Master

Applied Econometrics and Forecasting

Master's Final Work

Dissertation

INTERACTIONS OF MONETARY AND MACROPRUDENTIAL POLICIES IN NEW ZEALAND: A SVAR ANALYSIS

Garikai Zvinavashe

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Supervision:
Professor Gabriel Florin Zsurkis

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Glossary

ADF – Augmented Dickey-Fuller.

CPI – Consumer Price Inflation.

CRD – Credit to Private Non-financial Sector.

DSGE – Dynamic Stochastic General Equilibrium.

LTV – Loan-to-value limits.

MaPP – Macroprudential Policy.

MP – Monetary Policy.

PP – Property Prices.

PR – Policy rate.

RGDP – Real Gross Domestic Product.

SVAR – Structural Vector Autoregressive.

VAR – Vector Autoregression.

VECM – Vector Error Correction Model.

ZLB – Zero Lower Bound.

ABSTRACT

The primary objective of this research paper is to investigate the interactions between monetary and macroprudential policies to achieve macroeconomic and financial stability, particularly housing prices within the context of New Zealand, an inflation-targeting economy. Employing a Structural vector autoregression model with quarterly data from 2000 to 2023, we analyse the transmission mechanisms of these policies and their combined impacts.

Findings suggest that contractionary monetary policy shocks, which hike policy rates, will decelerate economic activity and price levels (disinflation) but unexpectedly exacerbate real credit growth. Conversely, an expansionary macroprudential policy shock, which increases loan-to-value limits, will boost real credit and output in the short term. Additionally, both policy shocks result in higher property prices, which suggests evidence of wealth effects. These results are robust across the identification schemes, which are Choleski decomposition, long-run restrictions, and sign restrictions. Therefore, our study underscores the need for coordinated monetary and macroprudential policies to achieve both price and financial stability, cautioning against using monetary policy to directly address financial stability concerns.

KEYWORDS: Macroprudential Policy; Monetary Policy; Financial Stability; Price Stability; Choleski.

JEL CODES: E52; E58; G28.

RESUMO

O objetivo principal deste artigo de pesquisa é investigar as interações entre políticas monetárias e macroprudenciais para alcançar a estabilidade macroeconómica e financeira, particularmente os preços da habitação no contexto da Nova Zelândia, uma economia com um regime de metas de inflação. Utilizando um modelo VAR estrutural com dados trimestrais de 2000 a 2023, analisamos os mecanismos de transmissão dessas políticas e seus impactos combinados.

Os resultados sugerem que os choques da política monetária contracionista, que aumentam as taxas de juro, desaceleram a atividade económica e os níveis de preços (desinflação), mas surpreendentemente agravam o crescimento real do crédito. Por outro lado, um choque de política macroprudencial expansionista, que aumenta os limites de crédito à habitação, impulsiona o crédito real e a produção a curto prazo. Além disso, ambos os choques de política resultam em preços de imóveis residenciais mais elevados, o que sugere evidências de efeitos de riqueza. Estes resultados são robustos em todos os esquemas de identificação, que incluem a decomposição de Choleski, restrições de longo prazo e restrições de sinal. Portanto, o nosso estudo sublinha a necessidade de políticas monetárias e macroprudenciais coordenadas para alcançar tanto a estabilidade de preços como a estabilidade financeira, alertando contra o uso da política monetária para abordar diretamente as preocupações sobre a estabilidade financeira.

PALAVRAS-CHAVE: Política Macroprudencial; Política Monetária; Estabilidade Financeira; Estabilidade de Preços; Choleski.

JEL CODES: E52; E58; G28.

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1. Introduction

In the aftermath of the global financial crisis (GFC), achieving financial stability has been sacrosanct, following the consensus that the prevailing objective of monetary policy to attain price stability is inadequate to achieve the key goal. In this context, financial stability risks or systemic risks stemming from financial markets taking excess risk will be contained by macroprudential policy (Galati & Moessner, 2013). As such, research on ensuring financial stability and sustainability has surged over time.

Empirically, the research on the interactions between the two policy tools is still relatively budding, as monetary policy has been around longer than macroprudential policy. Scholars have pointed out a key limitation of monetary policy within the inflation-targeting framework, thus its inability to address both price and financial stability simultaneously (Kim & Mehrotra, 2017). This issue arises because monetary policy overlooks systemic risk developments, leading to the unchecked accumulation of financial vulnerabilities over time (Aikman et al., 2019). To counter this shortfall, scholars argue that each policy has its objectives and instrument sets that can be used to achieve its respective goals via its transmission mechanisms into the economy. Fortunately, because the policies may share the same transmission mechanisms, this helps leapfrog towards considering the coordination and interaction of monetary (MP) and macroprudential (MaPP) policies (Beau et al., 2012). Albeit, while the integration of macroprudential policy has helped strengthen financial stability, research highlights a potential trade-off between monetary and macroprudential policies, influencing both price stability and financial stability (Guibourg et al., 2015).

New Zealand presents a unique and compelling case study as it has one of the most advanced financial systems among inflation-targeting economies, characterised by a well-developed banking sector and comprehensive macroprudential policy measures. Since the early 2000s, New Zealand has shown an interest in implementing interventions that resemble, in some form, what would be referred to now as macroprudential, crucially highlighting the timeline as being the pre-global financial crisis. The idea was to alleviate the pressures of monetary policy and exchange rate overvaluation stemming from high capital mobility. At this time, the economy was riddled with a boom in the housing market as well, as an “informal” policy that could address domestic demand was in the books, such as loan-to-value ratios (Basel, 2006). After the global financial crisis with all its ramifications, credit conditions tightened up straight after the crisis. However, credit supply began to increase towards 2011 due to the low crisis era interest rates, which consequently led to an upward trend in property prices. These efforts have become more pronounced following the GFC, with the implementation of measures such as mortgage stress tests, capital buffer requirements, and borrower-based constraints to safeguard the financial system. Macroprudential policies were intentionally curated to address cyclical movements by leaning against procyclicality. Additionally, as a prominent inflation-targeting economy, New Zealand boasts a transparent and well-rounded monetary policy framework, which is well-tested. In summary, New Zealand provided the perfect case study for these interactions because of its significantly booming property market, transparent monetary policy, and discretionary approach to implementing macroprudential policies.

To study macroprudential policy tools in response to the global financial crisis to address systemic risk, given the pre-existing monetary policy, this paper will then focus on answering the following research questions:

1. What are the transmission mechanisms that macroprudential policy instruments will utilise to impact the economy?
2. What are the combined impacts of these policies on macroeconomic and financial stability?
3. How will policy shocks affect property prices?

Against this backdrop, this paper examines the real and financial effects of the interaction between monetary and macroprudential policies in New Zealand from 2000 to 2023, using a Structural Vector Autoregression (SVAR) model to address the three research questions. Firstly, it would be imperative to understand the theoretical channels through which macroprudential policies will pass through into the economy. This paper focuses on the borrower/asset-based tools of macroprudential policy, such as loan-to-value limits, debt-serving-ratios and loan-to-income ratios. These impositions on income positions ensure that financial institutions instil lending standards against bank balance sheets and avoid scenarios of excessive credit provision, such as during the global financial crisis. Lending institutions, in the face of tighter requirements, tend to be more risk-averse and reduce credit provision, which in turn insulates them from the adverse risk effects of asset price uncertainty.

Secondly, the paper considers how these two policy instruments might affect the economy, specifically what happens to macroeconomic and financial aggregates such as output, inflation, credit growth rates, and asset prices in response to the policies. This also involves acknowledging that the two policy tools may impact each other beyond their target variables. There is a chance that macroprudential policies could ultimately dampen or improve the effects of a monetary policy intervention. BIS (2010) provide insight that not only do macroprudential policies mitigate risk and financial vulnerabilities, they have a side-effect to "sponge up" the severity of financial shocks to monetary policy and economic activity as well.

Thirdly, we seek to address the asset prices and wealth transmission mechanism channel from these policy tools, as we assume that property prices, as a proxy for asset prices, provide a good starting point to attempt to understand events of the 2008 financial crisis and how to avoid them, especially given the COVID-19 crisis. The wealth effect generally postulates that due to people's perceptions, an asset price change driven by a policy change will impact their wealth. This will be addressed later in the paper when property prices are included in the model as a target variable, mainly for the loan-to-value limit and policy rate.

This study contributes to the literature by analysing monetary and macroprudential policies within a SVAR framework, focusing on New Zealand as a small open economy. Other contributions to the literature involve the testing of multiple identification strategies to reconcile conflicting findings, and modelling property prices as a transmission channel is underexplored in the SVAR framework.

As in other research, this study attributes credit to the non-financial sector as a representation of the overall financial system and uses average loan-to-value ratios to capture the systemic effects of macroprudential measures. The findings suggest that both monetary and macroprudential policies significantly impact output, price levels, and financial stability. The results indicate that these policies ought to be coordinated rather than implemented in isolation.

Additionally, the findings reveal a potential leverage cycle in the short-medium term, as shown by the positive property price and persistent credit growth. Leverage cycles are formerly defined as the self-reinforcing feedback loop mechanism between credit growth and asset prices, which more often lead to financial instability (Geanakoplos, 2009).

The remainder of this study is structured as follows: The next section provides a comprehensive literature review, followed by an explanation of the data and methodology. The results are then presented and discussed, leading to the study's concluding insights.

2. Literature Review

Overview

Following the aftermath of the global financial crisis, there has been a growth in interest regarding the effectiveness of monetary and macroprudential policies in addressing their objectives of ensuring price and financial stability (Galati & Moessner, 2013). Additionally, it highlights how the ability of the policies to succeed is influenced by their transmission mechanisms (Agénor & da Silva, 2019).

2.1. Theoretical Review

A substantial corpus of evidence establishes the interactions and coordination of monetary and macroprudential policy. Most of this evidence is found in advanced countries, but lately, emerging and developing countries have increased in the literature documenting these linkages. Theoretically, literature sought to address whether the policies are substitutes or complementary, considering that they seek to address different objectives.

Macroprudential policy was developed with the main intention of combating credit-fuelled asset price bubbles, managing financial vulnerabilities and overall ensuring stability in the financial system, safeguarding against systemic risk (Carreras et al., 2016) In a general sense, these prudential tools monitor measures of risks in the financial cycles, where these risks could be described as structural or cyclical (Aikman et al., 2019). Conducted through the three broader categories of prudential instruments, namely: capital-based, asset-based and liquidity-based. Capital-based measures focus generally on banks' capital, and they include tools such as capital ratios, countercyclical capital buffers and leverage ratios. Asset-based measures focus on restrictions on bank balance sheet positions, and they include tools like loan-to-value ratios and debt-to-income ratios. Finally, the liquidity-based instruments are targeted towards the protection of banks from over-exposure due to financing and not having adequate liquid assets. In essence, the capital and asset-based measures aim to address cyclical risk, whilst the liquidity-based measures are more focused on structural risk, since their instruments are a component of the Basel III framework (Carreras et al., 2016).

Before the global financial crisis, monetary policy had a clear objective, which was to address price stability. Additionally, monetary policy was to only address asset price fluctuations in the event of them affecting inflation and output (Kohn, 2008). In the advent towards the global financial crisis, monetary policy also advanced with the adoption of inflation targeting schemes (Mishkin, 2011). However, when the crisis struck, it became quite evident that monetary policy was not sufficiently equipped to address the financial distress. This led to the perspective of monetary policy shifting from only addressing price stability but a broader perspective of the financial system. This meant the inception of the literature that supported monetary policy taking a more "lean against the wind" approach than the reactive approach (Mishkin & others, 2011). The argument behind this literature posits that only addressing price stability without considering the financial system at large would lead to over-exposure by economic agents driven by over-inflated optimism about the economy (Cecchetti, 2000). Therefore, the interdependence of monetary and macroprudential policy led to the probability of there being accommodations and spillovers between the policy instruments.

Scholars have argued that monetary and macroprudential policies can be complementary if and only if they are coordinated properly. Under this narrative, macroprudential policy serves the purpose of counterbalancing the risks that may arise from monetary policies that may be too accommodative, notably in the face of asset price bubbles or periods of excessive credit growth. Borio (2014) posits that the complementarities between the policies are clear-cut, with macroprudential policy 'mopping up' the financial risks that monetary policy cannot address alone. Agénor & Silva (2019) also highlight that monetary policy ought to primarily focus on price and output stability, whilst macroprudential policy focuses on achieving financial stability.

Additionally, macroprudential tools like loan-to-value ratios have the potential to curb and mitigate the unintended effects of monetary policy tightening (Angelini et al., 2011). Furthermore, macroprudential policy could assist monetary policy with its output goals, while simultaneously achieving its own goal of financial stability (N'Diaye, 2009).

Additionally, empirical studies have provided robust evidence that supports the notion that macroprudential policies are complementary to monetary policy due to their ability to mitigate financial risk. Wright et al. (2015) postulate that these prudential tools will aid in smoothing credit supply shocks, while Ozkan & Unsal (2014) highlight the welfare benefits of coordination. Ghosh, Ostry & Chamon (2016) further find that in the absence of macroprudential policy, monetary policy runs the risk of exacerbating financial cycles and consequently asset-price bubbles.

Jiang et al. (2019), whilst studying the coordination between the two policies, but primarily driven to only control for the housing prices, found that the prudential policy would sweep up after the monetary policy to deal with the shocks. Their paper adds to the scarce literature that focuses on the effects of changing cycles on the coordination of policies. Concerning our study, we target macroprudential measures that affect the household's demand for housing credit using instruments such as loan-to-value limits and maximum debt-to-service income ratios. Thus, this body of research advocates for a policy framework that employs both instruments to achieve its objectives.

2.2. Empirical Review

Literature regarding the affordability constraint

In this paragraph, we highlight the papers evaluating the potential coordination of monetary and macroprudential policies using loan-to-value limits as the borrower-based macroprudential instrument. These would directly affect the scale of borrowing, affecting households' demand for housing and housing prices. One such study with a household and banking sector estimated a dynamic stochastic general equilibrium (DSGE) model and found that the macroprudential tools would reduce systemic risk by curbing overleveraging, thereby achieving their financial stability objective (Wan,2018). Such policy coordination could also have the effect of steadying housing prices and improving the broader economy (Pan & Zhang, 2020). However, Gelain et al. (2012) point to such policy coordination having a perverse impact on inflation and other macroeconomic variables. Based on cross-country and panel studies where the macroprudential policy tool included loan-to-value limits, Martin et al.(2021) found that macroprudential policy tools mitigate systemic risk by handling the growth of credit, leverage and house-based price inflation. Cerutti et al.(2017), with a dataset of more than 100 countries, find that though macroprudential policies can address credit booms and asset prices, their effects are dependent on monetary policy. This finding suggests that the effectiveness of the policy tools is not always isolated, and one tool could affect the magnitude of another on the target variables. In a nutshell, the paper suggests that monetary policy implementation has to be accommodative of macroprudential policy, and this challenges the notion of policy independence.

When considering the debt-service-income ratios, scant research is centred around these specific macroprudential policy tools. Some literature addresses them, but only in a model that includes the household sector. One finding suggests that the policy tool would have the effect of smoothening responses to shocks (Ingholt & others, 2018). Greenwald (2018) focused on the transmission mechanism channels and found that the affordability constraint instrument and monetary policy instruments would have shared channels that are better at achieving financial stability. This further justifies the addition of such a tool to the macroprudential toolbox. However, our paper's model does not have much extensive workaround for policy coordination.

The empirical work that focuses on the impact of asset-based policies on credit and housing is quite limited and heavily debated. One of the main drawbacks of the studies is that they impose the policy tools during times when the markets were very volatile, and also include shorter time ranges. Igan & Kang (2011) investigated the effects of loan-to-value limits in the context of Korea, which is another inflation-targeting small open economy. They found that a contractionary macroprudential policy shock will delay the increase in economic activity and house prices, with higher effects for output. However, they also find that an expansionary macroprudential shock will not significantly affect both output and house price inflation. In support of no significant effects, Wong et al.(2011), with evidence from Hong Kong, show that a contractionary loan-to-value limit has little to no impact on the house price increase, suggesting market-specific factors may have diluted the efficacy of policy tools. Conversely, Kuttner & Shim (2012), using a panel of 60 countries, suggest that not only does tightening loan-to-values curb credit growth by 1-2%, but they also have a significant effect on house prices, especially in the long term; the effects were more pronounced.

Although earlier empirical research has primarily implemented the VAR methodology to model and identify policy effects, there is a growing practice in implementing DSGE models. One potential reason is the ability to calibrate and experiment with different policy regimes more easily. The first example of literature is set in a zero lower bound (ZLB) environment using a DSGE model and finds that unconventional monetary policy will alter the interaction of the policies, especially in the face of a liquidity (Ferrero et al., 2018). Millard et al.(2024) integrate these affordability constraints into the pre-existing Gertler & Karadi (2011) banking frictions models, and find that this will reduce the need for monetary policy to react to such shocks, although it may be supportive. Modelling in such environments has been shown to be essential, as periods around the ZLB were rife with unconventional monetary policy decisions. The other strand of literature builds on the premise that macroprudential and monetary policy do not coordinate or interact. Gelain & Ilbas (2017), for example, utilise a two-period (overlapping generations) model, where individuals consume and buy houses in the first period and then in the second period, the individuals sell the houses to fund consumption and find that credit controls could independently cool down housing demand. In support, Kuttner & Shim (2016)posit that contractionary prudential instruments will inevitably lead to a decline in credit demand. Iacoviello (2015) represents the empirical work that replicates the DSGE framework but using the VAR methodology to assess the impulse responses, with output, house prices, price inflation and the federal fund rate and found that monetary policy shocks impacted the United States housing market.

3. Data Description

To investigate the macroeconomic scene in this small open inflation-targeting economy, especially to capture the aftermath of the 2008 crisis and the 2019 COVID period, the sample extends quarterly data from Q1:2000 to Q4:2023. The choice of data duration was based solely on the availability of average loan-to-value limits data, where the series for New Zealand started implementing limits in the year 2000, like most inflation-targeting economies. In line with Kim & Mehrotra (2017), this study employs a logarithmic transformation to the real gross domestic product, consumer price index, property price and real credit, but loan-to-value and policy rates are left in levels. The estimation of the model will also be in levels, and since we include the two potential crisis period dates in our sample, we will use Monte-Carlo standard error bands for our impulse responses. Table I and Figure 1 will sufficiently provide some definitions, source information and visualisation of the data used in the study.

TABLE I – DATA DEFINITION

Variable	**Definition**	**Source**
RGDP	Seasonally adjusted, volume index (2015=100), log-transformed	Organisation for Economic Cooperation and Development
Credit	Credit from all sectors to the Private non-financial sector, log-transformed	Bank of International Settlements
CPI	Consumer price index: All items (2010 = 100), log-transformed	Organisation for Economic Cooperation and Development
PP	Residential property price index (2010 = 100), log-transformed	Bank of International Settlements
LTV	Average Loan-to-Value limit	Integrated macroprudential policy database
PR	Policy/Official Cash Rate	Reserve Bank of New Zealand

Note: RGDP = Real gross domestic product, PR = Central bank policy rate. Following Alam et al. (2019) closely, the variable LTV is the average limit recorded per month and country, regarding mortgage loans.

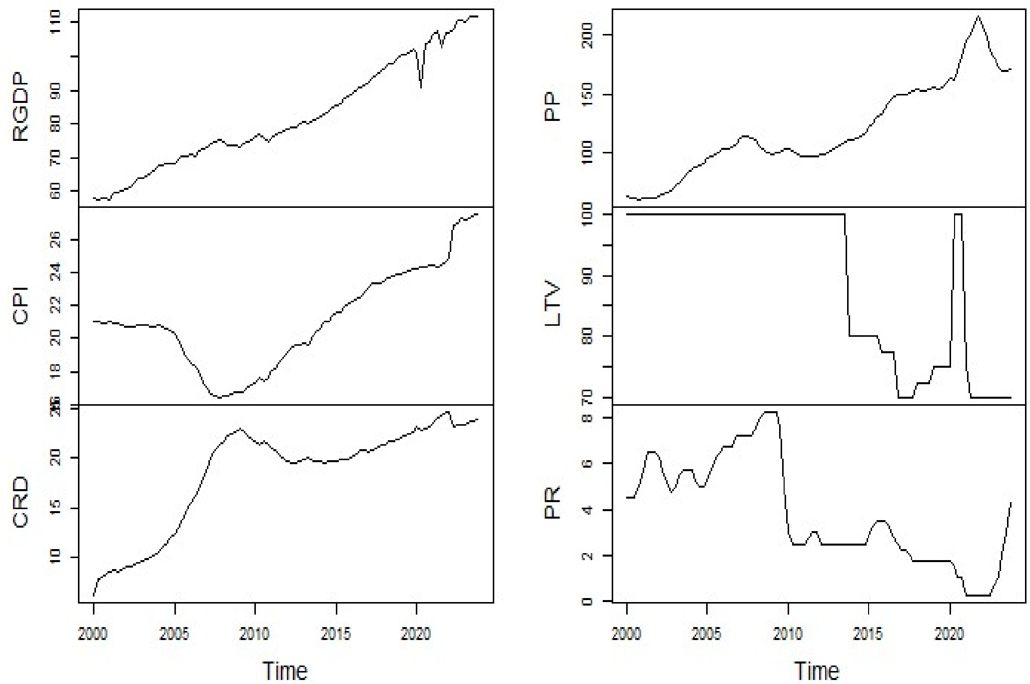

FIGURE 1 – Observable Variables.

4. METHODOLOGY

To empirically investigate the interaction between monetary and macroprudential policies and their effects on output, prices, and financial stability, this study employs a Structural Vector Autoregressive (SVAR) model. The SVAR framework is particularly suited for this analysis because it allows for the identification of structural shocks and the dynamic interrelationship among multiple macroeconomic variables without imposing strong theoretical assumptions. Unlike the reduced-form VAR, which only captures statistical correlations, SVAR models utilise economic theory to impose identifying restrictions that help infer causal relationships. Where these identifying restrictions on the estimated reduced-form model are fundamentally based on theory, and as such, a structural form can be attained. Additionally, as these are multivariate-based models, all the variables are considered to be endogenous and hence a simultaneously estimated system (Sims & Zha, 2006).

Model specification

The general structural form of the SVAR model is represented as:

(1) $$Ay_t = c + A*_1 y_{t-1} + \ldots + A*_p y_{t-p} + \varepsilon_t$$

Where $t \in \{1, 2, \ldots, T\}$

Y_t is a N x 1 vector of endogenous macroeconomic variables in period t, A is a matrix capturing contemporaneous structural relationships among the variables, then $A*_1$, $A*_2$,.., $A*_p$ is a K x K lag polynomial matrix of structural coefficients, ε_t is a vector of structural shocks assumed to be serially uncorrelated, and c is a K x 1 vector of constant terms. The diagonal elements of the variance-covariance matrix denote the variance of the structural disturbances, and the off-diagonals are the covariances. The structural VAR cannot be estimated directly using OLS due to the contemporaneous attributes in the A matrix. Hence, a reduced form VAR will be estimated, and certain identification assumptions are then imposed such that structural properties of the economy can be recovered. We estimate the following reduced-form VAR:

(2) $$y_t = v + A_1 y_{t-1} + \cdots + A_p y_{t-p} + u_t$$

$$A(L)yt = v + u_t$$

Where $A(L)$ is the matrix polynomial in the lag operator L, u_t is the vector of reduced form residuals, and v is a K x 1 vector of constant terms. To be able to recover the structure of the economy, restrictions are imposed on the A matrix, and the parameters are recovered from the estimated reduced form Equation (2).

Regarding inflation-targeting economies, Kim & Mehrotra (2017) utilise a panel VAR model to study the effects of interacting monetary and macroprudential policy with the Choleski decomposition as the identification strategy, which this paper follows closely. The recursive factorisation/choleski decomposition is an identification strategy that was first coined in 1989, where the timing assumptions place the most endogenous variable last in the ordering and the most exogenous first (Sims, 1989). The three main macroeconomic variables will be the real GDP (rgdp), consumer price index (cpi) and total credit to private non-financial sectors (crd), and the policy tools will be policy rate (pr) for monetary policy and for macroprudential policy, which is the average loan-to-value ratio (ltv) as used in Alam et al. (2019). Using this approach towards the macroprudential tool in the study is a slight deviation from the other literature, which uses a dummy type of instrument (Kim & Mehrotra, 2017).

Modelling loan-to-value limits using a dummy index requires transforming the variable into binaries to represent periods of either tightening or easing instead of using the limit value. However, for our paper, using the average limit values allowed us to model the variable continuously for better economic interpretability and infer the precision and intensity of the policy tool. Additionally, unlike the binary index that mostly shows policy tightening, the continuous nature allows us to model both tightening and easing. The key assumption in the variable selection is that the monetary policy tool will seek to achieve output and price stability, whilst the macroprudential tools will target financial stability by considering their influences on the stock of credit to the private non-financial sector, which in this study will represent the financial cycle (Nier & Kang, 2016). The rationale is that total credit is able to capture evidence of excess credit creation, which would be an ideal predictor of financial crises. Kim & Mehrotra (2017) cite the empirical commonality of credit growth preceding crisis, further justifying the importance of credit in the model.[1]

Identification strategy

The identification of structural shocks is achieved through a Cholesky decomposition of the variance-covariance matrix, assuming a recursive ordering as a baseline. The ordering of variables follows economic theory and VAR literature, placing the macroeconomic variables (RGDP, CPI, CRD) first and then followed by the policy instrument (LTV and PR) (Christiano et al., 1999). In line with Kim & Mehrotra (2017), when imposing the Choleski decomposition, the only deviation in this study will include having consumer prices being contemporaneously exogenous to real credit. In this identification strategy, the target variables will be deemed to be more exogenous to the policy instruments, and it will be inferred that the policy rate will be responding

[1] Real credit is the total credit to non-financial sector deflated by the consumer price index.

endogenously to the state of the economy.

Real GDP is deemed the most exogenous in the model and, as such ordered first because output is predetermined in New Zealand (Binning, 2024). Reserve Bank of New Zealand (2023) posits that price inflation tends to respond to output with a lag, hence they are placed second. Since New Zealand's housing market is driven by debt, real credit is placed after prices but before property prices in the fourth place (Dye & Patel, 2019). Loan-to-value limits are placed fifth since it is a policy tool and are adjusted after observing the housing market (Kendall & Ng, 2016). In line with the Taylor rule, the policy rate is the most endogenous and is placed last, as the policy rate reacts after observing all the variables in the economy (Huang et al., 2020).

It is also crucial to be mindful of the existence of a leverage cycle due to the potential endogeneity between real credit and property prices. The leverage cycle suggests that the feedback mechanism between the two variables can be reinforcing, such that rising prices lead to more willingness to borrow and more credit provision, which in turn further increases the property prices. Therefore, our identification scheme can mitigate the endogeneity problem using theoretical and empirical literature. The identification scheme in Equation (3) below, where A is the lower triangular matrix.

$$A = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 \end{pmatrix}, \quad u_t = \begin{pmatrix} u_t^{rgdp} \\ u_t^{cpi} \\ u_t^{crd} \\ u_t^{ltv} \\ u_t^{pr} \end{pmatrix}, \tag{3}$$

To ensure the robustness of the results, alternative identification schemes, including sign restrictions (as per Uhlig (2005)) and long-run restrictions (Blanchard & Quah (1989)), are implemented. The inclusion of zero long-run identification strategies aligns with economic theory that tends to be more concerned with long-run neutrality concerns rather than short-run concerns. Additionally, to address the impact of such policy interaction on housing prices, the variable residential prices are included in the larger model for parsimony, introducing an additional transmission channel, the wealth channel. As expected, the residential property prices are assumed to be similar to the other target variables and will therefore be exogenous to the policy instruments. Additionally, in the model, residential prices are assumed to be endogenous to real GDP, CPI and real Credit, but they are exogenous to loan-to-value limits and policy rates. The baseline model will be as follows: [2]

(4) $$y_t = (RGDP_t, CPI_t, CRD_t, LTV_t, PR_t)$$

4.1. Preliminary econometric tests

The paper then conducts preliminary econometric tests that check for stationarity and possible cointegrating relationships between the variables. We employed the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) to test the null hypothesis that a series has a unit root against the alternative hypothesis of stationarity. As shown in Table II, the paper is not able to reject the null hypothesis that the series has a unit root for all variables in levels. To ensure we obtain consistent and robust unit root test results, the paper included the Zivot-Andrew unit root test that accounts for a structural break, and the results align with the ADF. After first differencing, the unit root is removed in all the variables except for loan-to-value and policy rate, as they are not first differenced and are kept in levels, as shown in Table III. The paper then tests for cointegrating relationships using the Johansen approach. This tests the null hypothesis of no cointegrating relationship within the series against the alternative of some existing cointegrating relationship. Results suggest that we are able to reject the null hypothesis and conclude that there are at least two cointegrating relationships between our series using the Trace test.

Most empirical work using the VAR model suggests that all the variables in the model ought to be stationary to avoid spurious results. However, in this paper, we proceed with the analysis using the variables in levels instead of the first differences for a few reasons. Firstly, the loan-to-value ratio is a policy tool that does not change as often; therefore, when it is first differenced, almost all the information is lost as most of the values drop to zero. Secondly, Sims et al. (1990) argue that imposing too many restrictions and transformations will lead to the adverse effect of spurious results. This supports the ideology used in this paper, and we are motivated that non-stationarity will not necessarily affect our results.

[2] The baseline model with property prices ordering includes (rgdp,cpi,crd,pp,ltv,pr) and will only be used just to answer the research question on the effects of MP and MaPP on property prices.

Additionally, in line with Sims et al. (1990) and Kim & Mehrotra (2017), an unrestricted VAR estimation in levels is rather more preferred even if series are *I(1)* as long as the system is not explosive and there exists a cointegrating relationship, as the impulse response functions are consistent. Lütkepohl (2017) further solidifies this notion, as they cite that structural VAR with variables integrated of order one, to achieve identification, would require one cointegrating relationship and impose long-run restrictions avoiding cointegration. Given the two cointegrating relations, a VECM would be more optimal, but it is not necessary since the goal of this study is to investigate and analyse structural dynamics using impulse response functions.

To select the optimal lag choice that will be used in the paper, we used inference from the results provided by the Akaike Information Criteria, Schwarz Information Criteria and Hannan-Quinn Information Criteria. The results from the selection criteria suggest the paper chooses between lag lengths 2 and 3, but most of the criteria select 3 lags. Afterwards, we delve into diagnostic testing of both a VAR (2) and a VAR (3) model for parsimony and congruence. Firstly, we test for autocorrelation in the residuals using the necessary Portmanteau test, which in this paper was the Breusch-Godfrey serial autocorrelation test. The results show that using the asymptotic type, we are unable to reject the null hypothesis for no residual autocorrelation only for the VAR (3) model. These findings suggest no evidence of autocorrelation in our model's residuals at lag 3, which is ideal for our study.

Next, the paper goes on to infer the normality and presence of variance heteroskedasticity in the residuals, which are also essential diagnostic checks. The null of the normality test suggests that the data follows a normal distribution against the alternative hypothesis of a non-normal distribution, which, in this study, we can reject the null hypothesis. This suggests our data diverges from a normal distribution, but we find that this is a common finding in empirical macroeconomic work. The test for conditional variance heteroskedasticity will be approached using ARCH tests; the null hypothesis suggests that no conditional heteroskedasticity exists in the residuals. The test is relatively common when the study seeks to address the occurrence of volatility in our modelling. This study cannot reject the null hypothesis and suggests that there is no conditional heteroskedasticity in our VAR model. Therefore, for the remainder of this paper, using the information criteria and diagnostic checks, the paper will estimate a VAR (3) model with a constant and trend.

TABLE II - UNIT ROOT TEST IN LEVELS

Variables	Deterministic Specification	Augmented Dickey-Fuller	Phillips-Perron	Zivot-Andrew
RGDP	Constant and trend	-1.781	-3.563	-3.690
CPI	Constant and trend	-1.726	-1.193	-4.752
CRD	Constant and trend	-2.163	-2.766	-4.811
PP	Constant and trend	-2.852	-1.679	-4.362
LTV	Constant	-0.812	-1.342	-5.092
PR	Constant	-1.865	-1.515	-3.653

The ADF, PP, and ZA tests assume the null hypothesis of non-stationarity. Statistical significance implies rejection of the null hypothesis. Source: Own Estimates

TABLE III - UNIT ROOT TEST IN FIRST DIFFERENCES

Variables	Deterministic Specification	Augmented Dickey-Fuller	Phillips-Perron	Zivot-Andrew
RGDP	Constant and trend	-5.611	-15.523	-6.270
CPI	Constant and trend	-2.284	-6.166	-3.977
CRD	Constant and trend	-2.310	-10.749	-4.532
PP	Constant and trend	-4.644	-3.903	-5.424
LTV	Constant	-0.821	-1.342	-5.092
PR	Constant	-1.865	-1.515	-3.653

The ADF, PP, and ZA tests assume the null hypothesis of non-stationarity. Statistical significance implies rejection of the null hypothesis. Source: Own Estimates

5. RESULTS

The analysis in this section will commence as follows: the first section will present the baseline impulse response functions of the targeted macroeconomic variables in response to the policy-related shocks. The second section shows the impulse responses of property prices in response to monetary and macroprudential policy shocks and addresses the third research question in this paper. The next chapter addresses the baseline model's robustness using the impulse response function with different identification schemes.[3]

The identification strategies used for robustness will be the long-run restriction, following closely the approach in Blanchard & Quah (1989). The framework posits that certain structural shocks are assumed not to have any long-run effects on some variables, which would be a zero long-run restriction matrix. In their seminal two-variable model,

[3] In the robustness chapter we only address the response of the targeted macroeconomic variable and will not address the property prices.

with unemployment and output, the demand shocks were assumed to have no long-run effects on output, and only supply shocks had long-run effects.

The other identification strategy applied is the sign restrictions imposed on the short-run (transitory) responses to shocks, the rationale is that identification of the structural shocks here will not rely on the exact numerical zero restriction or variable ordering as in the baseline Choleski model but relies on specification of expected response directions over a given horizon (Uhlig, 2005). An example of an application using sign restrictions is by Peersman (2005), where they imposed sign restrictions in a simple four-variable VAR with monetary policy shocks. They find that a contractionary monetary policy shock will decrease output, price levels and money aggregates, hence monetary policy aligns with theory and expectations without imposing recursive restrictions. As such, this paper will follow their approach to identify monetary policy shocks. More information pertaining to each scheme is provided later in the paper.

5.1. Effects of monetary and macroprudential policy

5.1.1. Baseline Model

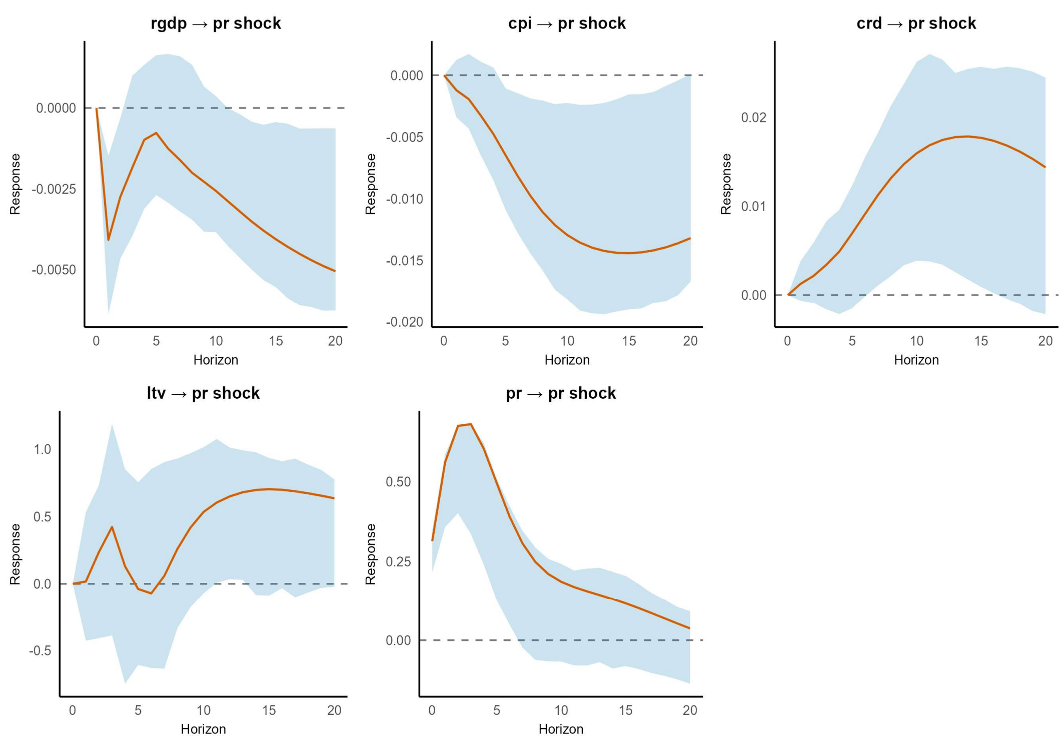

FIGURE 2 – Impulse response functions (Monetary Policy Shock)

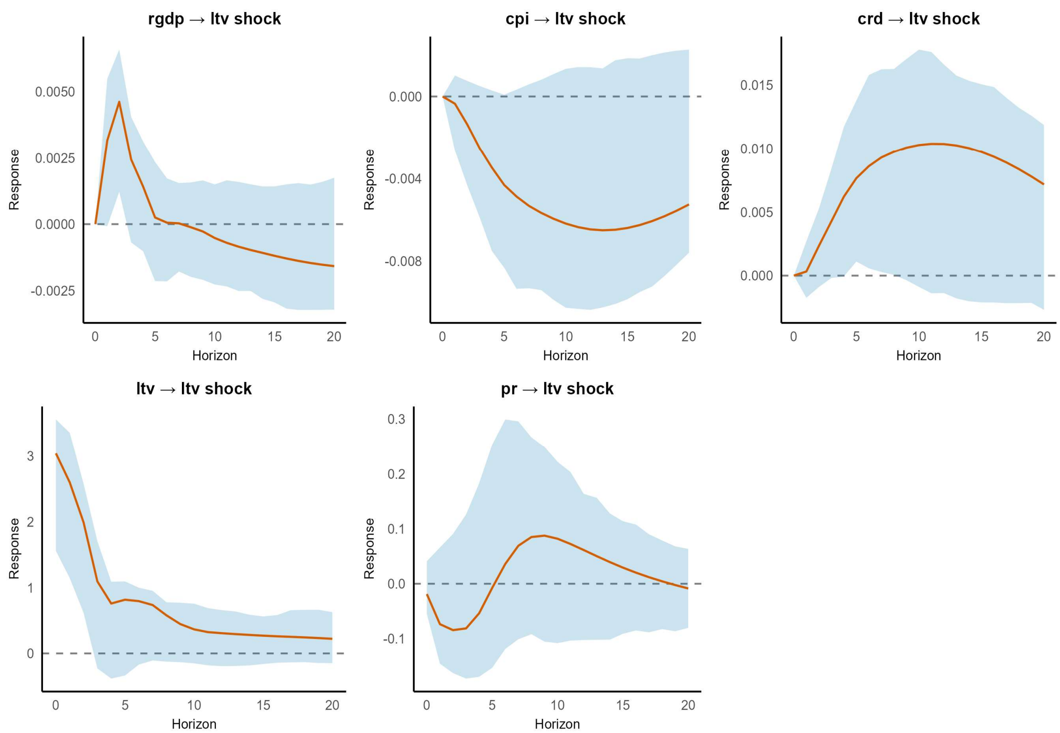

FIGURE 3 – Impulse response functions (Macroprudential Policy Shock)

The baseline model uses the Choleski identification strategy as mentioned earlier, and the variable ordering will be essential. Using the optimal lag order three and one standard deviation for the model shocks, the impulse responses will include a 90% confidence interval and are computed using Monte Carlo simulations with 1000 iterations. Kim & Mehrotra (2017) also partly influenced variable selection and identification here.

The impulse response analysis reveals Figure 2, the distinct dynamic effects of a contractionary monetary policy (MP) shock on key macroeconomic variables. Following the shock, the policy rate shifted with a sharp increase and a peak at 0.7ppts, with statistically significant persistence. Real GDP exhibits a decline in response to a contractionary MP shock. There is a statistically significant decline till a peak in the 2nd quarter at about 0.5%; this is followed by a slight increase, which ultimately decreases in the long term; however, it is not statistically significant. This pattern suggests that the dampening of economic activity stemming from higher borrowing costs will be stark and significant in the short term but seems to persist, arguably into the long term. This result, in the short term, is supported by economic theory.

Price levels show an immediate and statistically significant response to the contraction MP shock; there is a steep decline in price levels until they hit a trough at approximately 1.5% in the 15th quarter and then gradually recover in the long run. The findings broadly validate New Keynesian predictions, where contractionary policy reduces inflation in the short-to-medium term without contemporaneous effects, while real variables adjust more sluggishly due to frictions in economic activity.

However, a monetary policy tightening of 100 basis points increases real credit by about 2% and it peaks at 15 quarters. This result seems to contradict the theory, as a contractionary MP is expected to cause a decline in levels of real credit. Possible reasons for the perverse results could be that during this period, the real credit to non-financial markets might have been growing. However, interest rates were entering the Zero Lower Bound period, hence the use of unconventional monetary policies. Therefore, official cash rates were probably unable to capture the real transmission mechanism channel concerning real credit. Although not included in this paper, we split our dataset into two: a pre-2008 sample and a post-2008 to pre-2020 set, to test if the impulses would be different from the full sample. In the pre-2008 sample, we find that the macroeconomic variables all had the expected response to a policy shock. However, when we sample after the crisis, the results are similar to the findings in this paper. Therefore, this could suggest the need to model for regime switching using our data, especially in periods of low interest rates and unconventional monetary policy.

Figure 3 shows the impulse response analysis of an expansionary macroprudential policy shock, characterised by a one percentage point (100 basis point) increase in the loan-to-value (LTV) limit, which reveals clear-cut dynamics on real credit. A macroprudential policy easing of 100 basis points increases real credit by 1% and peaks in the 15th quarter. Real credit responds with a delayed peak at approximately 3 years, therefore aligns with theory-based expectations. We can infer that the delayed, yet persistent positive response suggests that expansionary macroprudential measures, such as loosening LTV constraints, may stimulate credit expansion over the medium term, albeit with a lag. The observed lagged effect aligns with institutional and behavioural rigidities, such as time delays in financial intermediation or borrower adjustment to new lending conditions. The findings support empirical studies indicating that relaxed macroprudential policies can bolster credit activity, though their transmission operates through gradual channels rather than instantaneous adjustments. This underscores the importance of accounting for delayed effects when setting up macroprudential tools to influence credit cycles. Additionally, in response to the expansionary shock, real GDP increases by about 5% up to a peak in the 3rd quarter and then declines after the 5th quarter. However, only the increase is statistically significant. Based on economic theory, one would expect a higher limit on loans will increase demand to some extent, but for this increase to be in the short term. Finally, the price levels show a delayed decline in response to easing limits, but this result is not significant either in the short-term or long-term.

5.1.2. Policy Effects of Property Prices

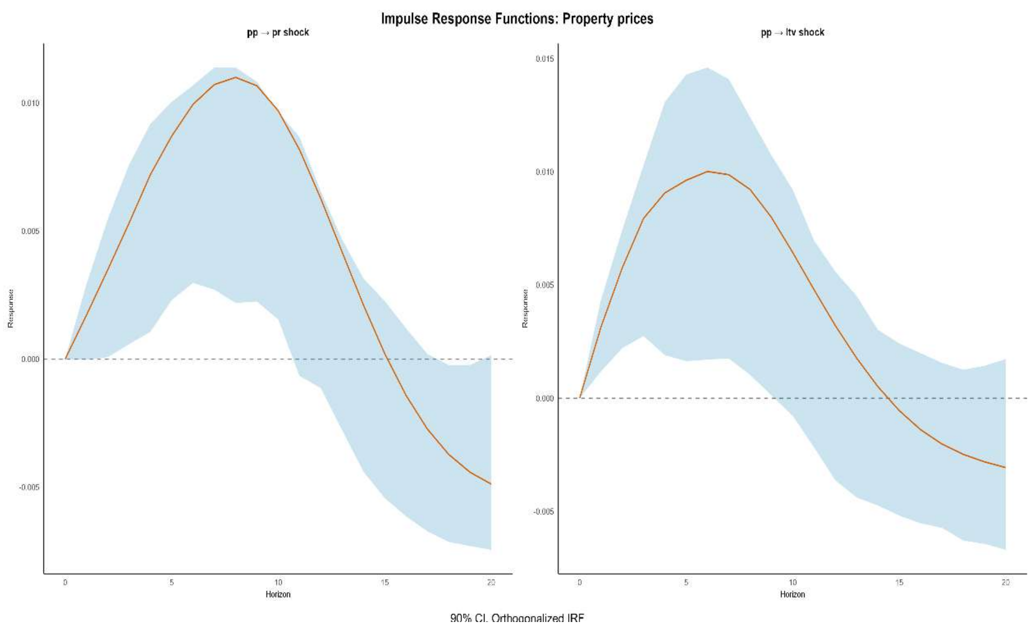

FIGURE 4 – Impulse response functions (Property Price to both shocks)

The analysis of residential price responses further illuminates the wealth channel through which monetary policy (MP) and macroprudential policy (MaPP) shocks are transmitted using Figure 4. A contractionary monetary policy shock will result in an increase in residential property prices of about 1% till a peak in the 8th quarter, then a decline in the 15th quarter that persists, both statistically significant. When prices rise in the first 2 years, it is plausible to assume that, since prices are sticky in nature, the transmission mechanism of monetary policy is sluggish concerning property prices.

Therefore, the expected response to contractionary policy rates is only observed after 3 years, which further suggests this is a credit-driven economy and, hence, the increasing real credit. This prolonged adjustment aligns with theoretical expectations that tighter monetary policy conditions spill over into asset markets by raising borrowing costs, thereby suppressing housing demand and valuations. Albeit, in terms of policy implications, one can suggest that since the transmission mechanism of monetary policy is sluggish concerning property prices, monetary policy is not the best policy tool to address asset prices and the credit crisis. Therefore, when it comes to the "lean vs clean" debate, monetary policy is not the optimal policy instrument for "lean against the wind" of asset price bubbles like the housing market bubble. European Central Bank (2010) find that monetary policies must not be set to target asset prices. However, a policy strategy that employs some traits of the leaning against the wind approach could achieve price stability.

Conversely, an expansionary macroprudential policy shock triggers an immediate surge in housing demand. Property prices spike to about 1% at the peak in the 8th quarter, reflecting the rapid transmission of increased credit availability into the housing market. However, this boom proves short-lived as prices begin declining after the 15th quarter. This pattern suggests that while relaxed macroprudential rules initially stimulate housing activity by easing credit access, market corrections, potentially driven by affordability constraints or regulatory adjustments, temper out within 3 years. However, the long-term negative decline in property price levels is not statistically significant.

These findings underscore the distinct temporal dynamics of policy transmission: monetary policy impacts housing markets persistently but with lagged effects, while macroprudential policies induce slightly sharper responses followed by gradual normalisation. The results affirm the critical role of housing as a wealth channel in macroeconomic policy frameworks and highlight the need for coordinated timing when deploying MP and MaPP tools to stabilise asset markets.

TABLE IV – FORECAST ERROR VARIANCE DECOMPOSITION

Horizon	RGDP	CPI	CRD	PP	LTV	PR
1	100.00	0.00	0.00	0.00	0.00	0.00
6	63.78	4.90	2.72	19.96	7.58	1.06
12	43.39	16.26	7.44	27.01	5.15	0.75
15	36.12	24.46	8.66	25.36	4.40	1.00
18	29.83	31.53	9.41	23.49	3.96	1.79
1	0.24	99.76	0.00	0.00	0.00	0.00
6	0.59	92.14	0.33	2.34	2.40	2.20
12	3.24	79.84	0.84	0.97	6.15	8.97
15	5.01	74.26	1.48	0.75	7.11	11.38
18	6.39	69.91	2.12	0.60	7.78	13.20
1	2.03	63.91	34.07	0.00	0.00	0.00
6	4.36	70.90	11.45	8.67	2.74	1.88
12	5.99	62.80	4.72	10.63	7.98	7.88
15	7.75	58.25	3.53	9.69	9.63	11.16
18	9.74	54.05	2.93	8.81	10.70	13.77
1	8.32	4.00	1.21	86.46	0.00	0.00
6	0.83	9.74	3.14	79.07	4.49	2.73
12	2.29	9.18	3.45	67.63	8.20	9.25
15	4.45	12.33	3.20	63.05	7.73	9.23
18	5.05	16.70	3.02	59.24	7.28	8.71
1	1.98	1.62	4.31	1.33	0.16	90.59
6	9.89	7.87	3.97	12.91	1.19	64.18
12	13.15	12.01	5.58	14.79	2.23	52.24
15	12.18	13.51	5.34	16.92	3.12	48.93
18	11.86	13.55	5.33	16.63	3.75	48.87

Note: Values represent the percentage of forecast error variance explained by each variable.

Source: Own estimates.

The study further examines an alternative to the impulse response function that shows the relative importance of each structural shock in explaining the endogenous variability using forecast error variance decompositions. The approach will show the percentage of the fluctuations attributed to each shock across different horizons. Table IV presents the findings over an approximately 2-year forecast horizon. The main policy objectives are price and financial stability; the study focuses on real GDP and CPI as targets for MP and real credit and potential asset prices as targets for MaPP. Based on economic reasoning, the variance decomposition of a variable and its shocks is expected to be higher than from other shocks, such as evidence from real GDP, where in period 1, 100% of the variation is explained by itself. A similar result can be postulated from the price level.

Regarding policy relevance, we should investigate the variation in response to policy rates and loan-to-value limits. In the 6th quarter, only 7% of the MaPP shocks and 1% of the MP shocks explain the variation in real GDP, and these values remain lower over the full horizon. However, by the 12th quarter, 16% of the price level shocks and 27% of the property price shocks explained real GDP. In the final horizon, price level shocks explained 31% of the variation and exceeded property prices at 23%. This shows that policy tools had a more sluggish transmission to real GDP, but shocks emanating from different sectors, such as the real macro-aggregates, have a larger influence on output. It is also worth noting that MaPP shocks explained more variation in real GDP than MP shocks in the period. This could be a testament to the zero lower-bound policy regime.

In addition, MP shocks explained approximately a 9% variation in price levels in the 8th quarter, and MaPP explained a 6% variation in price levels. Over the horizon, the variations continued to grow, with MP shocks still explaining more variation than MaPP shocks. Concerning price levels, most of the variation in the shocks can be attributed to price shocks themselves, then MP shocks, and lastly, MaPP shocks, although real GDP contributions grow by the last horizon to 6%. We can conclude that targeting price stability also entails employing macroprudential tools beyond traditional monetary tools.

Furthermore, in the 6th quarter, MaPP shocks contributed approximately 3% to the variation in real credit, and MP shocks contributed about 2% to real credit. This would be an expected outcome, considering MaPP is calibrated to target financial stability, which stems from credit conditions. In the 18th quarter, MP shocks surpassed MaPP shocks in explaining the variation in real credit. However, the major contributor to variations in real credit over the whole horizon is the price levels, with a high of 70% in the 4th quarter but a decrease to 54% in the 18th quarter. Real credit variations in this economy seem better explained by external non-policy related variables, including property prices, explaining 10% in the 12th quarter. We can infer that real credit is more risk-prone from price levels than the policy target tool of loan-to-value limits or even policy rates. These results could also be a factor of the zero lower bound regime and periods of unconventional monetary policy; conventional tool effects were mitigated.

The wealth channel was also represented in the decomposition to address asset prices. As expected, the larger contribution to variations in property prices has been caused by shocks to property prices. In the 1st quarter, both MP and MaPP had zero contributions to property prices; however, real GDP contributed 8% and price levels 4% in this period. Over the horizon, price level shocks increased in contribution to 16% in the 18th quarter, while real GDP contributions decreased over time. In the 6th quarter, the contribution to property prices by MP and MaPP was 2% and 4% respectively. Then, in the 12th period, MP shocks contributed 9% before closing with an 8% contribution in the 18th quarter. Meanwhile, MaPP shocks contributed 8% in the 12th quarter and then ended at 7% in the 18th quarter. Regarding asset prices, price levels seem to cause more variation, but although the impact from the policy tools is slow, it does increase. The fact that property prices contributed further validates the argument of the unconventional monetary policy period with lower interest rates. There is proof that the policy tool's transmission mechanism channels work better in future periods.

Additionally, central banks face a trade-off between achieving price and financial stability, especially in a model where monetary policy responds to real credit. Whilst macroprudential policy could seem feasible in targeting financial stability, this could compromise price stability (Tayler & Zilberman, 2016). Such a scenario is particularly evident when these policy shocks result in a negative correlation between real credit and price levels, which is evident in this paper. Central banks are then faced with the challenge of choosing between price and financial stability when they include real credit to the monetary policy target variables.

6. Robustness Analysis

This section will present various specifications of the baseline model to ensure that the results in this paper are robust to many elements, including spurious regression from the non-stationary variables and identification problems. Firstly, we impose long-run restrictions on our model to identify whether there will be long-run effects of monetary policy (MP) and macroprudential policy (MaPP) shocks on their target variables. Secondly, we impose sign restrictions to recover the structural shocks without imposing strict/hard restrictions on the coefficients.

6.1. *Long-Run Restrictions*

Main Restrictions

- Money neutrality: MP has no long-run effect on real GDP and price levels
- Macroprudential Independence: MP has no long-run effect on loan-to-value
- Credit neutrality: MP has no long-run effect on the level of real credit.

$$A = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 \end{pmatrix}, \quad u_t = \begin{pmatrix} u_t^{rgdp} \\ u_t^{cpi} \\ u_t^{crd} \\ u_t^{ltv} \\ u_t^{pr} \end{pmatrix}, \tag{5}$$

Economic theory is not always enough to provide meaningful contemporaneous restrictions. Therefore, we shift attention towards imposing the long-run properties of shocks and allowing the neutral effects of certain shocks over time. The assumption is that some shocks will not have any long-run effects on certain variables over time; thereby, the paper can identify transitory and permanent effects. Based on the New Keynesian framework and monetary neutrality, we impose that monetary policy shocks will be short-lived to real GDP, price levels and real credit (Galí, 2015). Additionally, in the long run, the target variables will adjust to the shocks such that monetary policy shocks have no permanent effects on them, following closely the impositions in the Blanchard-Quah long-run decomposition. Albeit macroprudential policy is likely to possess long-run properties on specific variables.

Gertler, Kiyotaki & Prestipino (2020) posit that credit market conditions may persist over time if they can alter financing conditions, in this case, credit availability. Shocks related to credit conditions, like real credit and loan-to-value limits, are likely to have lasting effects on credit availability in the economy, which introduces a credit accelerator transmission mechanism channel of macroprudential policies. Therefore, based on the bank balance sheet, Woodford (2003) finds that short-term monetary policy shocks would fade out as capital levels adjust, thereby supporting the assumption of credit neutrality.

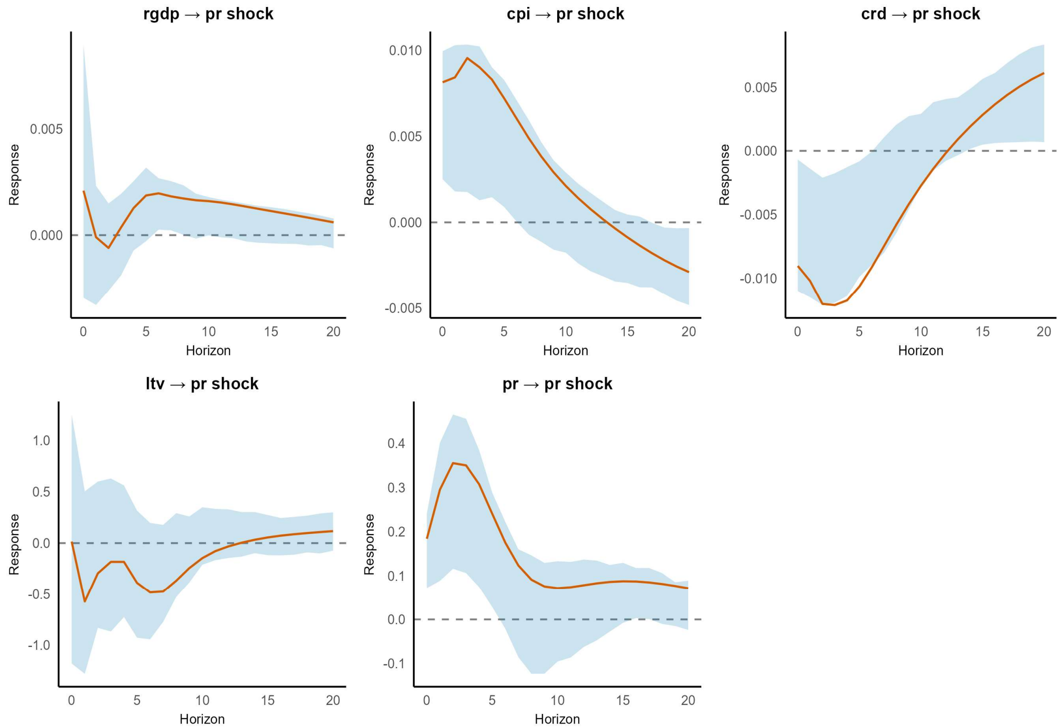

FIGURE 5 – Impulse response functions: Long-run (Monetary Shock)

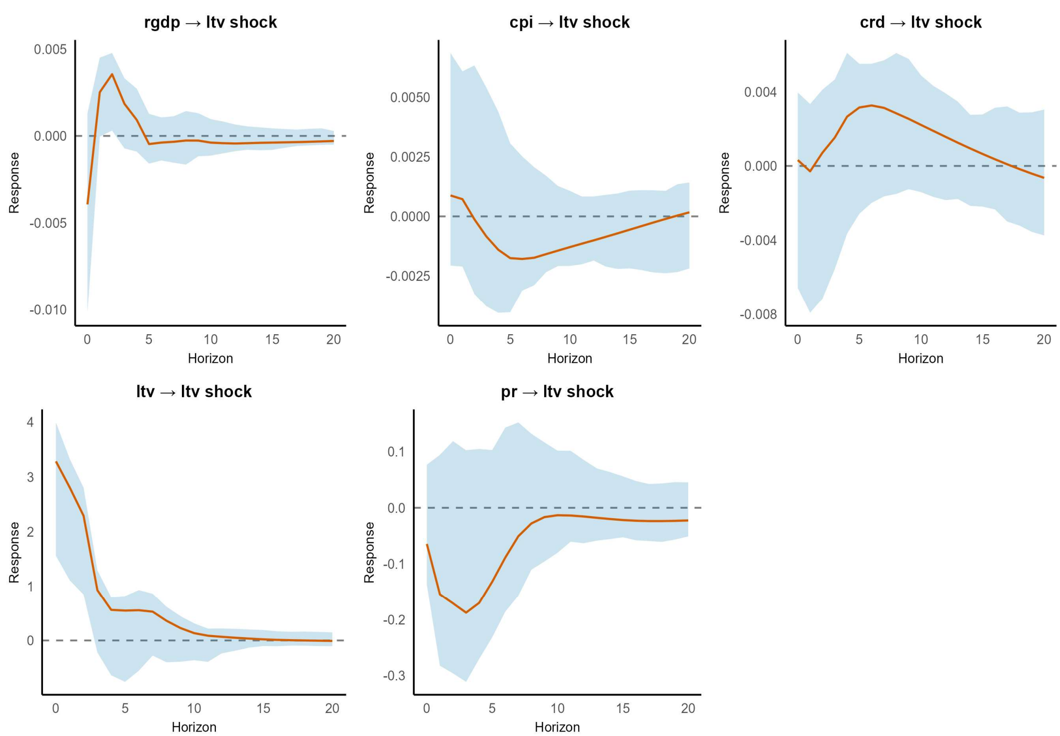

FIGURE 6 – Impulse response functions: Long-run (Macroprudential Shock)

Figure 5 and Figure 6 study the impulse response functions of the Blanchard & Quah (1989), long-run decomposition, but with an inclusion of a macroprudential shock when modelling, and reveal contrasting findings amongst the policy tools. A contractionary MP shock leads to a short-lived decline in real GDP up to the 4th quarter and is followed by a quick readjustment, which matches the theory that contractionary MP dampens economic activity briefly. Price levels rise and peak in the 4th quarter before gradually declining by the 10th quarter. The delayed response of price levels is proof of price stickiness, which, as alluded to before in this study, could be a by-product of the unconventional monetary policy during the Zero lower bound regime.

The sharp decline to a trough in the 4th quarter for real credit, followed by the exponential recovery, signifies the late effect of the MP shock. The transmission mechanism of monetary policy shocks to real credit in this economy is sluggish, but when they are apparent, they hold per credit market dynamics. A contractionary MP shock to the average loan-to-value limit highlights insignificant impulses and suggests that not much inference can be drawn between loan-to-value limits and policy rate during this period. This could also provide further evidence that loan-to-value limits are a policy tool and are set separately rather than in an unsupervised, responsive manner.

An expansionary MaPP shock leads to a statistically significant increase in real GDP, peaking at 0.5% between the 3rd and 4th quarter, then followed by a decline and normalised to the steady state, suggesting a theoretically grounded proof that credit boosts economic activity. Price levels decline and reach a trough in the 5th quarter, but the impulses are not statistically significant. Real credit responds to the expansionary shock with a peak increase in the 6th quarter and gradual decline, supporting the macroprudential transmission channel to credit, where high limits on loan-to-value allow for more borrowing abilities and, subsequently, credit booms. We can conclude that under this analysis, MaPP expansionary shocks had a much stronger and immediate effect on real GDP and real credit than a MP contractionary shock. Additionally, the findings from this long-run decomposition are somewhat identical to those from the baseline Choleski identification; therefore, our results are robust to this identification strategy.

6.2. *Sign Restrictions*

Following Uhlig (2005), we analyse the effects of monetary policy shocks on our target variables, namely the real GDP and price level, to infer if any "price puzzle" exists.[4]

In terms of restrictions, we want to impose that an unanticipated contractionary monetary policy (MP) shock:

- Does not decrease the monetary policy rate for x quarters after the shock.
- Does not increase the real GDP for x quarters after the shock.
- Does not increase the price levels for x quarters after the shock.
- Does not increase the real credit for x quarters after the shock.

Thus, when regarding monetary policy shocks, the paper leaves the loan-to-value and the policy rate unrestricted in the constraint matrix. Furthermore, the paper goes on to impose restrictions on the target variables in response to unanticipated macroprudential shocks, that is, an increase of one percentage point in the loan-to-value limit. For these shocks on real GDP, price level and policy rates were left unrestricted. The paper imposes that an unanticipated expansionary macroprudential policy (MaPP) shock:

- Does not decrease the loan-to-value limit for x quarters after the shock.
- Does not decrease the real credit for x quarters after the shock.

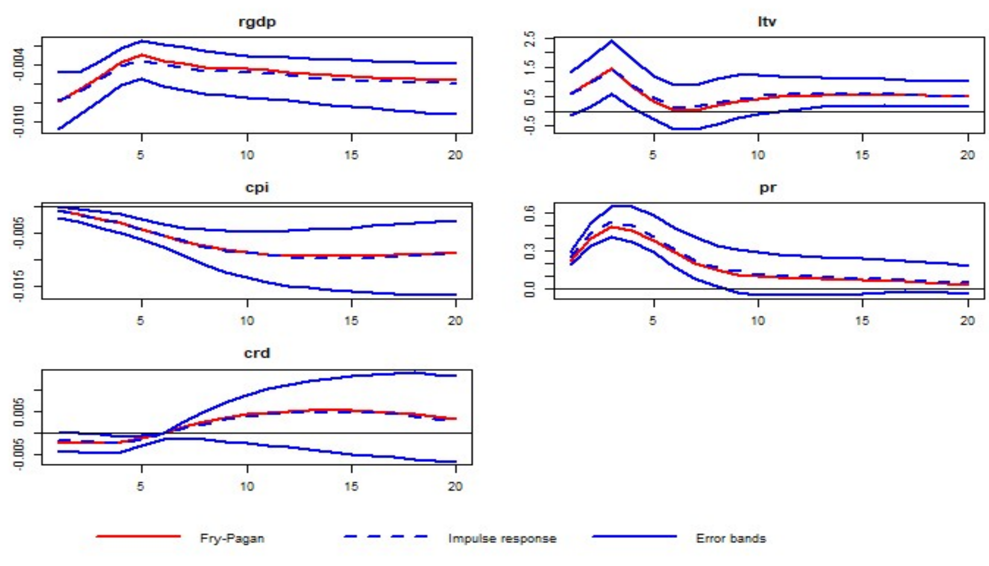

FIGURE 7 – Impulse response functions: Sign restrictions (Monetary Shock)

[4] Regarding the puzzle, the rationale posits that a contractionary interest rate shock will result in an increase in price levels (inflation).

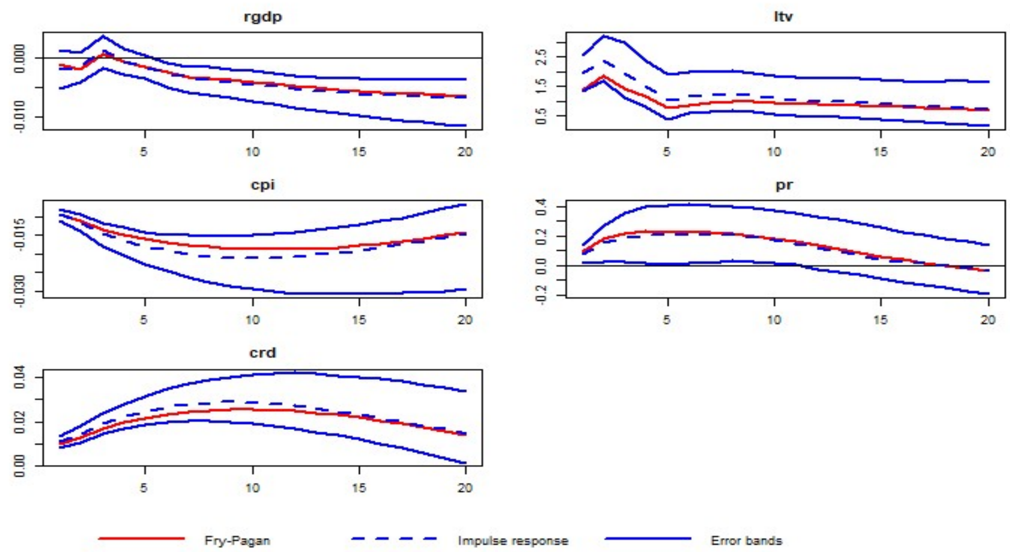

FIGURE 8 – Impulse response functions: Sign restrictions (Macroprudential Shock)

The sign restrictions strategy, as a robustness test, allows the user to test the implications of all the types of restrictions. [5]

Figure 7 & Figure 8 present the impulse response function of all the variables in response to the monetary and macroprudential policy shocks with the theory-driven sign restrictions imposed. To confirm a significant and well-identified model, impulse responses are shown along with the median-target method (Fry & Pagan, 2011). The method is a diagnostic device such that large deviations between the impulse of the median-target and median impulses from estimation will indicate bias and misleading results. In this paper, only the penalty function method from Uhlig (2005) shows similar patterns to the median-target and will be used for inference.

A contractionary monetary policy shock to real GDP results in a statistically significant decline over the period. There is a slight incline, but real GDP stabilises negatively, supporting the classical theory of contractionary MP dampening economic activity. Similarly, the price levels significantly show a persistent decline over the horizon, suggesting strong evidence of disinflation and, thus, no price puzzle. In response to the shock, real credit shows a decline from the 1st quarter to the 5th, then a slow re-adjustment to the steady state over time, aligning with the theory that suggests credit

[5] The impulse response functions were generated using the Uhlig penalty method for imposing sign restrictions for h = 4.

dampening. Although the restriction was not imposed, loan-to-value limits increased with a peak around the 3rd quarter, followed by a stabilisation from the 6th quarter onward.

An unexpected expansionary macroprudential policy shock leads to a slight but temporary incline in the real GDP, with a peak in the 3rd quarter and a steady decline over time. We gingerly posit the expected positive effects of expansionary MaPP on economic activity, but they are short-lived in this paper. Price levels in response to the expansionary shock will cause a decline throughout the horizon, partly due to price stickiness and are statistically significant. As expected, real credit increased strongly and persistently from the 1st quarter to the 20th quarter. These results suggest that an expansionary MaPP shock in the form of loan-to-value easing will bolster lending and credit availability.

Therefore, we conclude that in this sign-restricted identification scheme, a contractionary monetary policy shock can achieve the expected macroeconomic goal of dampened economic activity, inflation and real credit in the short term. Whereas an expansionary macroprudential policy is able to achieve the goal of increasing real credit significantly, we find that loan-to-value easing also temporarily boosts economic activity in the short run. Thus, these results show that even though the MP and MaPP policy tools may have their target variables, their transmission mechanisms also spill over to other policy target variables.

7. Conclusion

The global financial crisis PROVIDED evidence that banks and the financial sector at large were not efficiently insulated from leverage effects and currency mismatches. This resulted in the growing interest in implementing macroprudential policies to ascertain and ensure a sound financial system to avoid a build-up of systemic risk. This paper investigates the interaction of monetary and macroprudential policies for New Zealand, an inflation-targeting economy, using a SVAR model with quarterly data from 2000 to 2023.

Key findings reveal that an expansionary macroprudential policy shock will lead to a boost in credit and real GDP in the short term, while a contractionary monetary policy shock will dampen output and prices but unexpectedly increase real credit. Both policy shocks lead to initial rises in property prices, providing evidence of wealth effects, though with differing persistence. Insights from the variance decomposition highlight that macroprudential shocks explain more of the variation in real GDP compared to monetary policy shocks. This accentuates the significant role of macroprudential policy in influencing economic output and underscores the need for coordinated policy approaches.

The policy implications are clear-cut: central banks ought to be very careful when their policy tools react to variables that are not their objective variables. Macroprudential policy should focus on its primary goal of financial stability, while monetary policy focuses on price stability. Conventional monetary policy should not attempt to lean against the wind of asset prices and seek to achieve financial stability, as it could lead to unintended consequences, given the delayed and intricate transmission mechanisms. In addition, policymakers should exercise caution, particularly during credit booms with low interest rates and inflation, while considering the wealth effects on asset prices.

This study contributes to the literature by providing empirical evidence on the interplay between monetary and macroprudential policies in a small, open economy. However, it has limitations. The SVAR model assumes linear relationships, which may not fully capture dynamics during major economic disruptions like the 2008 financial crisis or the COVID-19 pandemic. Future research could employ non-linear models or regime-switching approaches to better understand these periods. Additionally, incorporating more recent data or exploring other policy instruments could offer further insights into the evolving policy landscape. In conclusion, this research emphasises the critical need for coordination between monetary and macroprudential policies to achieve both macroeconomic and financial stability, particularly in the context of housing markets. By deepening our understanding of how these policies interact and affect key economic variables, policymakers can make more informed decisions to navigate future economic challenges effectively.

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APPENDICES

The empirical analysis conducted in this thesis was carried out using the R statistical environment (R Core Team, 2023). Below is information regarding the list of packages used in the analysis and highlights where they were pivotal for the analysis. **VARsignR** (Dannes, 2015) was essential for estimation of sign restrictions using the Uhlig penalty function; the package **vars** (Pfaff, 2008) was essential for estimating the VARs, Blanchard-Quah long run decomposition and generating the impulse response functions; the package **tsm** (Kotze, 2023) was used in the thesis primarily for data visualization and unit root testing using the function gts_ur(). Finally, the package **Texevier** (Katzke, 2017) was used to generate and knit the document in Rmarkdown.