Policy Rate, Mortgage Rate and Housing Prices: Evidence from New Zealand

Song Shi

School of Economics and Finance, Massey University

Jyh-Bang Jou

Graduate Institute of National Development, National Taiwan University

David Tripe*

School of Economics and Finance, Massey University

Version: May 2013

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

* Corresponding author. Ph +64 6 356 9099 ext 2337, fax +64 6 3505660, e-mail D.W.Tripe@massey.ac.nz. Address: School of Economics and Finance, Massey university, Private Bag 11- 222, Palmerston North 4442, New Zealand

Policy Rate, Mortgage Rate and Housing Prices: Evidence from New Zealand

Abstract

This paper investigates how changes in central bank policy and retail mortgage rates affected real housing prices in New Zealand during the period 1999-2009. We find that the policy rate is strongly linked with real floating mortgage rates and weakly linked with real fixed mortgage rates. Given that real fixed interest rates are positively related to real housing prices, increases in the policy rate were thus unable to depress real housing prices. However, based on the rational expectation hypothesis, we find little evidence of housing price bubbles, even though housing prices appreciated rapidly during 2000s in New Zealand. The rapid appreciation resulted from external factors that negate the effect of the policy rate on the housing market. These were the resilient domestic demand for housing and the long-term favourable taxation treatment of housing investment. The results set international exemplars which have important policy implications.

Keywords: Housing market, monetary policy, mortgage rates, house price bubbles

1. Introduction

The strong growth in house prices that began from early 2000 subsided during the global financial crisis (GFC) in 2007/08. Many researchers view this as a United States phenomenon, although similar periods of strong housing price growth also occurred in other countries. Ireland and Spain were commonly cited examples, but rapid growth in house prices was also seen in New Zealand (Bollard and Smith, 2006). The New Zealand housing market was exceptional because real interest rates were positively correlated with house price growth rather than negatively related as commonly seen in other countries. Figure 1 shows the relationship between the Reserve Bank of New Zealand (RBNZ)'s Official Cash Rate (OCR), mortgage rates and real house price growth in Auckland City (New Zealand's largest) between 1999 and 2009.

<Insert Figure 1 >

In this article, we investigate the relationships between the OCR, mortgage rates and housing prices, and identify some important policy implications for housing. Housing prices may increase for a variety of reasons, including population growth, rising incomes and low interest rates. Previous research has pointed out that monetary policy can impact housing prices (Bernanke and Gertler, 1995; Mishkin, 2007; Shiller, 2006). There is, however, no consensus regarding the impact of policy rate changes on housing prices through retail mortgage rates. Houses often form an important part of household asset portfolios, with this particularly the case in New Zealand where housing represented 74% of gross household assets in 2011. Rising house prices create a wealth effect which may encourage households to increase spending, resulting in inflationary pressures and macroeconomic instability.

Rising house prices are often associated with increased bank lending for housing, thus leading housing to become an even more important part of banks' asset portfolios such that any problem in the housing market becomes a major problem for banks. We have seen these consequences in the USA, Ireland and Spain in particular. Effects in New Zealand have been less severe as reductions in nominal house prices after 2008 were relatively small (10-15% nominal price reductions on average across various cities), with these losses since recovered. There is thus a reasonable argument that asset prices, and housing prices in particular, matter for financial stability. If house prices stop increasing, or if they fall, we are inclined to see marked slowdowns in housing construction, with negative effects on the rest of the economy. The argument of Alan Greenspan and others that asset prices don't matter may not be sustainable, and for these reasons our research has important policy implications.

Recently, a number of central banks around the world, including the RBNZ, have been looking at potential macro-prudential tools, such as limits on loan-to-value ratios and varying capital levels. The principle behind such macro-prudential tools is that the economic imbalances associated with house prices can be brought under control more effectively than by relying just on interest rates (and increasing interest rates may have undesirable negative outcomes elsewhere in the economy). There is also a question as to how effective interest rates are as a means of restraining sharply rising house prices, or more generally, how strong the impact of interest rates is on house prices. Taylor (2007, 2009) argues that low interest rates contributed to a boom and bust in the USA,[1] while Glaeser et al. (2010) found that decreases in interest rates could only explain 20% of the increases in real house prices.

We use New Zealand data in this study because New Zealand has one of the most liberal economies in the world, and because it is considering macro-prudential policy instruments to restrain growth in house prices. Important parts of the New Zealand economy include tourism and international trade, which are much affected by global factors. As in other countries, the ability of the RBNZ to affect the domestic housing market through its policy rate is thus thought to be limited (see e.g. Rogoff, 2006). The results of this study will therefore provide an international exemplar on these issues.

In the next section we look at monetary policy and interest rates in New Zealand in more detail, and at how they might be expected to interact with each other and with the housing market. Section 3 presents the theoretical framework and outlines the econometric tools used. Section 4 describes the data while Section 5 reports the empirical results. Section 6 outlines policy recommendations and Section 7 concludes.

2. New Zealand Interest rates

The RBNZ's monetary policy mandate is an inflation target, currently set at a range of 1 to 3%, with this providing the basis for the implementation of monetary policy. The key policy rate is the Official Cash Rate (OCR), which defines the rate banks earn if they deposit funds overnight with or borrow from the RBNZ. Any borrowings are on a repo basis, and there is a 50 basis point spread between the borrowing and lending rates. The OCR thus sets a benchmark for interbank overnight

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

borrowing, and the short end of the yield curve, with market rates for longer maturities being impacted by the standard set of factors that influence the yield curve.

The OCR is subject to review 8 times a year, although on one occasion (19 September 2001), it was changed at other than a scheduled review date. Following any OCR review, the dates for which are scheduled a year or more in advance, there should be no further change for another 6 to 7 weeks, meaning that overnight market rates will remain more or less at the OCR up until the next scheduled review. The inflation targeting approach means that the OCR should be higher when inflation is higher, and real interest rates should therefore be less variable than nominal interest rates. The highest nominal rate reached for the OCR was 8.25% between 26 July 2007 and 24 July 2008, while its lowest level has been 2.5% between 30 April 2009 and 10 June 2010, and again since 10 March 2011.

Longer term money market rates also move in response to the OCR, although the yield curve was negatively sloping between 2004 and 2009. This reflected an anticipation that the RBNZ would ease short-term interest rates in response to easing inflation pressures (an outcome that was delayed, at least in part, because of booming house prices). Longer term rates fell significantly after the middle of 2008.

New Zealand borrowers generally have a range of choices as to lending interest rates. They can borrow at floating rates, which can be changed at relatively short notice (one month or less), or they can fix the interest rate on their mortgage borrowing for a period between six months and five years [2]. Floating rate borrowers can switch to fixed rates at any time, but fixed rate borrowers can only change their arrangements at the end of the period for which they have taken a fixed rate, unless

[2] As in the USA mortgage market, mortgage loans in New Zealand can be for 25 or 30 years, but the usual maximum term for a fixed interest rate is 5 years.

they pay an early repayment penalty (generally calculated on the basis of interest rate differentials). One of the consequences of the use of fixed rate loans is a delay between changes in market rates and changes in what borrowers actually pay, dampening the effect of monetary policy changes on household spending capacity.

Actual rates charged to retail mortgage borrowers for different periods to repricing generally track movements in the underlying money market rates. Tripe et al. (2005) found that, since the adoption of the OCR approach in 1999, key lending rates had become more responsive to changes in underlying wholesale rates, and the RBNZ monetary policy could thus be described as having become more efficient. Liu et al. (2008) found that the introduction of the OCR increased the pass-through to floating rates, but not to fixed mortgage rates. No prior research has looked at how either New Zealand money market or retail rates impact on house prices.

3. Estimation strategies and the empirical models

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

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

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 rational price bubble. When *n* is sufficiently large, the second term will converge to zero. The well-known Gordon growth model is accordingly set as follows:

$$P_t = \frac{(1+G)D_t}{R-G}, \quad (2)$$

where *G* is the constant growth rate of cash flows and is less than *R*. When G is zero, this becomes:

$$P_t = \frac{D_t}{R}. \quad (3)$$

This formula is widely used in the valuation of income producing properties. *R* is referred as the capitalisation rate or investment yield in real estate. The model implies that house prices are positively related to rental rates, but negatively related to the household's discount rate.

The assumption of a constant expected discount rate R is analytically convenient, but is inconsistent with the variation in the investor's expected rate of returns over time. It is logical to infer that time-varying discount rates are closely linked to the retail mortgage rates prevailing in the housing market. Other caveats for successfully applying Equation (3) are that R must reflect future rental growth, real interest rates and the housing premium. We follow Campbell, Davis, Gallin and Martin (2009) in adding other economic variables in Equation (3) to better forecast real interest rates, rental growth and the housing premium. Because house prices are I(1) variables we specify our estimation models in the first-order difference form. Taking the first-order difference and logarithm of Equation (3), adding macroeconomic conditions and location differences, we obtain:[3]

$$\Delta p_{i,t} = \alpha_0 + \beta \Delta d_{i,t} + \lambda \Delta m_t + \psi X + \sum_{j=1}^{11} \phi_j S_j + \varepsilon_{it} , \quad (4)$$

where α_0 is a constant, i denotes different cities, t denotes the time period, $p_{i,t}$, $d_{i,t}$ and m_t are log prices, log rents and mortgage rates, respectively, X is a vector of economic variables, 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.

This estimation equation could be improved by using a vector error correction model (VECM) to study the long-run relationship of interest rates and housing prices. One problem is that the OCR regime has only been in place since April 1999, making long-run analysis problematic. Another challenge is that the VECM estimations of the long-run relationship between the variables are not stable.[4] Instead, estimated long-run relationships change dramatically for different localities. To overcome those problems, we use pooled OLS to show the relationships between the variables.

3.2 Rational expectations and bubbles

Under rational expectations (Lucas and Sargent, 1981) households will use all past information up to time period t to approximate house price growth at time t+1. Following this strategy, we first estimate Equation (4) using all past information up to time t, then use the estimated coefficients of Equation (4) and t+1 information to forecast the house price change Δp_{t+1}. In this process, rational expectations of house

[3] Following Wheaton and Nechayev (2008) and Igan and Loungani (2012), we do not include any lagged price difference variable in Equation (4).
[4] The results of VECM estimations are available from authors on request.

prices are developed from a mixture of current and past fundamental information. Similar estimation strategies were used by Clayton (1996) to derive a rational expectations house price model for housing price volatility. His approach of forecasting rents and other market fundamental data was based on the time series properties of the data. He assumed that rents follow an AR(4) process. Other exogenous variables such as net immigration and the stock of newly completed but unoccupied homes were forecast using the Box-Jenkins technique. His conclusions were thus sensitive to these in-sample results. In this study, we follow a more general approach to forecast the expected house price change Δp_{t+1}, which can be written as:

$$E_{i,t+1}[\Delta p_{i,t+1}] = \widehat{\alpha_{i,t}} + \widehat{\beta_{i,t}}\Delta d_{i,t+1} + \widehat{\lambda_{i,t}}\Delta m_{i,t+1} + \widehat{\psi_{i,t}}X_{i,t+1} + \sum_{j=1}^{11}\widehat{\phi_{i,t}^{j}}\, S_{i,t+1}. \quad (5)$$

where $E_{i,t+1}[\Delta p_{i,t+1}]$ is the expected next period house price change for city *i* using information of other variables at time period t+1, and "$\widehat{\ }$" denotes the estimated value.

In Equation (5) the expected house price change not only depends on changes of variables at t+1, but also on changes of parameter estimates (coefficients) at time t. In other words, households' discount rates are not only linked to mortgage rate changes, but also to changes in coefficients of other variables. The difference between the actual and expected price change is:

$$\epsilon_{i,t+1} = \Delta p_{i,t+1} - E_{i,t+1}[\Delta p_{i,t+1}]. \quad (6)$$

We examine the distribution and time series properties of $\epsilon_{i,t+1}$ in order to find whether housing price bubbles exist. Our hypothesis is that if households are rational with varying discount rates, the size of $\epsilon_{i,t+1}$ must be small and its distribution should be close to normal. If a rational bubble exists, it will generate a set of small positive $\epsilon_{i,t+1}$ over time, followed by a large negative excess return at the time of the crash (e.g., Blanchard and Watson, 1982). The distribution of $\epsilon_{i,t+1}$ for this type of bubble will therefore be leptokurtic. One concern of this estimation strategy for bubbles is that the current price information may contain a "bubble" component, thus undermining testing for a bubble in subsequent periods. Bubbles are hard to identify until they burst. Nevertheless, the trend of $\epsilon_{i,t+1}$ will provide indications for the existence of a bubble.

For comparison, we also estimate housing price misalignment assuming that the relationship between households' discount rates and other variables are constant. A similar approach is used by Igan and Loungani (2012) in estimating global housing cycles. In their study, they first modelled housing price changes in terms of changes in fundamental variables in a base period, and then used the parameter estimates obtained to forecast future house prices. The gap between actual house prices and their predicted values is used as an indication for a price "bubble." However, the usefulness of this approach is limited for several reasons. First, the estimation model must be complete. Second, the chosen base period is arbitrary as prices must be at their fundamental levels, i.e., prices are not overvalued or undervalued during the base period. Third, the relationship among variables for determining households' discount rates are assumed to be the same in the future, i.e., parameter estimates obtained in the base period will not change over time.

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, using the repeated sales method at monthly intervals, from transaction data, which was 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, North Shore, Waitakere, Manukau (all of which are now part of an expanded Auckland city), Wellington and Christchurch, chosen because they accounted for more than 50% of New Zealand housing stock and sales volume.

It is important to consider sample sizes when measuring local house price movements 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 methods that use all transaction sales data. Previous work indicates that frequently traded houses (sold more than twice within a period) are more likely to be the “starter” houses or houses for opportunistic buyers (Clapp and Giaccotto, 1992; Haurin and Hendershott, 1991). Previous studies also indicate that the repeat sales index is prone to a systematic downward revision due to lagged sales (Clapham et al., 2006). To minimise these problems, we measure local house price indices over an extended time period from 1994 to 2009. Table 1 shows the distribution of house sales and numbers of dwellings, both of which indicate that we have sufficient repeated sales, minimizing sample selection bias. Note that we use real house prices, defined as nominal house prices adjusted by the CPI (Consumers Price Index).

<Insert Table 1>

QV also produces a house price index, but 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. Compared with the quarterly reported index, our estimated monthly price index unsmooths price movements and increases the number of observations in the time series. Monthly analysis also allows us to make more effective use of New Zealand interest rate data.

As the repeat sales method is vulnerable to outliers (Meese and Wallace, 1997), we use prior knowledge to eliminate 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 except Auckland City, we can eliminate pair sales where quality has changed, thus minimizing the constant quality problem faced by the standard repeat sales method.[5] In total, we exclude 15% to 24% of initial pair sales from estimation of the final index, depending on local housing markets. We ended our data set in 2009 because it was the latest year for which we held a complete sale data set. Our repeated sales price indices for the 6 selected cities are presented in Figure 2.

< Insert Figure 2>

We obtain monthly rental data for detached or semi-detached houses from the Tenancy Services Division of the Department of Building and Housing (DBH) in

[5] Building consent data is collected for revaluation purposes only where QV is the valuation service provider for the Council. This is not the case for Auckland City.

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 tenancy. The DBH rental data is transaction based and very comprehensive in terms of recording market rent settings for all new residential tenancies.

We use the monthly median rent for each local housing market, which is usually equal to the median rent for a 3-bedroom house. 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 would inevitably introduce measurement errors. Second, the proportion of rental housing in the New Zealand housing stock is large and increasing over time. By 2004 rental housing comprised around 30% of the national housing stock.[6] Thirdly, 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, retail residential mortgage lending rates and values of outstanding mortgage loans from the RBNZ. We use a monthly average OCR. Retail interest rates include floating (or adjustable) rates, and rates fixed for 6 months, 1, 2, 3, 4 and 5 years. For the whole period of this study, fixed rate loans accounted

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

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

for the majority by value of all housing loans. We also use real interest rates, which are defined as nominal interest rates adjusted by the CPI.

For the period from 1999 to 2009, for mortgage loans, we use data for household lending from the RBNZ's data table C5. Finally, unemployment rate data comes from Statistics New Zealand. Summary statistics for the data are shown in Table 2.

<Insert Table 2>

5. Empirical Results

5.1 Policy rate and retail mortgage rates

We first look at the correlation coefficients between log real OCR changes and log real retail mortgage rate changes. Results are shown in Table 3, which indicates that the OCR is more closely related to shorter-term mortgage rates. The results are consistent with the findings in Liu et al. (2008). The correlation coefficient between the real OCR and the real floating-rate is 0.75, and it drops gradually for longer periods of repricing to 0.35 between the real OCR and the real 5-year fixed-rate. This is expected as the short-term interest rate is more directly linked to the OCR. By contrast, long-term interest rates are linked to corresponding bond yields, and thus linked to the OCR only through expectations for the trend in the OCR.

<Insert Table 3>

We then employ Granger causality tests to see whether changes in the real OCR lead changes in real retail interest rates or vice versa. A similar approach is also used by McDonald and Stokes (2011) in their study of the federal funds rate and housing prices. We present the Granger causality results in Table 4, which shows that for longer term rates we reject both hypotheses at the 5% level; that the OCR change does not Granger-cause retail real interest rate changes and that retail real interest rate changes do not Granger-cause the real OCR change. For longer term rates, Granger causality runs two-way from the real OCR change to real retail interest rate changes and from real retail interest rate changes to the real OCR change. In contrast, the Granger causality runs one-way from 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. Announced changes in the OCR often provide 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 an OCR announcement because they anticipate the policy change or simply have to follow pre-emptive actions of other lenders in changing their mortgage rates. The relationship with longer term rates is likely to be an indication of the way long-term rates predict future shorter-term rates. This suggests 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 4>

5.2 Housing prices and retail mortgage rates

Table 5 reports the relationship between house prices and mortgage rates based on the basic present value model specified in Equation (3). It shows that house price

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

growth is positively correlated with changes in real rental rates and real retail interest rates, both floating and fixed. Moreover, real fixed-rates show a larger impact on housing prices than the real floating-rate. For example, a 1% change in the real floating-rate will increase (at the 10% level of significance) house prices by only 0.093%. By contrast, the same change in the real 1-year fixed rate will result in (at 5% significance) house price growth of 0.589%. Our findings are in line with recent work on the USA market by Miles (2013), who found the long term rate highly significant for housing while the short term fed funds rate was not (although the relationships were negative, rather than positive in our case). The findings have important implications, which we will discuss in detail in Section 6.

<Insert Table 5>

Our results indicate that households' real discount rates have a positive effect on the real housing price, which significantly differs from the other housing markets worldwide. In contrast with the literature, however, Equation (3) disregards two sets of factors. The first is demand fundamentals such as employment and income (Campbell et al., 2009; Wheaton and Nechayev, 2008), and net immigration (PricewaterhouseCoopers, 2009); the second is credit market terms such as the loan-to-value ratio and approval rates (Glaeser et al., 2010). While data on these exists in the USA, detailed information on loan terms is not generally published by financial firms in New Zealand.[9] Furthermore, the impacts of these terms on housing prices are inconclusive. While Khandani, Lo and Merton (2009), and Wheaton and Nechayev

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

(2008) find that they play a pivotal role, Glaeser et al. (2010) find that they are minor factors.

To address the concern of demand fundamentals and credit market conditions on house prices, we include two further variables, the unemployment rate and housing lending data (see Equation (4))[10] We hypothesize that changes in the unemployment rate will be negatively related to changes in house prices, while changes in housing lending will be positively related to changes in house prices, but negatively related to changes in interest rates. The more money that goes into the housing market, the higher housing prices will be. On the other hand, higher interest rates should dampen the demand for mortgage loans. However, we face the problem of identifying causation, as it could be either that higher house prices cause increases in housing lending or that increased housing lending leads to higher house prices. We report results for Equation (4) in Table 6.

<Insert Table 6>

These results show that changes in house lending positively cause house price changes (at 1% significance level) and the short-term interest rate changes negatively cause house price changes, up to 1 year. For rates fixed for 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 (at the 5% level).[11] Thus, it appears that households' short-term and long-term discount rates for housing are different. An increase in short-term interest rates causes

[10] We also tested adding net migration data to equation (4), but the migration variable was found to be insignificant.

[11] We have also tested the alternative by adding the lagged log of price-to-rent ratio to equation (4) in a robustness check. The added price-to-rent ratio will serve as an indication of housing affordability level in the sense of an error correction mechanism in equation (4). The results are very similar.

house prices to drop, while an increase in long-term rates may push house prices up. Why should this be?

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 the risk of future interest rate increases. We thus saw an increase in the relative proportion of fixed rate lending, 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 (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 their smaller amount of 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, it was not enough to discourage borrowers, who perceived that property prices would continue to increase.

5.3 Looking for bubbles

We use various statistical tests to examine whether the time series properties of $\epsilon_{i,t+1}$ in Equation (6) exhibit a pattern of bubbles. To estimate $\epsilon_{i,t+1}$, we first calculate the coefficients of Equation (4) using data from April 1999 to December 2001, and we then calculate $\epsilon_{i,t+1}$ for January 2002 based on the coefficients estimated up to December 2001. To calculate $\epsilon_{i,t+1}$ for February 2002, we re-estimate the coefficients of Equation (4) using all information from April 1999 to January 2002, and so on. We calculate the residual term $\epsilon_{i,t+1}$ for each of the six cities and seven types of mortgage rates. In total, we estimate 42 time series of $\epsilon_{i,t+1}$ starting from January 2002 and finishing in December 2009. The length of base period chosen for the estimation is somewhat arbitrary. If it is too short, the first few months' (or years') estimated $\epsilon_{i,t+1}$ will not be reliable. On the other hand, if it is too long, we will end up with fewer observations for analysis. Another consideration is market conditions. A stable housing market is preferable when choosing the base period. Table 7 provides results for those estimated $\epsilon_{i,t+1}$.

<Insert Table 7 >

Table 7 shows that the forecasting errors $\epsilon_{i,t+1}$ for most cities and mortgage rates are close to zero. Results for kurtosis also confirm that they are mostly in line with a normal distribution (equal to 3) although slightly leptokurtic, except for Waitakere City. Table 7 results show little evidence for bubbles.[12] This is somewhat surprising given the rapid increase in housing prices during the period studied. A possible explanation is that the "bubble" might slowly die out over time, and would therefore not be seen in the analysis. To explore the price evaluating process, we break the summarised forecasting errors $\epsilon_{i,t+1}$ down into different time periods, to help us see how house prices evolve over time.

Table 8a shows the numbers of positive and negative forecasting errors in each calendar year from 2002 to 2009, based on the floating mortgage rate. The results

[12] To show the reliability of our prediction, we plot those actual and estimated price changes over time in Appendix 1. The results show that the predicted price changes are closely in line with the actual price changes except during the global financial crisis in 2007/2008.

show house prices appreciated rapidly during 2002 and 2003 with consecutive positive forecasting errors. For example, North Shore City has 12 months positive forecasting errors in 2002, with 9 positive and 3 negative monthly forecast errors in 2003. Similar patterns are also observed to varying degrees in other cities. The results suggest that if a bubble existed, it might have started prior to or in 2002/2003. From 2004 to 2006, the housing market seemed to reach a new equilibrium. In 2007/2008, the market started to adjust downward due to the global financial crisis, but it has recovered since 2009. Table 8b shows the results based on the 5 year fixed mortgage rate, which largely confirms the results in Table 8a. Overall, the months of positive growth and negative growth are fairly consistent with each other, with slightly more positive growth months, suggesting that the bubble eventually died out or became less significant.

<Insert Table 8a and 8b>

We also compare our approach to that suggested by Igan and Loungani (2012) to estimate the price gap in levels. For this, due to our market knowledge,[13] we choose April 1999 to December 2001 as the base period. Equation (4) is then estimated based on that base period. Using the parameter estimates obtained, we forecast future price changes from January 2002 until December 2009. Setting that the price index at December 2001 at 100, we convert the price changes to price levels (indices). The forecasted price indices are then compared to the actual price indices to calculate price gaps.

[13] The housing market was much more stable in New Zealand over the period 1999 to 2001, as can be seen with the house price movements for Auckland City shown in Figure 1.

Table 9 shows the estimated price gaps relative to the actual price indices, in percentages based on different mortgage rates. For example, as indicated by the floating rate (Table 9, column 1), house prices in North Shore City were overvalued by about 32% in 2005, 34% in 2006, 38% in 2007, 33% in 2008 and 34% in 2009. Among all cities, house prices in Auckland City and Christchurch City are mostly overvalued, while prices in Manukau City are slightly overvalued. However, house prices in Wellington City are slightly undervalued when using the floating mortgage rate as the explanatory variable, but slightly overvalued when using the fixed mortgage rate as the explanatory variable. Overall, the gaps between the forecasted and actual prices indicate price misalignments during 2005 and 2009. However, the results are subjected to several caveats as discussed in Section 3.

<Insert Table 9>

Finally, we use a panel unit root test to test the stationarity of the above forecast errors. We include six cities and seven mortgage rates (42 cross sections) from 2002 to 2009, and reject both panel unit root and individual unit root processes at the 1% significance level. In other words, there is no evidence that the forecast errors are persistent during 2002 to 2009. The results are presented in Appendix 2.

Our results may lead to the argument that housing prices might have shifted from a low value to a high value regime during the 2000s. New Zealand is a small country with a total population of about 4.3 million. Its economy is largely tourism and trade oriented, with the country viewed as a lifestyle destination. As a result, domestic demand for housing is more resilient, while the policy rate and long term interest rates are more affected by global factors. This might cause a positive relationship between households' real discount rates and long-term interest rates as we have shown. Moreover, New Zealand has consistently offered favourable taxation treatment for housing. Homeowners and investors who hold housing assets long term pay no taxes on capital gain at sale. As a result, households' real long-term discount rates could afford to increase with long term real interest rates in exchange for no capital gains tax at future sales. The higher prices go, the greater the tax benefit obtained through holding housing assets.

5.4 Hedging effect of mortgage rate changes

We further explore mortgage choice and its impact on housing price as we believe that the choices, particularly between fixed and floating rate loans, have important policy implications. If more borrowers choose fixed rates, changes in floating mortgage rates will have less direct impact on housing prices. Figure 3 shows the ratio of the value of floating rate to overall mortgage loans over time. Since the RBNZ introduced the OCR in 1999, the proportion of floating rate loans by value 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 relative to total loans climbed above 25% by the end of 2009, and exceeded 50% by March 2011.

<Insert Figure 3>

To estimate the hedging effect on housing price, we first construct a structural equation based on Equation (4), written as follows:

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

where R_t is the change of the ratio of floating rate loans to overall value of mortgage loans at time *t*. All other variables are as in equation (4).

There is, however, a problem in using OLS to estimate the above equation.[14] As indicated by Follain (1990), mortgage choice (floating vs. fixed) is an endogenous variable, correlated with other factors such as expectation of future interest rate changes, so that R_t and $\varepsilon_{i,t}$ might be correlated. To accommodate this, we used the differential between the fixed and floating mortgage rates as instrumental variables (IVs) in a two-stage least squares regression. The reduced form equation is:

$$R_t = \alpha_0 + \beta \Delta d_{i,t} + \lambda \Delta m_t + \varphi E_t + \delta C_t + \tau_k I_k + \sum_j^{11} \phi_j S_j + \eta_t, \quad (8)$$

where k represents the individual fixed and floating rate periods and I_k is an instrumental variable representing the difference between the relative fixed and floating rates, and η_t is white noise. All other variables are as in equation (7).

The instrumental variable I_k is believed to be correlated with mortgage choice but uncorrelated with the error term $\varepsilon_{i,t}$ in equation (7).[15] This is likely as the differences between the fixed and floating rates will affect households' mortgage choice. A higher positive interest rate differential between fixed and floating rates (i.e. fixed rates are more expensive than the floating rate) will push more people onto a floating rate and vice versa. On the other hand, the interest rate differential between the fixed and floating rates should have minimal influence on housing price changes and therefore

[14] Regression results of the OLS estimation of Equation (7) are presented in Appendix 3.
[15] Regression results from the reduced form Equation (8) are presented in Appendix 4.

be uncorrelated with the error term $\varepsilon_{i,t}$. We present the results of the two-stage least squares in Table 10.

<Insert Table 10>

These results show that positive interest rate changes will cause positive house price growth, but a decreased proportion of floating rate loans will do the opposite to decrease prices, and vice versa. This is because when interest rates increase, people favour fixed rates against the floating rate, particularly as floating rates are likely to move more than fixed rates, which in New Zealand has often resulted in the yield curve becoming negative; the ratio of floating-rate loans to overall mortgage lending will thus fall. Moreover, our findings suggest that the overall effect of interest rates on housing prices shown in Table 6 is much weaker than that shown in Table 10. This might further explain why the policy rate (through retail mortgage rates) does not have much influence on housing.

6. Policy implications

Acceptance of findings that the connection between the policy rate (or short term rate) and housing prices are weak has important policy implications. Glaeser et al. (2010) argue that decreases in the real interest rate could only explain 20% of increases in the real housing price, if one allows the interest rate to be mean reverting. Dokko et al. (2011) also follow this argument. Looking at 17 OECD countries, they find that decreases in policy rates in these countries were not the main reason for housing price inflation during the mid-2000s. Given that fixed mortgage rates have a larger impact on house prices than the floating rate, and households have choices between floating and fixed mortgage rates, we thus argue that policy makers should seriously consider macro-prudential economic tools such as increasing down payment levels and capping loan-to-value ratios to influence the housing market, particularly when the policy rate is directed at inflation targeting while the national economy is exposed to global factors. This issue has particular currency in New Zealand in 2013.

Our bubble tests under rational expectations show little evidence for or a much less severe incidence of housing bubbles during the last decade, even though the real interest rate was positively correlated to real house price changes. This raises several questions. One possibility is that the housing price "bubble" in New Zealand might have largely died out during the GFC period in 2007/2008. High price levels since 2005 as compared to the base period house prices during 1999 to 2001 may be simply suggesting that house price levels have moved from a low value regime to a high value regime reflecting households' changing discount rates. While labour income may be taxed at 33% (the highest bracket), no housing capital gains tax has been imposed in New Zealand. This might affect households' expectation of return from owning. While a capital gains tax may be a tool to prevent a bubble, it is difficult to implement in practice, as demonstrated by the failure of 8 tax working groups and inquiries (established by successive governments) between 1967 and 2010 to lead to any such tax being enacted (Huang and Elliffe, 2011). A key question for policy makers is whether they really want house prices to fall.

7. Conclusions

This paper has investigated how changes in the policy rate and retail mortgage rates affect real housing prices in New Zealand during 1999-2009. We find that the announcement of policy rate changes Granger-causes real fixed interest rate changes.

We also find that real fixed interest rates are positively related to the real housing price, after controlling for other economic conditions such as the effect of real rental rates, unemployment rates, and housing credit. Thus, increases in the policy rate did not depress the real housing price during 1999-2009.

We also find that long term mortgage rates are highly significant in predicting housing growth when compared to short term mortgage rates. 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 is not easy for governments or the RBNZ 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, use of other tools such as a capital gains tax to mitigate some of the excesses of housing prices may be a more attractive option.

One of the limitations in this research is the relatively short period studied. This means that we have not seen as much variation in economic conditions as would be desirable to provide more robustness to our bubble test. But the other side of this is that there is scope for further research with the passage of time, so that we can observe whether households' future expectations for housing are rational against a background of greater diversity in both external and internal 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.

Blanchard, O., Watson, M., 1982. Bubbles, rational expectations and financial markets, NBER Working Paper Series No.945. National Bureau of Economic Research Cambridge MA.

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

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.

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.

Clayton, J., 1996. Rational expectations, market fundamentals and housing price volatility, Real Estate Economics 24, 441-470.

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.

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.

Igan, D., Loungani, P., 2012. Global housing cycles. IMF Working Paper No. WP/12/17.

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.

Lucas, R.E., Jr., Sargent, T., J., 1981. Rational expectations and econometric practice. The University of Minnesota Press, Minneapolis.

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

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.

Miles, W., 2013. The housing bubble: How much blame does the fed really deserve? forthcoming in Journal of Real Estate Research.

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

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.

Rogoff, K., 2006. Impact of globalisation on monetary policy. Federal Reserve Bank of Kansas City Proceedings, 265-305.

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

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 in the Major Cities in New Zealand, 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* include multiple sales.

Table 2: Summary statistics of raw data

Variables	Description	Date	Mean	SD	Max	Min	#Obs	Intervals
Price								
	North Shore	1994 - 2009	1907	598	2998	1000	192	monthly
	Waitakere	1994 - 2009	1983	611	3104	985	192	monthly
	Auckland	1994 - 2009	2181	746	3522	1000	192	monthly
	Manukau	1994 - 2009	1890	564	2975	1000	192	monthly
	Wellington	1994 - 2009	1943	694	3221	1000	192	monthly
	Christchurch	1994 - 2009	1660	569	2697	1000	192	monthly
Rent								
	North Shore	1994 - 2009	1391	248	1875	958	192	monthly
	Waitakere	1994 - 2009	1404	204	1750	1000	192	monthly
	Auckland	1994 - 2009	1433	218	1840	1000	192	monthly
	Manukau	1994 - 2009	1350	205	1773	1000	192	monthly
	Wellington	1994 - 2009	1410	276	2130	957	192	monthly
	Christchurch	1994 - 2009	1334	271	1889	1000	192	monthly
Interest								
	Floating	1994 - 2009	8.73	1.53	11.50	6.20	192	monthly
	6 months	1999 - 2009	7.45	1.21	9.93	5.52	129	monthly
	1 year	1999 - 2009	7.54	1.10	9.90	5.64	129	monthly
	2 years	1999 - 2009	7.71	0.86	9.63	5.94	129	monthly
	3 years	1999 - 2009	7.88	0.72	9.61	6.13	129	monthly
	4 years	1999 - 2009	8.01	0.65	9.56	6.42	129	monthly
	5 years	1999 - 2009	8.06	0.62	9.50	6.52	129	monthly
OCR		1999 - 2009	5.98	1.48	8.25	2.50	129	monthly
Unemployment rate		1994 - 2009	2.37	0.82	5.10	1.00	64	quarterly
Household lending		1998 - 2009	103000	38833	167942	53614	139	monthly
CPI		1994 - 2009	904	95	1095	758	64	quarterly

Notes: Both price and rent indices start from 1000 from January 1994. Household lending is in million dollars. The CPI is set at 1000 in June 2006.

Table 3: 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 taken to first difference. In total, there are 128 observations.

Table 4: 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, and "√ " denotes causality at 5% significance level. We include 6 lags for the test.

Table 5: Fixed effects pool regression – basic model, 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 shown by Equation (10) (except for excluding the economic variables X):

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

where α_0 is constant, *i* denotes different cities, *t* denotes the time period, $p_{i,t}$, $d_{i,t}$ and m_t are log prices, log rents and mortgage rates, 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. The regression is run with a cross-section fixed effect (city dummy variables).

Table 6: Fixed effects pooled regression with other economic conditions, 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 5% level; ** indicates significance at 1% level.

The regression model is as shown in Equation (4):

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

where Δ denotes the first difference, α is constant, i denotes different cities, t denotes the time period, $p_{i,t}$, $d_{i,t}$ and m_t are log prices, log rents and log mortgage rates, respectively, E_t denotes the percentage change of unemployment rate, C_t denotes the percentage change of real house lending. S_j denotes the monthly seasonal dummy variables, and $\varepsilon_{i,t}$ is white noise. The regression is run with a cross-section fixed effect (city dummy variables).

Table 7: Summarised statistics of forecasting errors for monthly house price changes, 2002 - 2009

	Floating	6 months	1 year	2 years	3 years	4 years	5 years
North Shore City							
Mean	0.001	0.001	0.000	0.000	0.000	0.000	0.000
Median	0.002	0.002	0.002	0.002	0.001	0.001	0.001
Maximum	0.051	0.053	0.053	0.052	0.053	0.052	0.053
Minimum	-0.046	-0.046	-0.045	-0.045	-0.046	-0.045	-0.046
Std. Dev.	0.016	0.016	0.017	0.017	0.017	0.017	0.017
Skewness	0.148	0.273	0.295	0.271	0.230	0.254	0.279
Kurtosis	4.082	4.199	4.197	4.144	4.308	4.146	4.237
Observations	96	96	96	96	96	96	96
Waitakere City							
Mean	0.002	0.001	0.001	0.001	0.001	0.001	0.001
Median	0.004	0.003	0.003	0.003	0.003	0.003	0.003
Maximum	0.040	0.038	0.041	0.041	0.041	0.041	0.040
Minimum	-0.035	-0.035	-0.036	-0.038	-0.040	-0.039	-0.041
Std. Dev.	0.016	0.016	0.016	0.016	0.016	0.016	0.016
Skewness	0.022	0.090	0.074	0.044	0.016	0.017	-0.031
Kurtosis	2.779	2.681	2.689	2.712	2.740	2.705	2.685
Observations	96	96	96	96	96	96	96
Auckland City							
Mean	0.000	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
Median	0.001	0.000	0.001	0.001	0.001	0.000	-0.001
Maximum	0.053	0.061	0.062	0.063	0.063	0.064	0.064
Minimum	-0.044	-0.043	-0.043	-0.048	-0.046	-0.044	-0.044
Std. Dev.	0.018	0.019	0.019	0.019	0.019	0.019	0.019
Skewness	-0.014	0.095	0.159	0.143	0.101	0.103	0.116
Kurtosis	3.175	3.434	3.550	3.704	3.669	3.628	3.623
Observations	96	96	96	96	96	96	96
Manukau City							
Mean	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Median	0.000	0.001	0.002	0.001	0.001	0.001	0.001
Maximum	0.047	0.046	0.046	0.046	0.045	0.046	0.046
Minimum	-0.053	-0.053	-0.053	-0.053	-0.052	-0.052	-0.052
Std. Dev.	0.017	0.018	0.018	0.018	0.018	0.018	0.018
Skewness	-0.036	-0.129	-0.029	-0.086	-0.123	-0.088	-0.087
Kurtosis	3.688	3.328	3.341	3.333	3.319	3.299	3.322
Observations	96	96	96	96	96	96	96
Wellington City							
Mean	0.000	-0.001	0.000	0.000	0.000	0.000	0.000
Median	-0.001	-0.001	-0.001	-0.001	0.000	0.000	0.000
Maximum	0.054	0.053	0.054	0.054	0.054	0.054	0.054
Minimum	-0.050	-0.053	-0.053	-0.053	-0.053	-0.053	-0.053
Std. Dev.	0.020	0.020	0.020	0.020	0.020	0.020	0.020
Skewness	0.100	0.068	0.093	0.046	0.070	0.064	0.059
Kurtosis	3.215	3.328	3.407	3.377	3.372	3.359	3.367
Observations	96	96	96	96	96	96	96
Christchurch City							
Mean	0.002	0.001	0.001	0.001	0.001	0.001	0.001
Median	0.002	0.001	0.001	0.001	0.001	0.001	0.001
Maximum	0.041	0.042	0.043	0.045	0.046	0.048	0.047
Minimum	-0.038	-0.036	-0.037	-0.037	-0.037	-0.036	-0.037
Std. Dev.	0.014	0.014	0.014	0.014	0.014	0.014	0.014
Skewness	0.162	0.280	0.320	0.312	0.352	0.436	0.377
Kurtosis	3.695	3.575	3.649	3.657	3.828	3.977	3.910
Observations	96	96	96	96	96	96	96

Notes: Forecasting errors $\epsilon_{i,t+1}$ are estimated using the following equation:

$$\epsilon_{i,t+1} = \Delta p_{i,t+1} - E_{i,t+1}[\Delta p_{i,t+1}],$$

where $\Delta p_{i,t+1}$ is the actual monthly house price change for the *i*th city at time t+1 and $E_{i,t+1}[\Delta p_{i,t+1}]$ represents the forecasted monthly house price change for the *i*th city for time t+1. To calculate the forecasting value of $E_{i,t+1}[\Delta p_{i,t+1}]$, information up to the time t is used and so on, rolling over the studied period.

Table 8a: Number of positive and negative forecast errors - floating rate

	2002	2003	2004	2005	2006	2007	2008	2009	overall
North Shore City									
+	12	9	4	7	3	7	3	9	54
-	0	3	8	5	9	5	9	3	42
Waitakere City									
+	8	10	5	6	4	7	5	9	54
-	4	2	7	6	8	5	7	3	42
Auckland City									
+	9	8	3	5	5	7	3	10	50
-	3	4	9	7	7	5	9	2	46
Manukau City									
+	8	5	4	6	6	7	4	8	48
-	4	7	8	6	6	5	8	4	48
Wellington City									
+	8	6	5	7	6	3	3	8	46
-	4	6	7	5	6	9	9	4	50
Christchurch City									
+	7	9	7	5	5	7	6	10	56
-	5	3	5	7	7	5	6	2	40

Table 8b: Number of positive and negative forecast errors – 5 years fixed rate

	2002	2003	2004	2005	2006	2007	2008	2009	overall
North Shore City									
+	11	8	3	6	3	8	4	9	52
-	1	4	9	6	9	4	8	3	44
Waitakere City									
+	9	8	5	6	4	7	5	9	53
-	3	4	7	6	8	5	7	3	43
Auckland City									
+	10	6	2	5	4	7	3	9	46
-	2	6	10	7	8	5	9	3	50
Manukau City									
+	8	5	6	7	5	7	4	8	50
-	4	7	6	5	7	5	8	4	46
Wellington City									
+	9	6	5	6	6	5	3	7	47
-	3	6	7	6	6	7	9	5	49
Christchurch City									
+	7	7	3	5	5	6	6	10	49
-	5	5	9	7	7	6	6	2	47

Table 9: Estimated price gaps

	Floating	6 months	1 year	2 years	3 years	4 years	5 years
North Shore City							
2005	32%	38%	30%	23%	23%	18%	23%
2006	34%	41%	32%	23%	23%	16%	22%
2007	38%	47%	37%	27%	27%	19%	26%
2008	33%	43%	31%	21%	22%	14%	21%
2009	34%	42%	30%	21%	22%	16%	23%
Waitakere City							
2005	38%	37%	37%	40%	40%	41%	39%
2006	42%	40%	40%	44%	44%	46%	42%
2007	47%	45%	45%	49%	49%	51%	47%
2008	45%	43%	43%	47%	47%	49%	45%
2009	44%	41%	41%	46%	46%	48%	45%
Auckland City							
2005	27%	27%	35%	42%	43%	44%	43%
2006	28%	27%	37%	46%	47%	48%	47%
2007	31%	30%	41%	50%	51%	53%	51%
2008	23%	23%	36%	46%	47%	48%	46%
2009	20%	19%	33%	43%	43%	45%	42%
Manukau City							
2005	17%	19%	29%	21%	11%	12%	9%
2006	19%	21%	32%	23%	11%	12%	8%
2007	19%	23%	35%	24%	11%	12%	8%
2008	16%	20%	33%	22%	8%	9%	6%
2009	16%	19%	34%	21%	8%	9%	6%
Wellington City							
2005	-4%	3%	6%	7%	6%	7%	9%
2006	-7%	2%	6%	7%	6%	6%	10%
2007	-10%	1%	6%	7%	6%	7%	10%
2008	-18%	-7%	-1%	-1%	-2%	-1%	2%
2009	-10%	-2%	4%	4%	2%	3%	6%
Christchurch City							
2005	34%	41%	41%	43%	42%	43%	42%
2006	37%	46%	46%	47%	47%	48%	47%
2007	41%	50%	51%	52%	52%	53%	52%
2008	37%	47%	48%	49%	49%	50%	49%
2009	39%	49%	49%	50%	50%	51%	50%

Notes: percentages represent the estimated price gaps between the actual house prices and predicted house prices, based on the house price levels during 1999 and 2001.

Table 10: The results of the two-stage least squares

	Floating		6 months		1 year		2 years		3 years		4 years		5 years	
α_0	-0.016	**	-0.010	**	-0.011	**	-0.014	**	-0.014	**	-0.015	**	-0.016	**
Δd_t	-0.001		0.003		0.002		-0.003		-0.005		-0.005		-0.006	
Δm_t	1.731	**	-0.031		0.588		0.984	*	1.287	**	1.304	**	1.427	**
E_t	-0.003		-0.007	**	-0.008	**	-0.005		-0.004		-0.002		-0.001	
C_t	2.357	**	1.388	**	1.445	**	1.795	**	1.990	**	2.147	**	2.287	**
$\widehat{R_t}$	0.396	**	0.048		0.097		0.205	*	0.260	**	0.291	**	0.327	**
S_1	0.005		0.012	**	0.012	**	0.011	**	0.009	**	0.008	*	0.007	*
S_2	0.004		0.006	*	0.006	*	0.007	*	0.006		0.005		0.005	
S_3	-0.004		-0.002		-0.002		-0.002		-0.003		-0.004		-0.005	
S_4	0.010	**	0.004		0.006		0.009	*	0.008	*	0.009	*	0.009	**
S_5	0.007	*	0.005		0.006	*	0.008	*	0.007	*	0.007	*	0.007	*
S_6	0.007	*	0.003		0.004		0.006		0.006		0.006		0.006	
S_7	0.012	**	0.007	*	0.008	**	0.010	**	0.010	**	0.010	**	0.011	**
S_8	0.015	**	0.008	*	0.009	**	0.011	**	0.011	**	0.012	**	0.012	**
S_9	0.014	**	0.012	**	0.013	**	0.014	**	0.014	**	0.014	**	0.014	**
S_{10}	0.000		0.003		0.002		0.002		-0.001		-0.001		-0.001	
S_{11}	0.000		0.003		0.003		0.003		0.001		0.000		0.000	
R-squared	-0.186		0.166		0.153		0.086		0.035		-0.008		-0.056	

Note: * indicates significance at the 5% level; ** indicates significance at the 1% level. The regression model is as follows:

$$R_t = \alpha_0 + \beta \Delta d_{i,t} + \lambda \Delta m_t + \varphi E_t + \delta C_t + \tau_k I_k + \sum_j^{11} \phi_j S_j + \eta_t, \quad (8)$$

$$\Delta p_{i,t} = \alpha_0 + \beta \Delta d_{i,t} + \lambda \Delta m_t + \varphi E_t + \delta C_t + \theta \widehat{R_t} + \sum_j^{11} \emptyset_j S_j + \varepsilon_{i,t}, \quad (7')$$

where Δ denotes the first order difference, α is constant, i denotes different cities, t denotes the time period, $p_{i,t}$, $d_{i,t}$ and m_t are log prices, log rents and mortgage rates, respectively, E_t denotes the percentage change of unemployment rate, C_t denotes the percentage change of real house lending. R_t denotes the change of the ratio of floating rate loans to overall value of mortgage loans, $\widehat{R_t}$ is the fitted value of R_t of equation (8), S_j denotes the monthly seasonal dummy variables, and $\varepsilon_{i,t}$ is white noise. k represents the individual fixed and floating rate periods, I_k is an instrumental variable representing the difference between the relative fixed and floating rates, and η_t is white noise. Equation (8) represents the first stage regression and equation (7') represents the second stage regression. The results are estimated using the two-stage least squares method with a cross-section fixed effect (city dummy variables) provided in Eviews7.

Figure 1: Prices and interest rates – Auckland City, April 1999 – December 2009

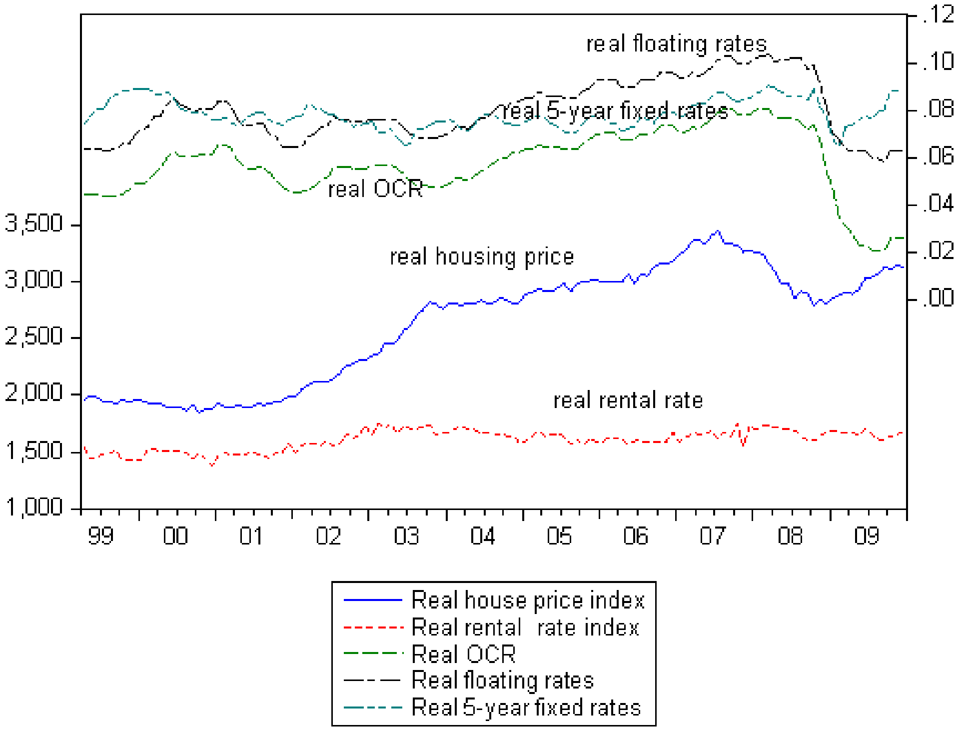


Figure 2: Log real house price indices measured by the weighted repeated sales method

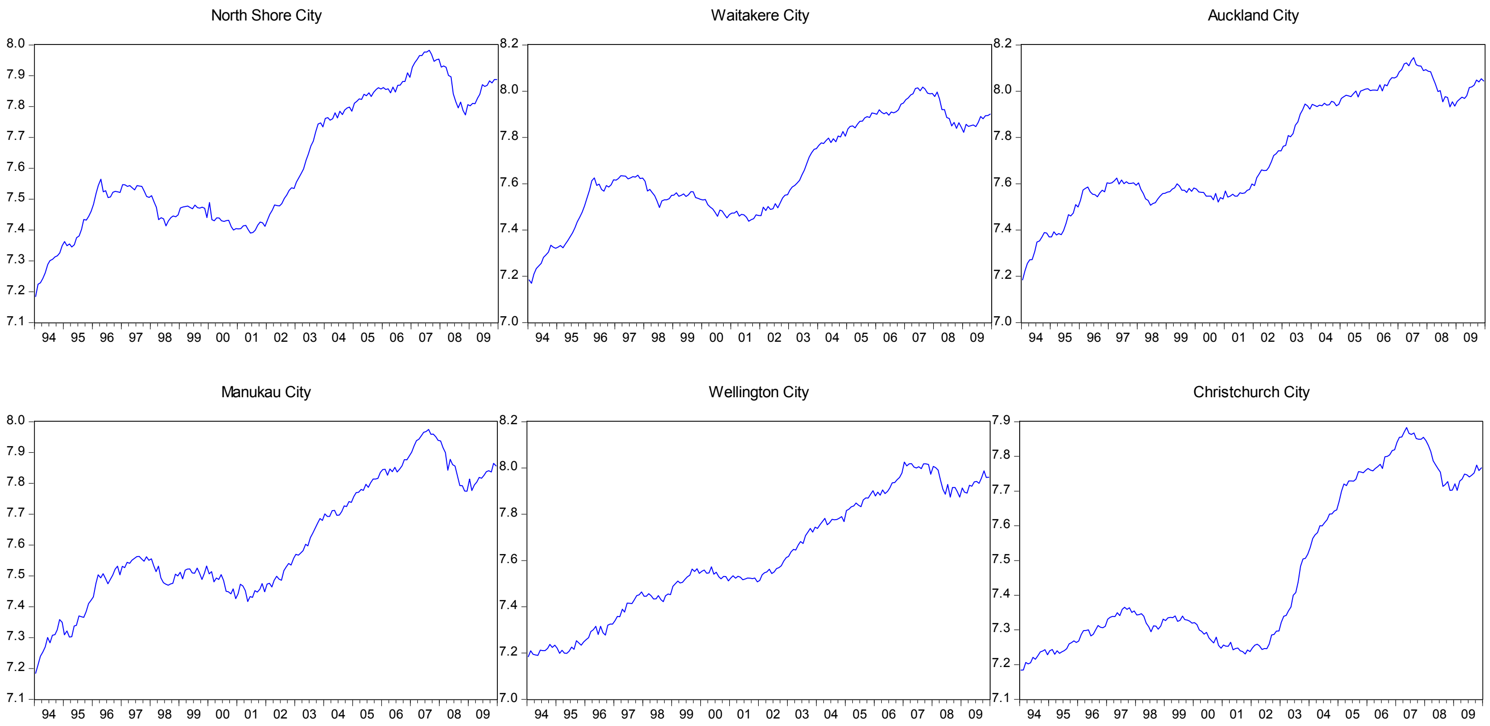
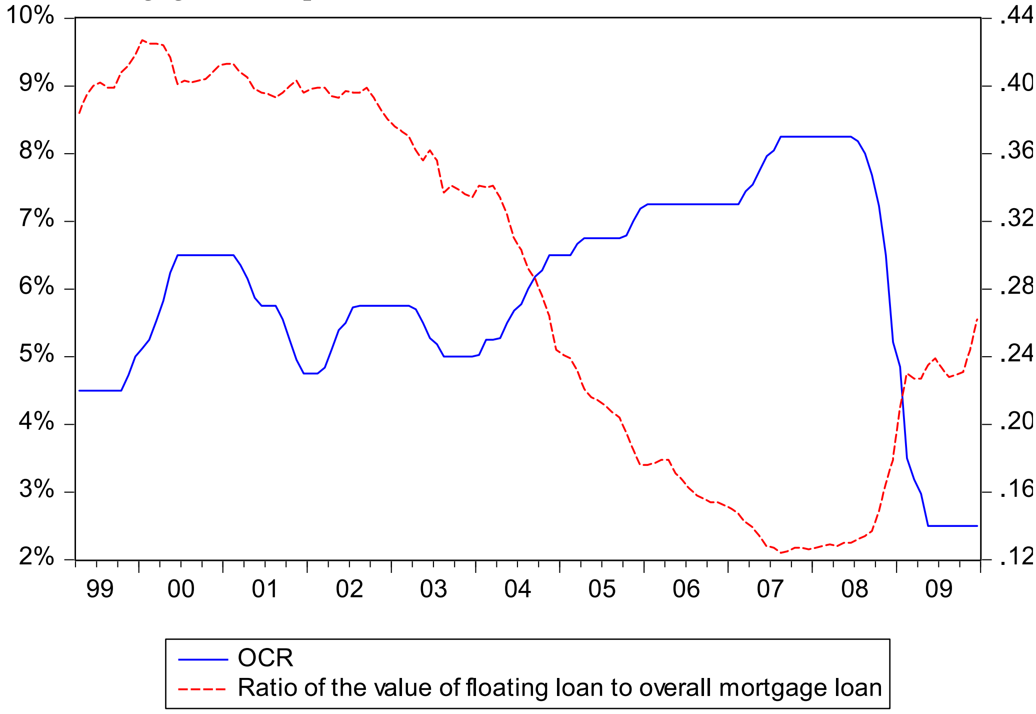


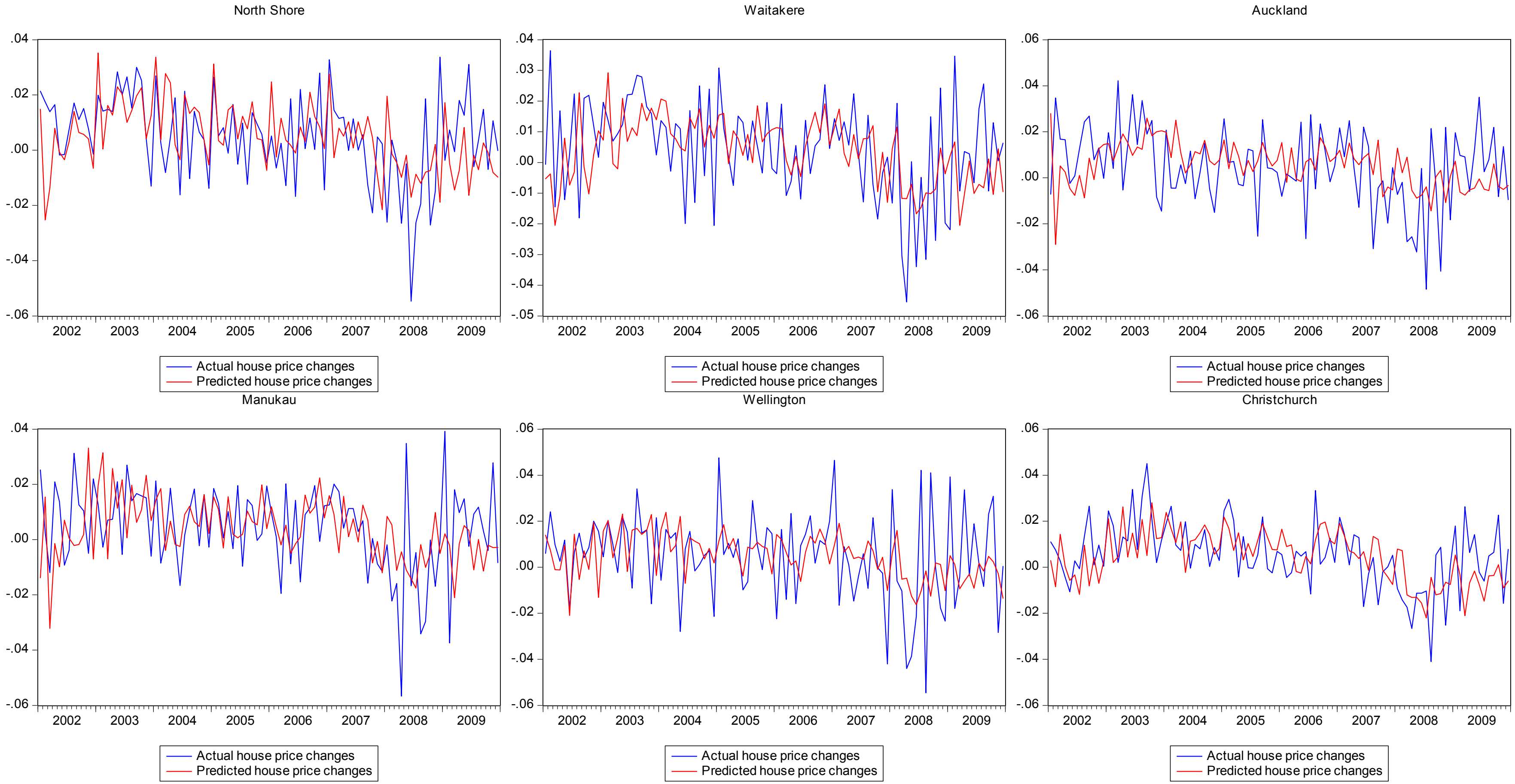
Figure 3: OCR movements and the ratio of the value of floating loan to overall mortgage loan, Apr. 1999 – Dec. 2009



Appendix 1: Actual house price changes and predicted house price changes, 2002m1 to 2009m12

Panel A: Floating rate

Panel B: 5 years fixed rate



Appendix 2: Panel unit root test

Method	Statistic	probability	Cross-sections	Number of observations
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-76.08	0.0000	42	4032
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-70.88	0.0000	42	4032
ADF - Fisher Chi-square	896.16	0.0000	42	4032
PP - Fisher Chi-square	962.75	0.0000	42	4032

Notes:

1. Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.
2. Include individual intercept in test equation.
3. Automatic selection of maximum lags based on SIC.
4. Newey-West automatic bandwidth selection and Bartlett kernel

Appendix 3: OLS estimations of Equation (7)

	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	0.008		0.004		0.004		0.003		0.003		0.003		0.003	
Δm_t	-0.413		-0.312		0.150		0.226		0.297		0.168		0.240	
E_t	-0.008	**	-0.008	**	-0.009	**	-0.009	**	-0.009	**	-0.009	**	-0.009	**
C_t	1.183	**	1.214	**	1.174	**	1.174	**	1.180	**	1.189	**	1.190	**
R_t	-0.020		-0.013		0.002		0.004		0.007		0.003		0.005	
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		-0.001		-0.002		-0.001		-0.002		-0.002		-0.002	
S_4	0.002		0.002		0.004		0.004		0.004		0.003		0.003	
S_5	0.005		0.004		0.005		0.005		0.005		0.005		0.004	
S_6	0.003		0.002		0.002		0.003		0.002		0.002		0.002	
S_7	0.007	*	0.006	*	0.007	*	0.007	*	0.006	*	0.006	*	0.006	*
S_8	0.006	*	0.006	*	0.006	*	0.007	*	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		0.003		0.004	
R-squared	0.151		0.151		0.150		0.150		0.151		0.150		0.150	

Notes: * indicates significance at the 5% level; ** indicates significance at the 1% level. The regression model is as follows:

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

where Δ denotes the first difference, R_t represents the percentage change of the ratio of floating rate loans to overall value of mortgage loans, α is constant, *i* denotes different cities, *t* denotes the time period, $d_{i,t}$ and m_t are log rents and mortgage rates, respectively, E_t denotes the percentage change of unemployment rate, C_t denotes the percentage change of real house lending. S_j denotes the monthly seasonal dummy variables, and η_t is white noise. The regression in Equation (7) is run with a cross-section fixed effect (city dummy variables).

Appendix 4: The results of reduced form of Equation (8)

	Floating		6 months		1 year		2 years		3 years		4 years		5 years	
α_0	0.015	**	0.044	**	0.029	**	0.026	**	0.019	**	0.018	**	0.019	**
Δd_t	0.009		0.017		0.020		0.030		0.032		0.029		0.029	
Δm_t	-5.577	**	-6.735	**	-6.426	**	-4.986	**	-4.982	**	-4.920	**	-4.530	**
E_t	-0.012	**	-0.019	**	-0.019	**	-0.019	**	-0.019	**	-0.021	**	-0.021	**
C_t	-2.369	**	-2.092	**	-2.348	**	-2.608	**	-2.694	**	-2.771	**	-2.879	**
Instrumental variables (I_k)														
floating rate - 5 years rate	-0.484	**												
6 months rate - floating rate			3.381	**										
1 years rate - floating rate					1.825	**								
2 years rate - floating rate							0.964	**						
3 years rate - floating rate									0.744	**				
4 years rate - floating rate											0.674	**		
5 years rate - floating rate													0.571	**
S_1	0.022	**	0.016	**	0.017	**	0.014	**	0.019	**	0.021	**	0.020	**
S_2	0.009	*	0.003		0.004		0.000		0.005		0.007		0.007	
S_3	0.008		0.005		0.005		0.003		0.008		0.011	*	0.010	*
S_4	-0.019	**	-0.032	**	-0.024	**	-0.024	**	-0.018	**	-0.017	**	-0.016	**
S_5	-0.004		-0.012	**	-0.009	*	-0.013	**	-0.008		-0.007		-0.007	
S_6	-0.009	*	-0.011	**	-0.008		-0.012	**	-0.010	*	-0.009	*	-0.010	*
S_7	-0.010	*	-0.014	**	-0.012	**	-0.016	**	-0.011	**	-0.010	*	-0.012	**
S_8	-0.019	**	-0.022	**	-0.019	**	-0.020	**	-0.016	**	-0.016	**	-0.017	**
S_9	-0.005		-0.009	*	-0.006		-0.010	*	-0.008		-0.005		-0.006	
S_{10}	0.009	*	0.005		0.011	**	0.006		0.014	**	0.014	**	0.013	**
S_{11}	0.007		0.002		0.006		0.005		0.011	**	0.012	**	0.011	**
R-squared	0.478		0.490		0.474		0.460		0.462		0.467		0.450	

Note: * indicates significance at the 5% level; ** indicates significance at the 1% level. The regression model is as follows:

$$R_t = \alpha_0 + \beta \Delta d_{i,t} + \lambda \Delta m_t + \varphi E_t + \delta C_t + \tau_k I_k + \sum_j^{11} \phi_j S_j + \eta_t, \qquad (8)$$

where Δ denotes the first difference, R_t represents the percentage change of the ratio of floating rate loans to overall value of mortgage loans, α is constant, i denotes different cities, t denotes the time period, $d_{i,t}$ and m_t are log rents and mortgage rates, respectively, E_t denotes the percentage change of unemployment rate, C_t denotes the percentage change of real house lending. The term k represents the individual fixed and floating rate periods and I_k is an instrumental variable representing the difference between the relative fixed and floating rates, S_j denotes the monthly seasonal dummy variables, and η_t is white noise. The regression in Equation (8) is run with a cross-section fixed effect (city dummy variables).