

# Analytical Notes

## Housing Supply, House Prices, and Monetary Policy.

Meltem Chadwick, Karan Dasgupta, and Punnoose Jacob

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Reserve Bank of New Zealand  
PO Box 2498  
Wellington  
NEW ZEALAND

[www.rbnz.govt.nz](http://www.rbnz.govt.nz)

## Key Findings

- House prices are expected to respond more to monetary stimulus when housing supply is less responsive to prices. We test this theory using data for New Zealand’s territorial authorities.
- We confirm that monetary policy stimulus triggers stronger house price movements in those New Zealand territories where the supply of housing is relatively less responsive.
- We consider an unanticipated increase of 40 basis points in the Official Cash Rate (OCR). The real median house price in the least supply responsive areas declined by over six times that of the most responsive areas, 12 months after the OCR increase (17.2% compared with 2.8%).

## Introduction<sup>1</sup>

The scarcity of housing supply in New Zealand has received much attention in the media ([Bell 2021](#), [Bradford 2021](#)) as well as in policy discussions ([New Zealand Infrastructure Commission 2022](#), [RBNZ 2021](#), [Woods 2021](#), [New Zealand Productivity Commission 2012](#)). The per capita availability of dwellings in New Zealand deteriorated through most of the period 2010-2020 ([Figure 1a](#)). Policy and retail interest rates in New Zealand have also declined steeply to historically low levels ([Figure 1b](#)) in recent years in line with the declining trend in global neutral rates ([Holston, Laubach and Williams 2017](#)). The declines in both dwelling availability and interest rates was paralleled by an acceleration in New Zealand house prices; house price inflation in New Zealand has been higher than the corresponding average measure for the OECD ([Figure 1c](#)) after the Global Financial Crisis (GFC). This reflects structural drivers in the housing market, such as regulations around zoning and tax settings, as well as cyclical factors.

These patterns in the historical data can also be partially attributed to the transmission of interest rate movements to the real economy. The lower cost of mortgage credit that is associated with cyclical monetary expansions or declining neutral interest rates fuels higher housing demand. Also, since houses take time to build, the response of housing supply to an increase in demand can be sluggish. The inelastic supply of housing relative to the elevated demand for housing is expected to push up house prices. This reasoning aligns well with a textbook model of demand and supply; prices will respond more to a given impetus to demand, when the quantity of the good supplied is less sensitive to price changes. [Figure 2](#) illustrates the theory in the context of the housing market, with a schematic plot.

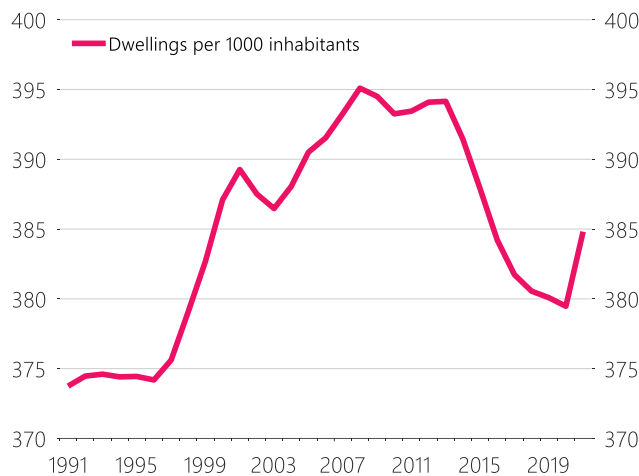
We present empirical evidence that confirms that the lower responsiveness of housing supply amplifies the effects of monetary policy on house prices in New Zealand. We proceed in two steps. Firstly, we estimate the sensitivities of new housing supply to house prices in New Zealand’s 66 Territorial Authorities (TAs). Secondly, categorising the TAs into 3 groups based on the responsiveness of housing supply, we assess the dynamics of house prices caused by surprise movements in monetary policy in each group. We find that monetary policy movements generate stronger house price dynamics in TAs where housing supply is least responsive to prices.

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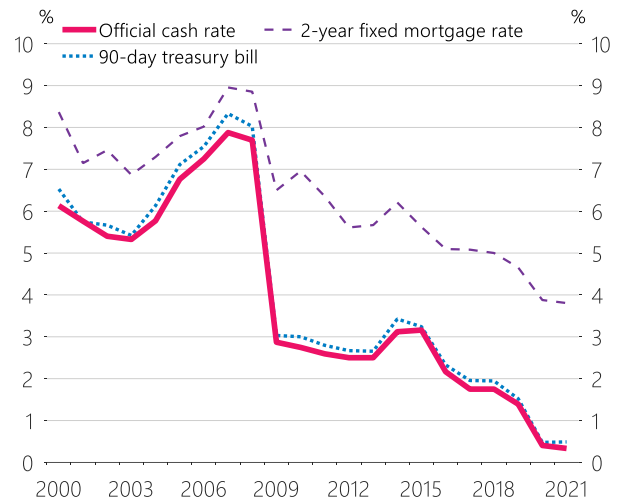
<sup>1</sup> The authors would like to thank colleagues across RBNZ for discussions and feedback.

**Figure 1: Dwelling availability, interest rates and house prices in New Zealand**

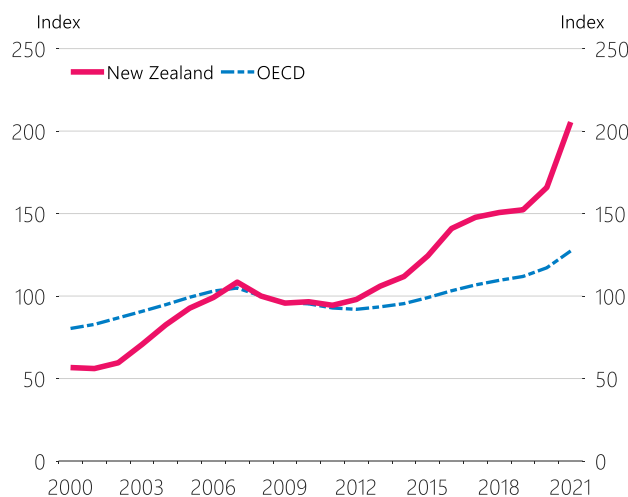
a. Total dwellings per 1000 inhabitants



b. Interest rates (annual averages)



c. Real house prices



Notes: The dwelling availability statistic in Panel (a) is based on RBNZ calculations that uses estimates of resident population and the number of private dwellings from Stats NZ. The data on real house prices (nominal house prices deflated by consumption deflators) in Panel (c) are sourced from CoreLogic, Stats NZ and the [OECD](#). The benchmarking of real house prices to the year 2008 is based on the authors' calculations.

This *Note* is part of a wider body of research initiated at the Reserve Bank to better understand the sustainability of house prices in New Zealand. [Brunton \(2021\)](#) defines the Bank's conceptual framework around assessing house price sustainability. Since land and houses contribute more than half of all household wealth in New Zealand, [Aguiar Carvalho, Baker and Farquharson \(2022\)](#) investigate if the share of housing in the national portfolio is oversized from a risk-return perspective. [Fitchett and Jacob \(2022\)](#) present a visualisation of housing market indicators in New Zealand and other developed economies over the past three decades. They note that house price inflation in New Zealand has been higher than in other countries since the GFC, primarily due to the inadequate response of the supply of houses to demand buoyed by a rapidly growing

population and a relatively sharper decline in mortgage interest rates.<sup>2</sup> In an empirical exercise similar to that pursued in this *Note*, Chadwick and Nahavandi (2022) study the transmission of surprise movements in monetary policy to cyclical movements in New Zealand house prices. However, they examine house prices at the national level, rather than the territorial level as in this *Note*, and find empirical evidence in support of the bank lending or ‘credit’ channel of monetary policy transmission. Finally, Brunton and Jacob (2022) emphasise that the longer-term upward trend in New Zealand house prices is mainly driven by the decline in longer-term interest rates, more influenced by global factors rather than by domestic factors such as monetary policy.

## What We Know About the Effects of Housing Supply on Monetary Policy Transmission in New Zealand

In the absence of formal empirical evidence, the policymakers’ narrative (e.g. Fitchett and Jacob 2022, [Orr 2021](#), [RBNZ 2021](#), [RBNZ 2019](#)) on the influence of the supply side of the New Zealand housing market on monetary policy transmission, has hitherto been inspired by standard economic theory as discussed above, or patterns observed in the historical data in the spirit of [Figure 1](#). To the best of our knowledge, the evidence that this *Note* presents on this aspect of the monetary transmission mechanism in the housing market makes it the first of its kind in New Zealand. The empirical literature that investigates this issue for other countries is also quite sparse.

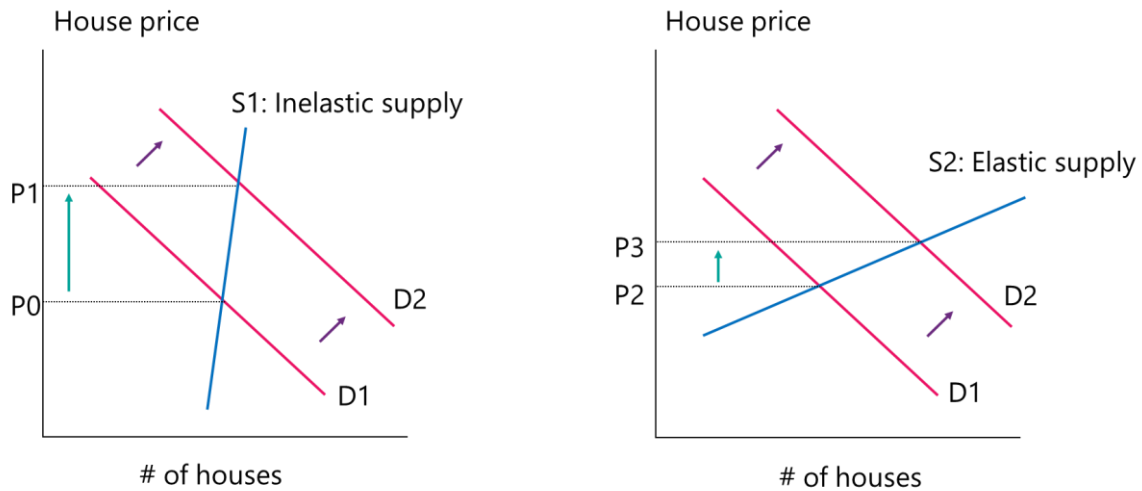
Previous studies have examined the responsiveness of housing supply to a change in house prices – estimating the price elasticity of supply. [Grimes and Aitken \(2010\)](#) use panel data techniques on TA-level data for New Zealand, to estimate a price elasticity of national housing supply. While we also use TA-level data, we seek to understand variation in supply responses *across* New Zealand’s regions. This dimension of our work is more in line of [Green, Malpezzi and Mayo \(2005\)](#). They estimate the price elasticities of housing supply for 45 metropolitan statistical areas in the United States, to understand why price elasticities vary across regions.

However, our purpose is different. We use our estimates of the price elasticity of housing supply to enhance our understanding of the transmission of changes in the stance of monetary policy to house prices. [Aastveit, Albuquerque and Anundsen \(2020\)](#) use data for 254 metropolitan areas in the United States and find that housing supply has become more inelastic over time. Consequently monetary policy has had a greater impact on house prices in more recent years. Results of a similar flavour are reported by [Albuquerque, Iseringhausen and Opitz \(2020\)](#) who use aggregate-level monthly data for the United States; declining housing supply elasticities may explain the higher sensitivity of house prices to monetary policy surprises over time. These are the only other empirical papers we are aware of that examine how monetary policy transmission is affected by variation in housing supply responsiveness.

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<sup>2</sup> Previous work by [Watson \(2013\)](#) also outlines how these demand factors can push up house prices when supply is restricted, for example, by the scarcity of land available for new construction.

**Figure 2: Price responses to identical demand movements when supply is less or more price-elastic**



## Explaining Our Data

The complete list of the data we use is presented in [Table 1](#). Our quarterly dataset covers the 66 TAs in New Zealand. The variables can be divided into three types: those that apply to all TAs, variables that are available for the regional level but applied to TAs, and finally TA-specific variables.

Crucial to our broader objective of understanding monetary policy transmission to the housing market, is the estimation of the response of housing supply to house prices. Our measure of housing supply is based on [Grimes and Aitken \(2010\)](#). We use the number of building consents granted for new residential dwellings. Data at the level of the TAs are chosen for the primary reason that it is these authorities that grant building consents. The data are seasonally adjusted, and rounded to the nearest whole number of consents. We then divide the TA-level consents data by per capita national housing stock, lagged a quarter.

We use several measures of house prices; in the baseline models, we use real median sales house prices in each TA. In robustness checks, we use house price indices that are available at the TA-level. Besides house prices, residential land values can also have an effect on the supply of housing. To approximate residential land values, we use TA household capital valuations data, which are undertaken by TAs to set local property taxes. Of the total capital valuation, the authority will also determine structure and land component proportions separately. The mean of the land component is reported by TAs as a proportion of the mean total valuation. Calculating the average residential land values, thus, involves simply multiplying the land component proportion by median house prices. Complications arise because these evaluations of capital value are done infrequently (roughly every three years), irregularly (the periods between evaluations are inconsistent), and also do not follow a consistent methodology across years and across TAs. We circumvent some of these issues using a simple assumption: a land component valuation holds until the next valuation is done. In other words, we assume that all median house prices in all intervening quarters are multiplied by the land component proportion at the start of the valuation period. A justification of this assumption is that, construction project costings will often use the last reported evaluation of the land component, as no better estimate is publicly available.

Construction costs are also expected to play a role in determining the supply response of housing. Construction cost indices are available for pre-defined macro-regions in New Zealand – that is, collections of regional authorities. We apply to each TA, the construction costs for the relevant macro-region, as we can safely assume that within each macro-region similar costs are incurred, such as labour and transportation costs, and workplace regulations are determined at the central government level. In addition, we also control for effects of population growth on housing supply using net immigration at the TA-level as a proxy, and also the share of apartments in planned consents.

## Methodology

The empirical analysis is carried out in two stages. In the first stage, we estimate the price elasticities of housing supply for each TA in New Zealand using a linear regression model. This allows us to sort the TAs in ascending order of their estimated price elasticities, and split them into terciles, *i.e.* groups of 22 TAs. At the second stage, we assess how TAs in each tercile respond to a surprise movement in monetary policy, by means of local linear projections, *à la* Jordà (2005), adapted to a panel data setting that also uses instrumental variables. In this manner, we can assess how monetary policy pass-through to house prices depends on supply responses.

As a baseline model specification for estimating the supply elasticities, we use an ordinary least-squares set-up with Newey-West standard errors for 66 individual regressions; thus, we estimate 66 supply elasticities. For each TA in any quarter  $t$ ,

$$y_t = \beta_0 + \beta_{hp}HP_{t-1} + \beta_{cc}CC_t + \beta_{lp}LP_t + \beta_m M_{t-1} + \beta_a A_t + \varepsilon_t. \quad (1)$$

As in Grimes and Aitken (2010), we use the natural logarithm of the ratio of consents to the housing stock per capita in the previous period as the dependent variable  $y_t$ . The regressors are: lagged inflation in real median house prices  $HP_{t-1} = \Delta \log(TA \text{ house prices}_{t-1})$ , construction cost inflation  $CC_t = \Delta \log(TA \text{ construction costs}_t)$ , land price inflation  $LP_t = \Delta \log(TA \text{ residential land values}_t)$ , lagged net migration  $M_{t-1} = \log(TA \text{ migration}_{t-1})$ , and the share of apartments in total consents  $A_t$ .  $\varepsilon_t$  is a residual error term that is assumed to be normally distributed. We estimate Equation (1) for the period 1996Q1-2021Q1.

The coefficient that we are particularly interested in is  $\beta_{hp}$  that represents the supply response ( $y_t$ ) to lagged house price inflation ( $HP_{t-1}$ ). It is important to note two aspects of the relationship between housing supply and house prices that we estimate here, that distinguishes it from the simple theoretical model presented in Figure 2. Firstly, we consider the *change*, *i.e.* inflation, in the (real) house price rather than the level. This is because the data series on house price levels are not stationary. Secondly, using the lagged value rather than the contemporaneous value of house price inflation is a strategy that we have adapted from Green, Malpezzi and Mayo (2005), in order to avoid issues related to endogeneity. We calculate 66 supply responses, and then group them into terciles.

To measure the effects of monetary policy changes on house prices in each tercile, we use estimates of monetary policy surprises compiled by Bernhard and Leong (2022). They extract high-frequency monetary policy surprises from daily changes in financial market variables, including 1-month and 3-month Bank Bills and 3-month Bank Bill futures (two to four quarters ahead). They

cover all monetary policy announcements in Monetary Policy Statements, Official Cash Rate (OCR) Reviews (Monetary Policy Reviews as of 2020) and unscheduled decisions from 1999 to 2021.<sup>3</sup>

**Table 1: Data**

Data series	Source	Area-level	Transformation
Median house price level	Ministry of Housing and Urban Development	TA	Real, logarithmic differences
House price index	REINZ	TA	Real, logarithmic differences
Construction costs	New Zealand building economist	Regional applied to TA	Logarithmic differences
GDP per capita	Statistics NZ	National	Logarithmic differences
Housing stock	Statistics NZ	National	Logarithms
Consents	Statistics NZ	TA	Logarithms
Apartments as a proportion of consents	Statistics NZ	TA	-
Residential land value	Ministry of Housing and Urban Development	TA	Logarithmic differences
Population	Statistics NZ	National	-
Permanent and long term net migration	Statistics NZ	TA	Logarithms

To avoid the obvious problems with endogeneity that arise when house prices are positioned as a function of the OCR, we adopt an instrumental variable (IV) framework. We use the aforementioned monetary policy surprises as an IV for changes in the monetary policy rate (OCR). For each tercile, the impulse response functions generated using an extension of the local linear projection technique of [Jordà \(2005\)](#). The model specification is as follows:

$$DP_{i,t+h} = \alpha_{i,h} + \sum_{q=1}^4 \kappa_{h,q} y_{i,t-q} + \sum_{q=1}^4 \mu_{h,q} M_{i,t-q} + \sum_{q=1}^4 \delta_{h,q} DP_{i,t-q} + \sum_{q=1}^4 \theta_{h,q} R_{t-q} + \eta_{i,t+h}, \quad (2)$$

for  $h = 0, 1, 2, \dots, s$ .

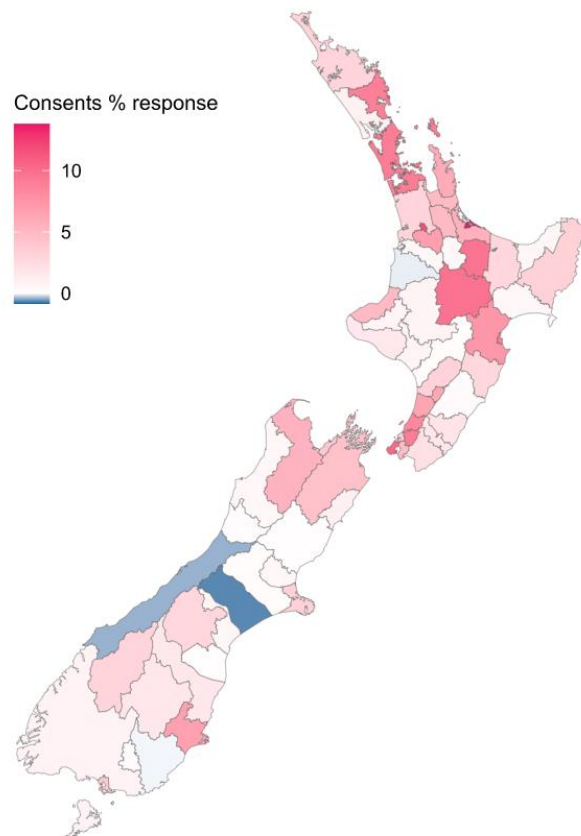
<sup>3</sup> See also [Bernhard, Graham and Markham \(2022\)](#) for more details of the estimated monetary policy surprises as well as an application that assesses monetary policy pass-through to retail mortgage rates.

The subscript  $i$  denotes the relevant TA and  $h$  denotes the length of forecast horizons from 0 to the maximum of  $s$ . Our dependent variable is inflation in the real median house price for each TA,  $h$  quarters ahead and is indicated by  $DP_{i,t+h}$ . The constant term  $\alpha_{i,h}$  measures the fixed effect for the TA for the relevant horizon. The other regressors include 4 lags each of (a)  $y_{i,t} = \log\left(\frac{\text{consents}_{i,t}}{\text{housing stock per capita}_{t-1}}\right)$ , the TA-specific supply measure used in the first step of the analysis (b)  $M_{i,t}$ : net migration to each TA which capture the impact of population changes (c)  $DP_{i,t}$ : inflation in the real median house price and (d)  $R_t$ : the monetary policy surprises which are used as the instruments for the change in the OCR. The symbols  $\kappa$ ,  $\mu$ ,  $\delta$  and  $\theta$  are the respective coefficients that will also vary across each forecast horizon, and  $\eta$  is a normally distributed error term. Since the time series for the estimated monetary policy surprises begins only after the OCR was introduced in 1999 and a few data-points are omitted due to the lag structure, the sample size is shorter for the estimation of Equation (2); the sample spans the period 2000Q3-2021Q1.

## Results

Figure 3 visualises the key results from the first stage of our analysis; estimates of the price elasticity of housing supply ( $\beta_{hp}$  in Equation 1) across all the TAs. The price elasticities underpinning the figure are presented in Table 2 that groups the estimates in each tercile in separate columns. Most of the price elasticity estimates are positive as expected, and about a third of the estimates are statistically significant. The few estimates that are found to be negative are also statistically insignificant.

**Figure 3: A geographic representation of the price elasticities of housing supply in New Zealand**





**Table 2: Estimates of the price elasticity of housing supply across New Zealand TAs**

LOW ELASTICITY (-0.006 – 0.0081)		MEDIUM ELASTICITY (0.0086 – 0.044)		HIGH ELASTICITY (0.048 – 0.138)	
Ashburton_District	-0.00649	Southland District	0.00862	Lower Hutt City	0.0475
Kawerau District	-0.00524	Kaipara District	0.00961	Hauraki District	0.0478***
Westland District	-0.00411	Kaikoura District	0.01	Matamata Piako District	0.0491*
Waitomo District	-0.000862	South Taranaki District	0.0156	New Plymouth District	0.0491*
Clutha District	-0.000467	Carterton District	0.0168	Tasman District	0.055**
Waimate District	0.00063	Waitaki District	0.0168*	Western Bay of Plenty District	0.0552**
Hurunui District	0.00117	Central Otago District	0.017	Thames Coromandel District	0.0597**
Grey District	0.00205	Masterton District	0.0197	Palmerston North City	0.0614
Rangitikei District	0.00219	South Wairarapa District	0.0216*	Horowhenua District	0.0637*
Selwyn District	0.00219	Central Hawkes Bay District	0.0278**	Dunedin City	0.0669*
Gore District	0.00341	Whakatane District	0.0286**	Waipa District	0.0686*
Tararua District	0.00342	Mackenzie District	0.0286**	Hastings District	0.0738***
Otorohanga District	0.00511	Waikato District	0.0302*	Kapiti Coast District	0.0833*
Wairoa District	0.00546	Far North District	0.0312**	Napier City	0.0887**
Buller District	0.0055	Queenstown Lakes District	0.0312	Whangarei District	0.0891***
Waimakariri District	0.00567	Manawatu District	0.0318	Upper Hutt City	0.0905***
South Waikato District	0.00595	Gisborne District	0.0326	Auckland	0.0911
Timaru District	0.00659	Christchurch City	0.0333	Rotorua District	0.0957***
Opotiki District	0.00686	Porirua City	0.0342	Taupo District	0.0974***
Stratford District	0.00754	Invercargill City	0.0374	Wellington City	0.103**
Wanganui District	0.00771	Nelson City	0.0395	Hamilton City	0.118***
Ruapehu District	0.00805	Marlborough District	0.0439**	Tauranga City	0.138***

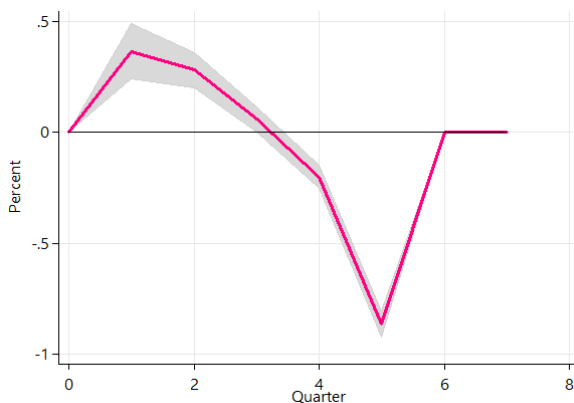
Note: The superscripts '\*', '\*\*' and '\*\*\*' denote statistical significance at the 10%, 5% and 1% level.

The majority of the TAs which show higher price elasticities are in the North Island. At the upper end of the spectrum are urban centres such as Tauranga, Hamilton and Wellington with estimates of 14%, 12% and 10% respectively. [Green, Malpezzi and Mayo \(2005\)](#) also report considerable variation in the price elasticities of supply estimated using more granular data, in their case, at the level of US metropolitan statistical areas; from -0.30% for Miami to 29.9% for Dallas. We also assess the price elasticity of national-level housing supply in New Zealand by estimating a panel version of [Equation 1](#). Our estimate of 1.66% is somewhat higher than the value of 1.1% obtained by [Grimes and Aitken \(2010\)](#).

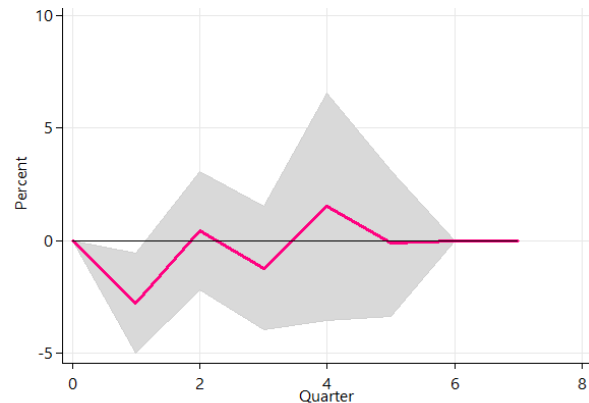
[Figure 4](#) presents the results for the second stage of our analysis, the house price dynamics triggered by a surprise monetary policy contraction in the 3 groups of TAs. We comment only on those dynamic responses that are statistically significant at the 5% level. The Official Cash Rate rises to about 40 basis points one quarter after the shock ([Figure 4a](#)). In the upper tercile, the monetary contraction triggers a decline in the real median house price of about 3.2% ([Figure 4b](#)) after a quarter. In the middle and lower terciles, the real median house prices decline by 15.4% ([Figure 4c](#)) and 17.2% ([Figure 4d](#)) respectively, both a year after the shock.

**Figure 4: Dynamics to a positive 1 unit monetary policy shock**

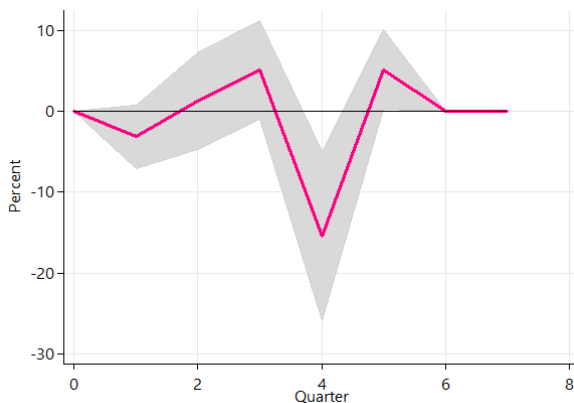
a. OCR



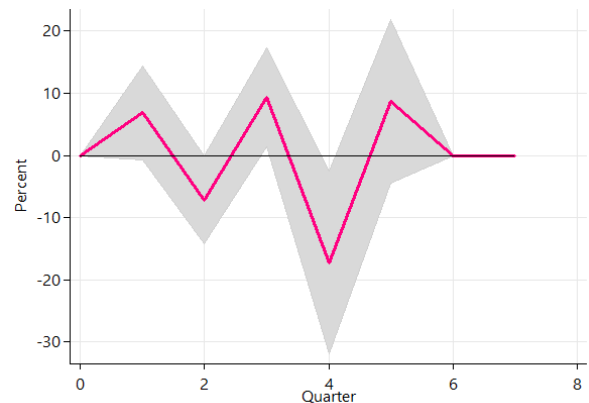
b. Real median house price in the upper tercile



c. Real median house price in the middle tercile



d. Real median house price in the lower tercile



Note: The mean of the impulse response functions and the 95% confidence bounds are plotted above. The terciles are based on the estimated price elasticities of supply.

The dynamics in Figures 4b through 4d confirm the intuition from economic theory; when housing supply responds sluggishly to price signals, a given stimulus to housing demand caused by monetary policy will generate a stronger response in house prices.

In order to assess the robustness of results at both stages of our analysis, we estimated several variants of our baseline models. When we experimented with house price indices rather than levels, the estimated elasticities were much more volatile and unrealistically large at times. We also tried to estimate the supply elasticities using an IV approach, but the candidate variables did not pass the relevant statistical tests for weak instruments. Finally, we also estimated the housing supply equations without controlling for the effects of migration and the share of apartments in each TA. These alterations did not change our results substantially.

At the second stage, when we assess monetary policy effects, we tried the panel local projection-IV estimation with different variables, included population and unemployment instead of migration. However, the relevant coefficients were not statistically significant. Also, including GDP as the economic activity variable did not change the results noticeably. Finally, we grouped the TAs differently, separating the TAs with statistically insignificant price elasticities of housing supply from those that showed statistically significant price elasticities. Again, the qualitative flavour of the baseline results was preserved.

## Summary

House prices are expected to respond more to monetary stimulus when housing supply is less responsive to prices. In this *Note*, we find support for this view in an empirical framework that uses data for New Zealand's 66 territories. We consider an unanticipated increase of 40 basis points in the Official Cash Rate. The median real house price declines by only 2.8% in the group of territories with the most responsive housing supply, and by 17.2% in the group of territories with the least responsive housing supply.

We have focussed on intra-national differences in the house price responses to monetary policy in order to understand the role of housing supply rigidities. The high variability of the data we obtained at the territorial level contributes to the high volatility that we observe in the estimated house price dynamics. Chadwick and Nahavandi (2022) estimate the monetary policy effects on the real house price at the national level, a measure that is much smoother than data available at the disaggregated level. They emphasise that the impact of monetary policy surprises on house prices at the national level in New Zealand is moderate.

A caveat to our results is that the estimates of the price elasticities of supply are based on the empirical strategy of [Green, Malpezzi and Mayo \(2005\)](#) who use the lagged value of house price inflation in order to circumvent issues related to endogeneity. An alternative identification scheme to address the endogeneity concerns would be to find suitable candidate data series to support an instrumental variables approach. Another potential direction to take would be to trace the sources of variation in territorial housing supply elasticities, disentangling the contributions of geographical or regulatory constraints. We leave these extensions for future research.

## References

- Aastveit, K.A., Albuquerque, B. and Anundsen, A. (2020). 'Changing supply elasticities and regional housing booms'. *Bank of England Staff Working Paper* 844. Forthcoming in the *Journal of Money, Credit and Banking*.
- Aguiar Carvalho, P., Baker, B., and Farquharson, A. (2022). 'Housing as an investment asset in New Zealand: Looking at risk-adjusted portfolio choices'. *Reserve Bank of New Zealand Analytical Notes* AN2022/07.
- Albuquerque, B., Iseringhausen, M. and Opitz, F. (2020). 'Monetary policy and US housing expansions: The case of time-varying supply elasticities'. *Economics Letters* 195(C), 109471.
- Bell, M. (2021). 'Five to seven years' to fix housing supply problem'. [www.stuff.co.nz](http://www.stuff.co.nz) (May 9).
- Bernhard, S. and Leong, J. (2022). 'Unconventional monetary policy shocks for New Zealand and their impact on financial markets and the real economy'. *Reserve Bank of New Zealand Discussion Paper* (forthcoming).
- Bernhard, S., Graham, J. and Markham, S. (2021). 'Monetary policy pass-through to mortgage rates'. *Reserve Bank of New Zealand Analytical Notes* AN2021/07.
- Bradford, K. (2021). 'Data proves lack of supply is driving New Zealand's housing crisis'. [www.1News.co.nz](http://www.1News.co.nz) (Feb 4).
- Brunton, M. (2021). 'Measures for assessing the sustainability of house prices in New Zealand'. *Reserve Bank of New Zealand Analytical Notes* AN2021/08.
- Brunton, M. and Jacob, P. (2022). 'New Zealand house prices and the decline in longer-term financing costs'. *Reserve Bank of New Zealand Analytical Notes* AN2022/10.
- Chadwick, M., and Nahavandi, A. (2022). 'How does monetary policy affect the New Zealand housing market through the credit channel?'. *Reserve Bank of New Zealand Analytical Notes* AN2022/09.
- Fitchett, H. and Jacob, P. (2022). 'How do we stack up? The New Zealand housing market in the international context'. *Reserve Bank of New Zealand Analytical Notes* AN2022/06.
- Green, R.K., Malpezzi, S., and Mayo, S.K. (2005). 'Metropolitan-specific estimates of the price elasticity of supply of housing, and their sources'. *American Economic Review* 95(2), pp.334-339.
- Grimes, A. and Aitken, A. (2010). 'Housing supply, land costs and price adjustment'. *Real Estate Economics* 38(2), pp.325-353.
- Holston, K., Laubach, T. and Williams, J.C. (2017). 'Measuring the natural rate of interest: International trends and determinants'. *Journal of International Economics* 108(S1), pp.59-75.
- Jorda, Ò. (2005). 'Estimation and inference of impulse responses by local projections'. *American Economic Review*, 95(1), pp.161-182.

New Zealand Infrastructure Commission (2022). 'The decline of housing supply in New Zealand: Why it happened and how to reverse it'. *Te Waihangā Research Insights*. Wellington: New Zealand Infrastructure Commission / Te Waihangā.

New Zealand Productivity Commission (2012). Housing Affordability Inquiry.

Orr, A. (2021). 'Housing matters'. *Reserve Bank of New Zealand speech* delivered to the Property Council of New Zealand Retail Conference (Nov 2).

Reserve Bank of New Zealand (2021). Monetary Policy Statement August 2021.

Watson, E. (2013). 'A closer look at some of the supply and demand factors influencing residential property markets'. *Reserve Bank of New Zealand Analytical Notes* AN2013/11.

Woods, M. (2021). 'Resource Management (Enabling Housing Supply and Other Matters) Amendment Bill — First Reading'. The New Zealand Parliament.