: * indicates significance at 0.05 level; ** indicates significance at 0.01 level. The regression model is as follows:

$$\Delta p_{i,t} = \alpha_0 + \beta \Delta d_{i,t} + \lambda \Delta m_t + \varphi E_t + \delta C_t + \sum_j^{11} \emptyset_j S_j + \varepsilon_{i,t} \quad (6)$$

where *p*, *d* and *m* are log prices, log rents and mortgage rates, a_0 is constant, *i* denotes different cities, *t* denotes the time period, E denotes the percentage change of unemployment rate, C denotes the percentage change of real house lending. *S* denotes the monthly seasonal dummy variables, and ε is white noise. Δ denotes the first difference. The regression is run with a cross-section fixed effect (city dummy variables).

Table 7: Fixed effects pool regression for estimating the hedging effect estimated by the two-stage least squares, Apr. 1999 – Dec. 2009

	Floating		6 months		1 year		2 years		3 years		4 years		5 years	
α_0	-0.010	**	-0.009	**	-0.009	**	-0.010	**	-0.010	**	-0.010	**	-0.011	**
Δd_t	0.004		0.004		0.003		0.002		0.001		0.002		0.001	
Δm_t	-0.182		-0.188		0.281		0.413		0.582	*	0.437		0.582	*
E_t	-0.008	**	-0.008	**	-0.009	**	-0.008	**	-0.008	**	-0.007	**	-0.007	**
C_t	1.334	**	1.291	**	1.255	**	1.328	**	1.413	**	1.416	**	1.507	**
R_t	0.029		0.014		0.030		0.054		0.080		0.071		0.098	*
S_1	0.013	**	0.013	**	0.013	**	0.013	**	0.012	**	0.012	**	0.012	**
S_2	0.006	*	0.006	*	0.006	*	0.007	*	0.006	*	0.006	*	0.006	*
S_3	-0.002		-0.002		-0.002		-0.002		-0.002		-0.002		-0.003	
S_4	0.003		0.003		0.004		0.005		0.005		0.005		0.005	
S_5	0.005		0.005		0.005		0.006	*	0.005		0.005		0.005	
S_6	0.003		0.003		0.003		0.003		0.003		0.003		0.003	
S_7	0.007	**	0.007	*	0.007	*	0.008	**	0.007	**	0.007	**	0.008	**
S_8	0.007	*	0.007	*	0.007	*	0.008	**	0.008	**	0.008	**	0.008	**
S_9	0.012	**	0.012	**	0.012	**	0.013	**	0.013	**	0.012	**	0.013	**
S_{10}	0.003		0.003		0.003		0.003		0.002		0.002		0.001	
S_{11}	0.003		0.003		0.003		0.004		0.003		0.003		0.002	
R-squared	0.170		0.173		0.171		0.168		0.163		0.163		0.155	

Note: * indicates significance at 0.05 level; ** indicates significance at 0.01 level. The regression model is as follows:

$$\Delta p_{i,t} = \alpha_0 + \beta \Delta d_{i,t} + \lambda \Delta m_t + \varphi E_t + \delta C_t + \theta R_t + \sum_j^{11} \emptyset_j S_j + \varepsilon_{i,t} \quad (7)$$

$$R_t = \tau_0 + \sum_{k=1}^{6} \tau_k I_k \quad (8)$$

where *p*, *d* and *m* are log prices, log rents and mortgage rates, a_0 is constant, *i* denotes different cities, *t* denotes the time period, E denotes the percentage change of unemployment rate, C denotes the percentage change of real house lending, R denotes the percentage change of the ratio of value of floating loan to the overall value of mortgage loan, *S* denotes the monthly seasonal dummy variables, and ε is white noise. Δ denotes the first difference. The regression is run with a cross-section fixed effect (city dummy variables).

k is representing the various mortgage rates from the floating to fixed rates. I_k are instrumental variables representing the differentials between various fixed mortgage rates.

Figure 1: Prices and interest rates – Auckland City, Apr.1999 - Dec.2009

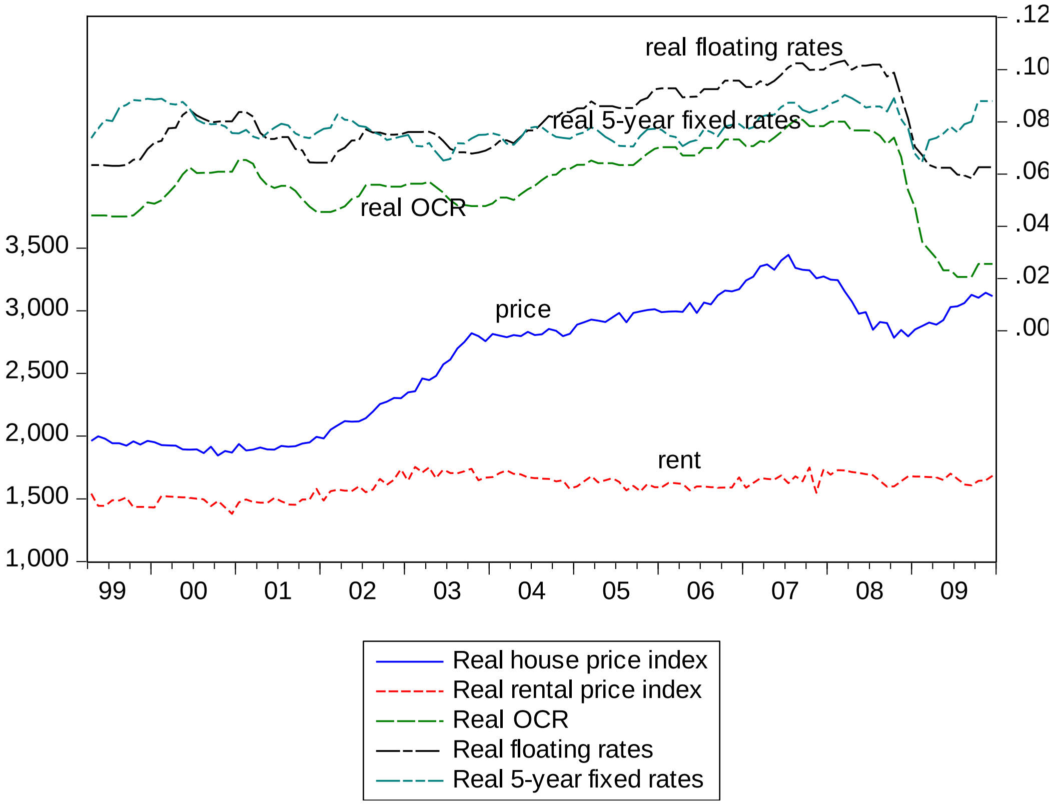

Figure 2: OCR movements and the ratio of the value of floating loan to overall mortgage loan, Apr. 1999 – Dec. 2009