DP2024-XX

Reserve Bank of New Zealand Te Pūtea Matua

Discussion Paper

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New evidence using Panel local projection.

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June 2026

Reserve Bank of New Zealand *Discussion Paper*

ISSN 1177-7567

The Reserve Bank of New Zealand's discussion paper series is externally refereed.

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The Bank's Discussion Paper series is available here.

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Responses of deposit and mortgage rates to monetary policy rate changes

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Abstract

This study provides new empirical evidence on the pass-through of changes in the monetary policy rate to mortgage and deposit rates using a bank-level weekly dataset of New Zealand banks. Applying the panel local projection method, we find that changes in the policy rate lead to substantial pass-through to both deposit and mortgage rates. The effects materialise gradually, with full pass-through typically observed only over longer horizons. Pass-through estimates tend to be larger when policy rate changes are instrumented with monetary policy surprises, which likely reflects forward-looking banks that might change interest rates in anticipation of policy rate changes, leading to downward bias in OLS estimation. We examine whether mortgage and deposit rates respond asymmetrically to increases versus decreases in the policy rate, and find limited evidence of asymmetry. The only notable exception is the 1-month term deposit rate, which reacts more strongly to policy rate decreases than increases. Finally, we study whether bank balance sheet characteristics shape monetary policy pass-through. We find that only banks with higher shares of non-performing loans exhibit lower pass-through for floating mortgage rates.

JEL Codes: E43, E52

Keywords: Monetary policy pass-through, monetary policy surprises, high frequency identification, local projections, asymmetry

Acknowledgements: The views expressed herein are those of the authors and do not necessarily represent the views of the Reserve Bank of New Zealand. We thank Christopher Ball and James Graham for useful comments and discussions. Any remaining errors are our own.

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1 Introduction

Increases in central banks' policy rates worldwide since 2021, and subsequent decreases, have sparked renewed interest in understanding how monetary policy affects retail interest rates. This paper examines the pass-through of monetary policy rate changes (i.e. changes in the OCR) to deposit and mortgage rates in New Zealand, highlighting the key role of bank retail rates in the monetary policy transmission channel. New Zealand's retail rates are particularly relevant due to the country's heavy reliance on the mortgage market, with mortgage loans making up approximately 64% of bank loan portfolios (See Figure 1). Unlike the U.S. or Europe, where mortgage terms extend up to thirty years, New Zealand's mortgages are typically much shorter. The advertised retail offerings are up to five years, with many under two years. These shorter maturities minimise term premiums, providing a clearer view of how monetary policy shifts affect retail rates.

The pass-through literature has followed two different approaches. The "cost-of-funds" approach investigates the relationship between bank retail rates and market interest rates of similar maturity. Market rates are presented as the closest measure of the marginal cost of funding for the banks (e.g. de Bondt (2005) and Bernhofer and van Treeck (2013)). The "monetary-policy" approach, which we follow in this paper, investigates the pass-through from monetary policy rates to bank retail rates (e.g. Sander and Kleimeier (2004) and Gregor and Melecký (2018)).[1]

The pass-through of monetary policy rates to retail banking rates has been explored in numerous studies. These studies either use aggregate interest data[2] or use bank-level panel data[3]. As highlighted by Andries and Billon (2016), typically, an empirical analysis of pass-through regresses bank retail rates on market rates estimated either in levels or first differences or using cointegration estimation. Usually, impact multipliers (which measure the immediate pass-through of changes in the market rate) and long-term multipliers (which measure the long-run pass-through) are then reported.

[1] In this approach, rather than the policy rate itself, often a short-term market rate that follows the policy rate closely is taken.

[2] Some studies using aggregate interest data across banks are Mojon (2000), Sander and Kleimeier (2004), de Bondt (2005), Kok and Werner (2006), Kleimeier and Sander (2006), Jobst et al. (2008), Blot et al. (2013), Bernhofer and van Treeck (2013), Hristov et al. (2014), Borstel et al. (2016), Gregor and Melecký (2018), Kapuściński and Stanisławska (2018), Ferstl et al. (2024), Michaelis (2024) and Beyer et al. (2024).

[3] Studies using bank-level panel data include Neumark and Sharpe (1992) for the US, Weth (2002) for Germany, Bernstein and Fuentes (2003) for Chile, Hofmann and Mizen (2004) and Fuertes et al. (2010) for the UK, Lago-González and Salas-Fumás (2005) for Spain, De Graeve et al. (2007) for Belgium, Gambacorta (2008) for Italy, Frappa et al. (2008) for France, Horváth and Podpiera (2012) and Havranek et al. (2016) for the Czech Republic, Valadkhani and Worthington (2014) and Holland et al. (2020) for Australia , Holmes et al. (2015) for Columbia, Stansilawska (2015) for Poland, Kitamura et al. (2016) for Japan, Holton and d'Acri (2018) and Altavilla et al. (2020) for the Euro area, and Divino and Haraguchi (2023) for Brazil.

Using a unique bank-level weekly dataset covering New Zealand deposits and mortgage rates, this paper contributes to the empirical literature on monetary policy pass-through in four ways. First, we address potential biases in estimating pass-through arising from anticipation effects and the endogeneity of monetary policy decisions. Second, we investigate whether pass-through differs following increases versus decreases in the policy rate. Third, we analyse potential heterogeneity in pass-through between mortgage rates and deposit rates. Fourth, we assess the role of bank-specific characteristics in shaping the magnitude of pass-through. Each of these contributions is discussed in turn below.

First, we focus on potential biases arising from banks' anticipation effects. Our review of the literature did not uncover robust empirical evidence that banks systematically adjust retail lending or deposit rates prior to official monetary policy announcements. As noted by Kleimeier and Sander (2006), this represents a significant gap in the existing literature. By contrast, a larger body of literature on financial markets provides clear evidence that anticipated policy moves influence prices before the day of the monetary policy announcement. For example, Lucca and Moench (2015) document pre-announcement drifts in financial markets, showing that risk premiums and asset prices respond in advance of policy decisions. Papadamou (2013) finds that treasury and money market rates incorporate expected policy changes before the official announcement. Similarly, Bauer and Swanson (2023) show that financial market agents such as macroeconomic forecaster often react before official monetary policy announcements because investors continuously update expectations based on available information. Bauer and Swanson (2023) argue that both the Fed and private forecasters simply responding to the same public news released in the days and weeks leading up to each FOMC announcement. In other words, we can conclude that anticipated policy moves influence pricing in markets before monetary policy announcement.

It is therefore plausible that banks also engage in anticipatory behaviour when setting retail rates. Failing to account for such anticipation could bias estimates of pass-through in regressions of banks' retail rates on monetary policy rates. To address this, we adopt a novel approach in the pass-through literature by combining panel local projections (following Jordà (2005)) with high-frequency monetary policy surprises to identify the impulse response of retail rates to policy changes. This strategy allows us to separate the endogenous and exogenous components of monetary policy movements. To our knowledge, only one prior study—Bernhard et al. (2021)—has used monetary policy shocks in the context of bank pass-through, focusing on two-year mortgage rates. By explicitly isolating the unexpected component of policy changes, our approach provides a cleaner estimate of how retail rates respond to monetary policy shocks while reducing potential biases from anticipatory adjustments.

We construct a time series of exogenous monetary policy surprises, using the high-frequency data approach by Gürkaynak et al. (2005). This approach starts by measuring unexpected shifts in market interest rates occurring within narrow time frames surrounding monetary policy announcements. By capturing these unexpected movements, we can identify variations in market interest rates that are likely to be exogenous. From these movements, we construct our monetary policy surprises. These in turn are then used as instruments in local projections of retail rates on monetary policy rate changes. We compare local projection results estimated using ordinary least squares with IV-local projections. We find that our IV estimates tend to show more pass-through than our OLS estimates (which do not incorporate monetary policy surprises), especially at longer horizons. This is consistent with the idea that forward-looking banks might change interest rates in anticipation of policy rate changes, leading to downward bias in OLS estimation. The downward bias refers to an understatement of the true pass-through, although still positive, because part of the adjustment in bank rates occurs prior to the monetary policy announcement.

Second, we explore whether pass-through is different after increases or decreases in the policy rate. Previous research, using different methodologies, consistently finds that banks adjust retail rates at different speeds depending on whether interest rates are rising or falling (see Neumark and Sharpe (1992), Fuertes et al. (2010), and Becker et al. (2012)). We find that the interest rate on 1-month term deposits reacts stronger to OCR decreases than to OCR increases. For other deposit rates and for mortgage rates we find little evidence of asymmetric pass-through for increases versus decreases of the OCR.

Third, we examine whether pass-through differs between mortgage rates and deposit rates. Differences in the speed and magnitude of pass-through on the asset and liability sides of the balance sheet can influence a bank's interest margin. We find that the spread between floating mortgage rates and 1-month deposit rates increases after OCR increases. This is due to a faster reaction of floating mortgage rates than 1-month deposit rates. Differences in the speed and magnitude of pass-through to the liability versus asset side of a bank will affect profitability. Gomez et al. (2021) show that banks with a maturity mismatch between assets (loans) and liabilities (deposits) may experience different monetary policy transmission effects on lending. For instance, Gomez et al. (2021) state when the Fed Funds rate increases, banks with a larger income gap—the difference between the interest rate sensitivities of their assets and liabilities—tend to generate higher earnings and reduce lending less than other banks. Similarly, Drechsler et al. (2021) argue that US banks with significant maturity mismatches actively manage the sensitivity of their income (loans) and expenses (deposits) to minimise interest rate risk. They do this by leveraging market power[4] to keep deposit rate sensitivity low while holding long-term fixed-rate assets to limit income fluctuations. This strategy of sensitivity matching leads to different pass-through dynamics for term deposits and loans while helping banks stabilise profits despite interest rate volatility.

[4]They define market power not as collusion or a lack of competition, but as banks' ability to keep deposit rates low and slow to adjust as part of their risk-management strategy.

Fourth, we examine whether bank characteristics matter for the pass-through. Studies by Gambacorta and Mistrulli (2004), De Graeve et al. (2007), Holton and d'Acri (2018), Byrne and Kelly (2019) and Altavilla et al. (2020) collectively show that small, illiquid, poorly capitalised banks with higher asset impairments and weaker balance sheets tend to exhibit greater pass-through, thereby amplifying the effects of monetary policy actions. We contribute to this literature by examining how banks' balance sheet characteristics—specifically, capital ratio, non-performing loan ratio, and bank size—affect the response of lending rates to monetary policy changes. We find that pass-through to floating mortgage rates is lower when banks have a larger share of non-performing loans, consistent with earlier literature.

The structure of our paper is as follows: In the next section, Section 2, we introduce our data and outline our methodological framework. Section 3 presents the empirical findings. Finally, Section 4 concludes.

2 Data sources and methodology

2.1 Data

We use weekly bank-level data on mortgage rates and term deposit rates of New Zealand's leading 10 banks.[5] The data on mortgage and deposit rates are published at a weekly frequency by interest.co.nz, which reports banks' advertised rates; while these weekly series are publicly available, the long historical time series we use is obtained directly from the Reserve Bank. Other bank characteristics come from Reserve Bank data as well, for which only shorter time series are available on the Reserve Bank's website. The mortgage rates data starts from July 20th, 2001, while the term deposit rates data starts from January 4th, 2002. Our dataset ends June 28th, 2024. We use three different term deposit rates: the one-month, the six-month, and the twelve-month rate. We also use three different mortgage rates: the floating rate, the six-month rate, and the twelve-month rate. The data is as of close of business (COB) Friday. Any Official Cash Rate (OCR)-related changes that occurred earlier in the same week are expected to be reflected in these data.

We focus on term deposits and mortgage rates with maturities of one year or less because the pass-through of monetary policy can be identified more cleanly at the short end of the yield curve. Short-maturity retail rates move closely with OCR changes, allowing us to isolate the effect of monetary policy with less contamination from other factors. In contrast, rates at longer maturities (such as 1–2 year fixed mortgages commonly used in New Zealand) embed a broader set

[5] Our data on mortgage and term deposit rates are self-reported interest rates for new loans and new deposits. The banks in our sample are ANZ, BNZ, ASB, Westpac, Kiwibank, TSB, SBS, Heartland Bank, Rabobank, and The Co-operative Bank.

of influences—including expectations of the future OCR path, term premia, the macroeconomic outlook, and banks' medium-term funding strategies.[6] In other words, limiting the horizon to 12 months is a modelling and identification choice.

In New Zealand, a large portion of the total stock of loans and deposits—not just new issuances—has maturities of one year or less. As a result, the majority of bank funding and lending resets within a year, making banks' balance sheets particularly sensitive to short-term interest rate changes and highlighting the relevance of these rates for capturing the main channels of monetary policy transmission.

We use the Official Cash Rate (OCR), which is New Zealand's key monetary policy rate. As control variables in our regressions, we use the inflation rate, the GDP growth rate and the housing price inflation rate[7], the ANZ Bank New Zealand Limited (2023) commodity price index and the NZD-USD and NZD-AUD exchange rate series from Reuters. We use the temporal disaggregation approach proposed by Quilis (2018) to convert the lower frequency control variables into weekly time series. Table 1 presents summary statistics of the data employed in our analysis.

[6] Financial yields can be decomposed into two components: the expected rate and the risk premium. Monetary policy shocks increase both, with the risk premium for short-term rates close to zero but rising with longer maturities, reflecting the combined effects of policy expectations and risk compensation (see, e.g., De Pooter et al. (2021)).

[7] The GDP growth rate and the housing price inflation rate are measured year over year at the quarterly and monthly frequency respectively.

Table 1: ***Summary statistics for New Zealand retail rates, macroeconomic variables, and bank characteristics***

Variable	Observations (converted freq)	Mean	Std. Dev.	Min	Max	Source	Frequency (W/M/Q)
Term Deposit-1M	9,164	2.47	1.50	0.07	8.25	RBNZ	W
Term Deposit-6M	9,150	4.35	1.78	0.60	9.00	RBNZ	W
Term Deposit-12M	9,156	4.55	1.76	0.75	9.00	RBNZ	W
Mortgage rate-Floating	10,303	6.72	1.60	3.40	10.95	RBNZ	W
Mortgage rate-6M	9,887	6.08	1.49	2.44	9.95	RBNZ	W
Mortgage rate-12M	10,297	5.93	1.65	1.85	9.95	RBNZ	W
NZDAUD	1,198	0.88	0.06	0.73	0.99	Reuters	W
NZDUSD	1,198	0.68	0.10	0.40	0.88	Reuters	W
ANZ Commodity Price index	1,198	257.54	71.17	126.68	414.45	ANZ	W
NZ Official Cash Rate	1,198	3.75	2.29	0.25	8.25	RBNZ	W
Monetary policy surprises	1,198	0.00	0.04	-0.52	0.29	RBNZ	W
Inflation rate	1,198	1.70	0.04	0.08	7.30	Stats NZ	Q to W (converted)
GDP growth rate	1,185	2.68	2.56	-9.78	17.73	Stats NZ	Q to W (converted)
Housing price inflation rate	1,198	7.34	8.27	-13.04	28.77	CoreLogic	M to W (converted)
Capital ratio	8,090	14.15	1.80	9.42	39.22	RBNZ	M to W (converted)
Total assets (NZDm)	4,455	51,961	59,768	2,271	201,134	RBNZ	M to W (converted)
Nonperforming loans	8,873	1.19	1.33	0.05	6.53	RBNZ	M to W (converted)

Note: Deposit and mortgage rates, NZ Official Cash Rate, monetary policy surprises, inflation rate, GDP growth rate, housing price inflation rate, capital ratio, and nonperforming loans are in percentages. The data set is not a balanced panel. Some banks have less than 1198 weeks of data.

Mortgages are important for the transmission of monetary policy in New Zealand. According to Stats NZ (2022) 32% of households have a mortgage on the primary residence. This underscores the influence of mortgage rates on the housing market and households' cash flow in New Zealand. Mortgages are important not only for the household sector but also for the financial sector. For the ten largest banks in New Zealand covered in our sample, approximately 64% of their loan portfolios consist of residential mortgages (see Figure 1).

Mortgages in New Zealand are either fixed-rate or floating-rate. With fixed-rate mortgages, the interest rate is fixed for a certain period. Payments are known and certain for this period, although some mortgages allow for additional or irregular payments within certain limits. Fixed-rate mortgages for two years or less are most common in New Zealand. At the end of the fixed-rate period, borrowers typically revert to the lender's standard floating rate unless they arrange a new fixed-rate term. To continue with another fixed-rate period, they must renegotiate the interest rate with their current lender. If no deal is made with the current lender, the borrower can obtain a (fixed-rate or floating-rate) mortgage with another lender and pay off the old mortgage with the new mortgage. In a floating-rate mortgage, the interest rate can change at any time. Repayments of the principal amount are flexible in this scenario, however, a minimum principal repayment is still required.

The practice of fixed-rate periods of mostly below three years implies that New Zealand's mortgage market has very short maturity periods compared to the United States or some European countries, where mortgages often extend up to 30 years. Figure 3 shows that, as of 2024, over 73% of the bank's mortgage loans have a residual maturity of one year or less.[8]

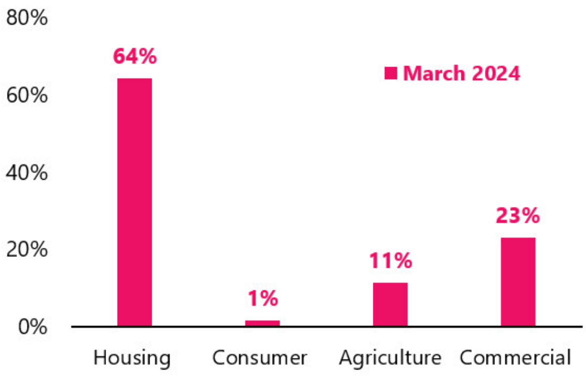
We also study the transmission of monetary policy to term deposit rates, since they are the primary drivers of funding costs for New Zealand banks. In the aftermath of the Great Financial Crisis (GFC) in 2008, New Zealand banks increasingly relied on more stable funding sources such as term deposits. As Wong (2012) states this strategic shift was motivated by the realisation that dependence on short-term wholesale funding or inter-bank borrowing during the GFC period exposed them to market volatility and liquidity risk. This shift toward term deposits as a stable funding source did not occur entirely by choice. Banks were also required to comply with regulatory mandates, including the Reserve Bank of New Zealand's core funding ratio (See Wong (2012)). Since 2010, New Zealand banks have been mandated to source a substantial portion of their funding from more stable sources[9] (as of 2025, this share is 75%).

Figure 2 illustrates that nearly 70% of New Zealand banks' funding sources are from domestic non-market sources, predominantly term deposits. Also, looking at term maturities of banks' funding sources, around 71% of their funding is coming from term deposits with maturities of one year or less (see Figure 4).

[8]The very short-term maturity of mortgages in New Zealand compared to the rest of the world is less surprising when taking into account the funding of banks. Banks in New Zealand generally fund themselves with short-maturity deposits, mostly below 5 years.

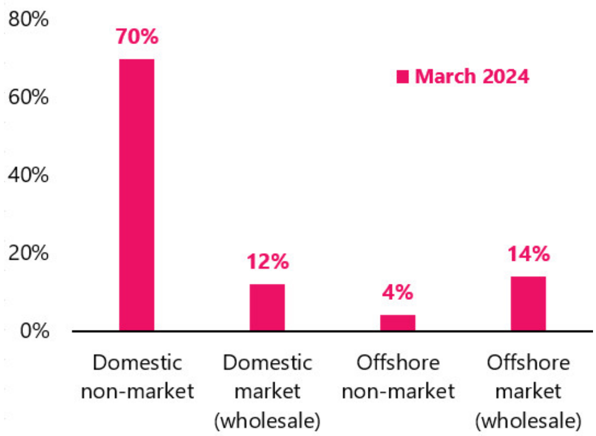
[9]Based on the requirements of the Reserve Bank of New Zealand's core funding ratio, a stable funding source is defined as funding expected to remain with the bank for at least one year such as retail deposits and long-term wholesale funding.

Figure 1: New Zealand banking system loans.



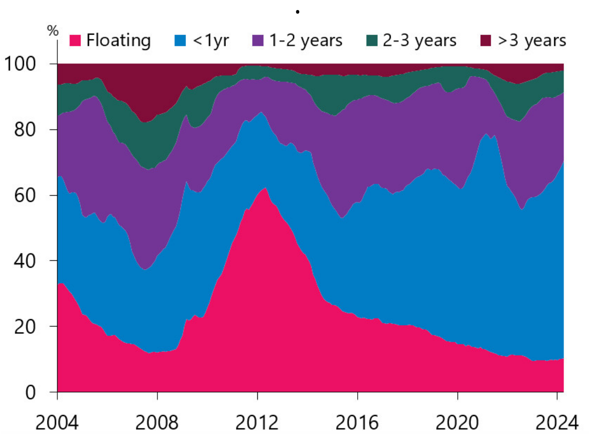
Source: Reserve Bank of New Zealand.

Figure 2: New Zealand banking system funding sources.



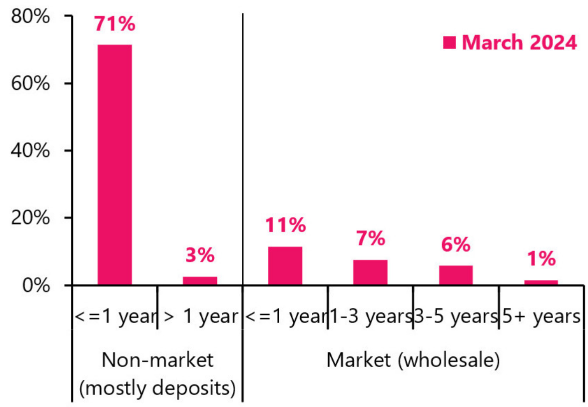
Source: Reserve Bank of New Zealand.

Figure 3: New Zealand banking system housing loans.



Note: The percentage shares are based on residual maturity rather than original maturity.
Source: Reserve Bank of New Zealand.

Figure 4: New Zealand banking system funding source maturities.



Source: Reserve Bank of New Zealand.

2.2 Methodology

The OCR is the main policy tool set by the Monetary Policy Committee of the Reserve Bank of New Zealand (RBNZ). The interest rates applied to settlement accounts at the RBNZ are tied to the OCR. Short-term market rates therefore closely follow the OCR. There were 175 monetary OCR announcements (see Table 2) during our sample period (July 2001 to June 2024). In 117 cases the Monetary Policy Committee kept the OCR unchanged, in 35 cases it increased the OCR, and in 23 cases it decreased the OCR. Increases and decreases were always 25 basis points or a multiple thereof. We exclude shocks caused by unconventional monetary policy measures.

In the presence of forward-looking financial markets, changes in the policy rate may already be priced into retail banking rates before the actual change occurs, an observation made by Sellon (2002) and reiterated by Kleimeier and Sander (2006). Regressing bank interest rate changes on actual policy rate changes might therefore lead to biased estimates of the true pass-through. One way out of this problem is to only use unexpected policy rate changes. By definition, unexpected policy changes cannot be priced in ex-ante. In practice, policy rate changes are imperfectly predicted. We aim to isolate the unexpected part of the monetary policy change (i.e. the monetary policy surprise) so that we can use it as an instrument for the actual change. By doing that, our estimates of the pass-through coefficients will be unbiased.

To construct the monetary policy surprises, we use the high-frequency method of Gürkaynak et al. (2005). We follow Gertler and Karadi (2015)'s approach and construct a time series of changes (i.e. surprise movements) on the announcement day in the interest rates futures that are closely linked to the policy rate. In the case of New Zealand these are the 2, 3, and 4 months ahead 90-Day Bank Bill rates. These futures price surprise movements are constructed as below:

$$Surprise_{w,\,d}^{h} = F_{w\,+\,h,\,d} - F_{w\,+\,h,\,d\,-\,1} \tag{1}$$

Where $F_{w\,+\,h,\,d}$ is the price of the h-months ahead 90-Day New Zealand Bank Bill contract in week w on day d which is monetary policy announcement day. Similar to Kuttner (2001), we select a one-day window to capture persistent effects and avoid the impact of background noise such as event traders. [10] It is important to note that due to our identification strategy we exclude unconventional monetary policy announcements. The exclusion restriction requires that monetary policy surprises affect retail rates only through changes in the OCR, which is plausible given that these surprises are measured in a narrow window around policy announcements and therefore primarily capture unexpected changes in the policy rate rather than broader macroeconomic news.

Following Gürkaynak et al. (2005), using the standard method of principal components on the matrix of surprise movements in futures prices, we extract two factors to characterise the monetary policy surprises. We perform a rotation on two factors, transforming the unexpected change in the OCR to be primarily influenced by the first factor named "target" while all other elements of OCR announcements impacting futures rates are driven by the second factor, named "path". For instance, any information that affects the anticipated trajectory of monetary policy over the forthcoming year will be captured by "path". To have a meaningful scaling, we select the 30-Day Bank Bill and 4-month ahead 90-Day Bank Bill to adjust one unit of "target" monetary policy surprise

[10] Using a one-day window to construct monetary policy surprises is a pragmatic choice that balances precision with completeness. Very short intraday windows (e.g., 30 minutes) minimise contamination from other events but can suffer from market microstructure noise and may miss the information conveyed during the central bank's press conference.

and one unit of "path" monetary policy surprise. See Gürkaynak et al. (2005), for more detail. We interpret the "target" factor to be the monetary policy surprises, $Surprise_{w,d}$, as it captures exclusively the unexpected change in OCR. Finally, our results are aggregated into a weekly series, as outlined below:

$$Surprise_w = \begin{cases} Surprise_{w,d}, & \text{if one announcement} \\ 0, & \text{if no announcement} \end{cases}$$

Figure 5 shows the monetary policy surprises. The largest shock, a negative 52 basis points, occurred on 16 March 2020, at the onset of the COVID-19 pandemic. This unscheduled announcement reflected the central bank's rapid response to economic uncertainty and came as a significant surprise to the market. The largest positive surprise was 29 basis points in 2023, occurring when the Silicon Valley Bank failure coincided with the Reserve Bank of New Zealand's April 2023 policy decision. In that meeting, the Reserve Bank of New Zealand raised the OCR by 50 basis points, from 4.75% to 5.25%, a move that came as a substantial surprise to the market participants.

Table 2: ***Descriptive statistics for Reserve Bank of New Zealand monetary policy changes***

	Obs	Mean	Std. Dev.	Min	Max
All meetings	175	0	0.27	-1.5	0.75
Increase	35	0.32	0.12	0.25	0.75
Decrease	23	0.49	0.37	0.25	1.5
No change	117				

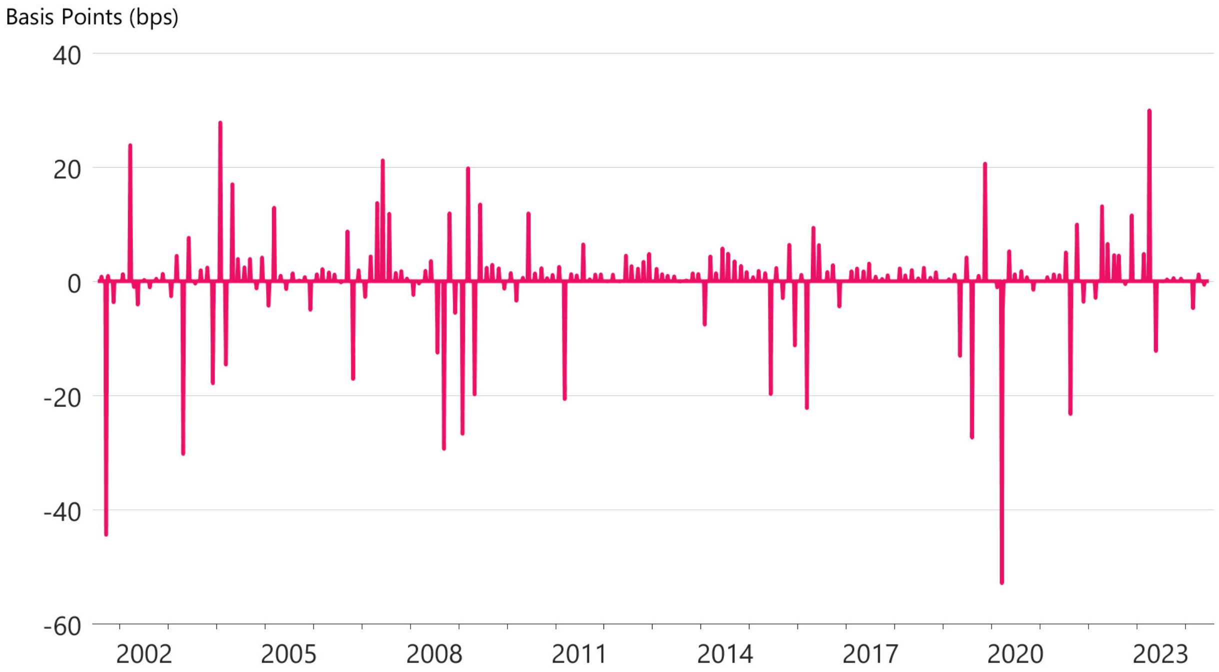
Reserve Bank of New Zealand OCR change announcement on meeting dates over the period July 2001–June 2024 (in percentage points).

We are interested in the immediate effect of the announcement on mortgage and deposit rates, as well as the pass-through of the announcement in the time following the announcement. We are also interested in whether policy tightening (increase in OCR) is differently passed-through than policy loosening (decrease in OCR) and whether bank balance sheet characteristics matter for pass-through. Below we describe how we tackle those questions.

Contemporaneous effect

What happens with mortgage and deposit rates immediately after the announcement? To answer this question, we estimate a panel regression model to obtain the contemporaneous pass-through of monetary announcements into mortgage rates and term deposit rates (Equation 2).

Figure 5: The weekly series of monetary policy surprises are constructed using data on futures contracts for the 90 days New Zealand bank bill.



$$Y^m_{j,w} - Y^m_{j,w-1} = \alpha_{j,y} + \beta(\triangle R_w) + \epsilon_{j,w} \tag{2}$$

Where $Y^m_{j,w}$ is the mortgage (deposit) rate with maturity m in week w by bank j and $\triangle R_w$ is the change in the OCR in week w. $\alpha_{j,y}$ is bank-by-year fixed effects to absorb any bank-specific [11] or business cycle movements in mortgage rates and term deposit rates. This means that fixed effects vary over time for each bank. The bank-by-year fixed effects should capture the business cycle movements. However, for robustness, we run regressions that include a vector of lagged control variables, including GDP growth, inflation, housing price inflation, USD and AUD exchange rates and the ANZ commodity price index. $\epsilon_{j,w}$ is mean zero error term capturing other shocks.[12] Our estimate of β can be directly interpreted as the fraction of the OCR change that is passed through immediately.

For a given banks' retail rate (mortgage or deposit) at a given maturity, we pool the weekly data for the 10 banks. We estimate Equation 2 separately for three different term maturities for mortgages and deposit rates. We consider model specifications with and without bank-by-year fixed effects as well as with and without control variables. Additionally, we employ two different

[11] Individual banks might price their mortgage loans and term deposit rates differently depending on several factors such as 1) market competition, 2) banks' specific policy or strategy (e.g., risk aversion, liquidity, hedging, etc), 3) size of the bank, 4) alternative source of funding, and 5) market demand for mortgages or term deposits. The bank-by-year fixed effect will absorb these factors.

[12] To avoid cluttering the notation, we dropped the superscript m on all coefficients and error term. We also do this in the equations that follow.

methodologies: ordinary least squares (OLS) and instrumental variables (IV), where we use our identified monetary policy shocks, $Surprise_w$, as an instrument for the OCR changes.

Impulse response function

How do mortgage rates and deposit rates respond in the weeks (and months) after a monetary policy announcement? To answer this question, we use Panel Local Projection methods to produce impulse response functions (IRFs). Our Panel Local Projection regression is as follows:

$$Y^m_{j,w+h} - Y^m_{j,w-1} = \alpha^h_{j,h} + \beta^h(\triangle R_w) + u^h_{j,w} \tag{3}$$

where $Y^m_{j,w+h}$ is the mortgage (deposit) rate with maturity m of bank j in week $w+h$. $\alpha^h_{j,y}$ is a bank-by-year fixed effect. β^h captures the pass-through of monetary policy to mortgage rates and term deposit rates at the horizon h, it can be interpreted as the fraction of the OCR change that is passed through in a period of h weeks after the announcement. $u^h_{j,w}$ is mean zero error term capturing other shocks. For a given retail product (mortgage or deposit) at given maturity, we again pool the data for the 10 banks and estimate Equation 3 for each horizon h (h=0,...26). We first estimate using OLS and thereafter again use our identified monetary policy shocks $Surprise_w$ as instruments for the OCR changes in an IV Panel-local projection.

Asymmetric pass-through

Banks might respond differently to decreases in the policy rate than to increases. Asymmetric pass-through from market rates or monetary policy rates to bank rates has been found in earlier studies. For instance, Neumark and Sharpe (1992) using panel data on consumer bank deposit interest rates, confirm that banks in concentrated markets [13] adjust their behavior to extract more surplus from depositors. Their study reveals that banks in concentrated markets are slower in increasing interest rates on deposits when market rates[14] rise, but they are faster in reducing them when market rates decline. Lim (2001) finds that in Australia, loan and deposit rates change in response to a change in the bank-bill rate, at a faster rate during periods of monetary easings than during periods of monetary tightening. Gambacorta and Iannotti (2007) find that in Italy banks adjust their loan rate faster during periods of monetary tightening, and deposit rates adjust faster during monetary easing. Fuertes et al. (2010) find similar results for the UK. They find that deposit rates tend to adjust faster when official rates are cut than when they are raised. For

[13] A "concentrated market" refers to a banking market where a relatively small number of banks hold large shares of total deposits, implying limited competition and greater market power for those banks.

[14] They use the 6-month T-bill as a measure of market rates, so their results are not directly comparable with ours. Similarly, using the 3-month T-bill rate as a measure of the market rate Hannan and Berger (1991) find upward rigidity of deposit rates (banks hesitate to raise rates on deposits).

mortgages they find the opposite: mortgages rates rise faster when official rates are raised. Holland et al. (2020) find a similar asymmetric behaviour for mortgage rates for Australian banks. In a cross-country study, Apergis and Cooray (2015) find asymmetric pass-through for the US, UK, and Australia.

Differences in pass-through for decreases and increases in the policy rate could make optimal monetary policy more challenging, particularly within the retail interest rate channel we analyse. Consequently, we investigate whether increases in the OCR (policy tightening) exert the same effect as decreases in the OCR (policy loosening) using the following model:

$$Y^{m}_{j,\,w\,+\,h} - Y^{m}_{j,\,w\,-\,1} = \alpha^{h}_{j,\,w} + \beta^{+}_{h} max\{\triangle R_w, 0\} + \beta^{-}_{h} min\{\triangle R_w, 0\} + u^{h}_{j,\,w} \tag{4}$$

The estimated coefficients β^{+}_{h} and β^{-}_{h} allow us to test for sign-dependent impulse responses. Perfect symmetric transmission of monetary policy changes would imply β^{+}_{h} - β^{-}_{h} =0. In contrast, asymmetric effects would exist when β^{+}_{h} - β^{-}_{h} significantly differs from zero.

Heterogeneous responses

Past literature has shown that banks' balance sheet characteristics affect how lending rates respond to monetary policy changes.[15] Using Belgian bank level data, De Graeve et al. (2007) find that the loan and deposit rates of well-capitalised and highly liquid banks are the least responsive to changing market conditions. Gambacorta (2008) finds for a set of Italian banks that interest rates on short-term lending of liquid and well-capitalised banks react less to changes in official policy rates. Holton and d'Acri (2018) using euro area bank level data finds that asset impairment leads to a significant decrease in pass-though. More recently, Altavilla et al. (2020) show that, for a set of 325 banks resident in the euro area, factors like capital ratio, exposure to domestic sovereign debt, the share of non-performing loans, and the stability of the funding structure create variations in how monetary policy is transmitted to lending rates.

Following this literature, we test whether the following balance sheet characteristics matter for the strength and speed of pass-through: size, capital ratio and share of non-performing loans. We estimate separate regressions in which we add the interaction of the OCR change with the balance sheet characteristic and add the banks' balance sheet characteristic separately.

[15]A related literature on the bank lending channel finds the effects of balance sheet characteristics on the lending volume. Kashyap and Stein (2000) find that banks with less liquid balance sheets experience a stronger impact of monetary policy on lending growth. Similarly, Kishan and Opiela (2000) provide cross-sectional evidence showing that lending of small and under-capitalised banks is more affected by monetary policy changes. Gambacorta and Mistrulli (2004) highlight the importance of bank capitalisation, noting that well-capitalised banks are better positioned to insulate their lending activities from monetary policy shocks due to their easier access to non-deposit funding sources.

Our Panel Local Projection regression for heterogeneous responses is therefore as follows:

$$Y^m_{j,w+h} - Y^m_{j,w-1} = \alpha^h_{j,h} + \beta^h_1 \triangle R_w + \beta^h_2 (\triangle R_w \times q_{j,w}) + \beta^h_3 q_{j,w} + u^h_{j,w} \tag{5}$$

where $q_{j,w}$ is a balance sheet characteristics of bank j in week w. If the estimated coefficient β^h_2 significantly differs from zero, the bank characteristic affects pass-through.

Monetary policy shocks as instruments

To evaluate instrument strength, we regress the change in monetary policy rate on the monetary policy surprises in a time-series first-stage regression, collapsing the panel between banks since the instrument is identical between banks at each point in time. We also run the test excluding non-OCR weeks when both monetary policy surprises and OCR changes are zero. Table 3 reports the first-stage results. The first-stage results show that the instrument strongly predicts OCR changes, with F-statistics well above the conventional threshold, supporting the relevance of the instrument. This suggests that our monetary policy surprises provide a valid source of exogenous variation for identifying the pass-through of policy rate changes to bank retail rates.[16]

Table 3: First-stage regression of policy rate changes on monetary policy shocks

Endogenous variable	Instrument	Coefficient	Std. Error	t-stat	F-stat
ΔOCR (all weeks)	MP Surprises (all)	1.348	0.065	20.57	423.18
ΔOCR (OCR announcement weeks)	MP Surprises (non-zero)	1.349	0.172	7.83	61.32

Note: The F-statistic indicates a strong instrument

3 Results

3.1 Contemporaneous pass-through

We start by discussing the immediate reaction of mortgage and deposit rates after the announcement. Table 4 reports our estimates of Equation 2 for the shortest maturity: the floating mortgage rate and the 1-month deposit rate. Results for mortgage rates are presented in the upper panel, and results for term deposit rates are presented in the lower panel. Columns (1) to (3) present OLS estimates. Columns (4) to (6) show IV estimates where we use the identified monetary policy surprises as an instrumental variable for the OCR change. The different columns represent respectively, results without fixed effects and controls, with fixed effects but without

[16] The scatter plot of monetary policy surprises and OCR changes can be found in the Appendix; see Figure 16.

controls, and with both fixed effects and controls. Column (6) provides our preferred estimates and includes bank-by-year fixed effects and a set of control variables. However, adding fixed effects or controls has little impact on the estimated pass-through.

In Column (6) of Tables 6 and 5, some coefficients are not statistically significant. The significance partly depends on the horizon. For the contemporaneous effect, the horizon is zero (shown in Figure 6). As the horizon increases, the effects become more pronounced and eventually reach conventional levels of statistical significance, which we discuss in more detail later in the paper.

A coefficient equal to one would indicate an immediate one-to-one pass-through, meaning that banks would fully pass any change in the OCR to retail rates within the week of the announcement. Using our preferred estimates, we find a pass-through coefficient of 0.377 for the floating mortgage rate and a pass-through coefficient for the 1-month deposit rate of 0.053. The pass-through for mortgages is much higher than for deposits. This is in line with earlier literature that finds sticky deposit rates. Interestingly for the mortgage rate, the coefficients estimated by OLS (between 0.274 and 0.295) are smaller than those estimated by IV (between 0.377 and 0.383) indicative of the idea that OLS coefficients are biased downward if part of the expected policy change is already passed through before the announcement as suggested by Sellon (2002) for mortgage rates in the US. However, OLS estimates are above IV estimates for 1-month deposit rates.

Table 5 and 6 report estimates for the 6-month and 12-month maturities. For both mortgages and deposits at 6-month and 12-month maturity, both the OLS and the IV estimates are far below one. Interestingly, the IV estimates are somewhat lower than the OLS estimates. The immediate pass-through appears to be rather similar for deposit rates compared to mortgage rates for these maturities.

Table 4: ***Floating mortgage rates and 1-month term deposit rates - contemporaneous effect***

	Mortgage rates					
	(1)	(2)	(3)	(4)	(5)	(6)
Variables	OLS	OLS	OLS	IV	IV	IV
$\triangle R_w$	0.295***	0.289***	0.274***	0.383***	0.377***	0.377**
	(0.044)	(0.051)	(0.045)	(0.077)	(0.078)	(0.090)
Fixed Effects	No	Yes	Yes	No	Yes	Yes
Controls	No	No	Yes	No	No	Yes
R-Squared	0.21	0.22	0.24	0.21	0.16	0.18
No. of banks	10	10	10	10	10	10
Observations	10180	10180	10072	10180	10180	10072
	Term Deposit rates					
	(1)	(2)	(3)	(4)	(5)	(6)
Variables	OLS	OLS	OLS	IV	IV	IV
$\triangle R_w$	0.086***	0.089***	0.079***	0.063*	0.063	0.053
	(0.016)	(0.013)	(0.013)	(0.026)	(0.030)	(0.042)
Fixed Effects	No	Yes	Yes	No	Yes	Yes
Controls	No	No	Yes	No	No	Yes
R-Squared	0.01	0.04	0.06	0.04	0.03	0.05
No. of banks	10	10	10	10	10	10
Observations	9154	9154	9070	9154	9154	9070

* p $<$ 0.05, ** p $<$ 0.01, *** p $<$ 0.001

Standard errors in parentheses. Standard errors are double-clustered by weeks and banks. Definition of variables: $\triangle R_w$ is monetary policy change. Our vector of control variables contains 18 lags of GDP growth, inflation, housing price inflation, USD and AUD exchange rates, and the ANZ commodity price index. To address potential serial correlation, we include 18 lags of $\triangle R_w$ in all models.

Table 5: ***6-month mortgage rates and term deposit rates - contemporaneous effect***

			Mortgage rates			
Variables	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) IV	(6) IV
$\triangle R_w$	0.163***	0.151*	0.122***	0.084	0.072	0.048
	(0.027)	(0.047)	(0.025)	(0.054)	(0.057)	(0.057)
Fixed Effects	No	Yes	Yes	No	Yes	Yes
Controls	No	No	Yes	No	No	Yes
R-Squared	0.10	0.11	0.14	0.09	0.06	0.10
No. of banks	10	10	10	10	10	10
Observations	9781	9781	9685	9781	9781	9685
			Term Deposit rates			
Variables	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) IV	(6) IV
$\triangle R_w$	0.183**	0.146**	0.121***	0.108**	0.088	0.065
	(0.043)	(0.042)	(0.037)	(0.040)	(0.042)	(0.045)
Fixed Effects	No	Yes	Yes	No	Yes	Yes
Controls	No	No	Yes	No	No	Yes
R-Squared	0.03	0.10	0.13	0.09	0.05	0.08
No. of banks	10	10	10	10	10	10
Observations	9139	9139	9055	9139	9139	9055

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Standard errors in parentheses. Standard errors are double-clustered by weeks and banks. Definition of variables: $\triangle R_w$ is monetary policy change. Our vector of control variables contains 18 lags of GDP growth, inflation, housing price inflation, USD and AUD exchange rates, and the ANZ commodity price index. To address potential serial correlation, we include 18 lags of $\triangle R_w$ in all models.

Table 6: ***12-month mortgage rates and term deposit rates - contemporaneous effect***

Mortgage rates						
	(1)	(2)	(3)	(4)	(5)	(6)
Variables	OLS	OLS	OLS	IV	IV	IV
$\triangle R_w$	0.174***	0.158*	0.132**	0.145**	0.131*	0.106
	(0.033)	(0.053)	(0.031)	(0.053)	(0.056)	(0.056)
Fixed Effects	No	Yes	Yes	No	Yes	Yes
Controls	No	No	Yes	No	No	Yes
R-Squared	0.09	0.10	0.14	0.09	0.05	0.10
No. of banks	10	10	10	10	10	10
Observations	10176	10176	10068	10176	10176	10068

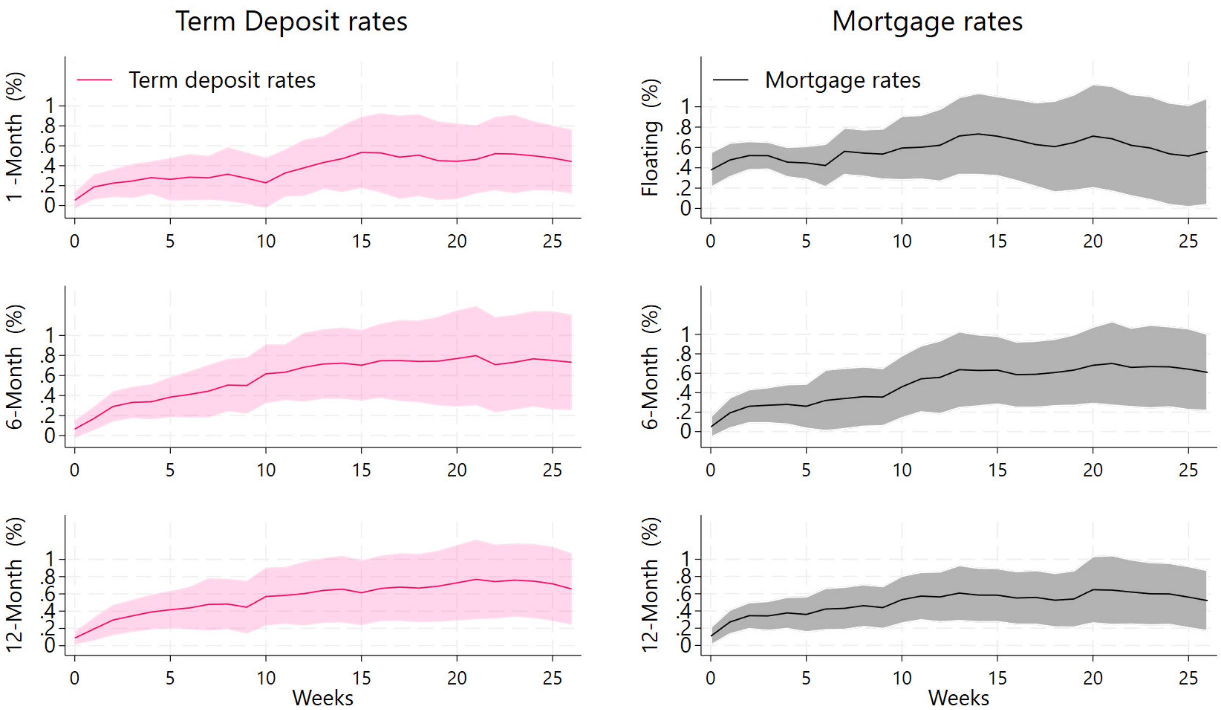
Term Deposit rates						
	(1)	(2)	(3)	(4)	(5)	(6)
Variables	OLS	OLS	OLS	IV	IV	IV
$\triangle R_w$	0.166**	0.142**	0.120**	0.127***	0.104*	0.089*
	(0.037)	(0.037)	(0.036)	(0.032)	(0.034)	(0.038)
Fixed Effects	No	Yes	Yes	No	Yes	Yes
Controls	No	No	Yes	No	No	Yes
R-Squared	0.03	0.12	0.15	0.10	0.06	0.09
No. of banks	10	10	10	10	10	10
Observations	9146	9146	9062	9146	9146	9062

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Standard errors in parentheses. Standard errors are double-clustered by weeks and banks. Definition of variables: $\triangle R_w$ is monetary policy change. Our vector of controls contains 18 lags of GDP, inflation, housing price inflation, USD and AUD exchange rates, and the ANZ commodity price index. To address potential serial correlation, we include 18 lags of $\triangle R_w$ in all models.

3.2 Impulse response functions

How do mortgage rates and deposit rates respond in the weeks (and months) after a monetary policy announcement? Figure 6 shows the responses of the three term deposit rates and the three mortgage rates over a 26-week time interval to monetary policy rate changes estimated using Equation 3 and IV-local projection. Here the pass-through is assumed symmetric for tightening and loosening events.The shaded area corresponds to a 95% confidence interval

Figure 6: Monetary policy pass-through-if the pass-through is symmetric (IV-estimates).



The figures present impulse responses of mortgage and retail rates to a 1 percentage point positive OCR change. We use monetary policy surprises as an instrumental variable for OCR changes. The shaded area corresponds to a 95% confidence interval. Standard errors are double-clustered by weeks and banks. To address potential serial correlation, we have included up to 18 lags of OCR change in our IV-LP model.

Term deposit rates and mortgage rates display a substantial and statistically significant pass-through response that increases over time and flattens after around 20 weeks. In the week of the monetary policy shock, pass-through is low, ranging from about 4–11% depending on the interest rate. After 10 weeks, only around 23–57% of the policy change has been transmitted, indicating a gradual interest rate adjustment. By 20–25 weeks, pass-through increases substantially, with point estimates suggesting 65–75% of full adjustment for most retail rates. We note that pass-through coefficient estimates at these longer horizons tend to have wider confidence intervals. As shown in Table 7, at these longer horizons, we cannot reject full (i.e. one-to-one) pass-through for most retail products, including 6- and 12-month deposit rates and floating- and 6-month mortgage rates. We reject full pass-through for the 1-month deposit rate in both the short and the long run.

Overall, these results indicate that pass-through is slow initially, but approaches one-to-one in the long run for most deposit and mortgage instruments (with the noteworthy exception of the 1-month deposit rate). Prior studies on New Zealand retail banks, including Liu et al. (2008) and Bernhard et al. (2021), find that immediate pass-through from market rates to retail rates is incomplete, but it generally approaches one-to-one over longer horizons. We also find that term length matters. Longer-maturity deposits and mortgages adjust more gradually but tend to reach higher cumulative pass-through, highlighting the importance of maturity structure in the transmission of monetary policy.

Table 7: Test of one-to-one pass-through to mortgage and deposit rates over weeks

Variables	Week 0	Week 5	Week 10	Week 15	Week 20	Week 25
1m deposit rate	0.053***	0.264***	0.229***	0.533**	0.444***	0.477***
6m deposit rate	0.066***	0.385***	0.617**	0.703*	0.770	0.751
12m deposit rate	0.088***	0.417***	0.570**	0.613**	0.728	0.717
Floating mortgage rate	0.377***	0.447***	0.595**	0.711	0.712	0.515*
6m mortgage rate	0.048***	0.261***	0.460***	0.632**	0.682	0.642*
12m mortgage rate	0.106***	0.360***	0.531***	0.583***	0.647*	0.561**

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
The table reports tests of whether the estimated pass-through coefficients differ significantly from full (one-to-one) pass-through.
Standard errors are not reported in this table.

The pass-through to mortgage rates occurs more quickly over shorter time intervals (i.e., more contemporaneously) compared to term deposit rates. Table 8 and 9 illustrate this point. Table 8 collects the pass-through coefficients at the very short time interval of one week. It shows that, across all maturities, the pass-through is generally lower to term deposit rates than to mortgage rates. However, at longer time intervals, such as at peak values (around 20 weeks after the OCR change), the pass-through to term deposit rates of 6 and 12 month maturities exceeds that of mortgage rates (see Table 9). This suggests that the speed of pass-through for term deposit rates increases as the time interval increases.

Table 8: Short-run pass-through (1-week horizon) of monetary policy to term deposit and mortgage rates

Maturity	Term deposit rates	Mortgage rates
1m / Floating	**0.19**	0.48
6m	**0.17**	0.19
12m	**0.19**	0.27

Note: Pass-through coefficients (β_h) are from IV estimates. Bold numbers highlight lower pass-through for term deposit rates.

Table 9: Long-run / Peak pass-through of monetary policy to term deposit and mortgage rates

Maturity	Term deposit rates	Mortgage rates
1m / Floating	**0.52**	0.71
	(h23)	(h20)
6m	0.80	**0.70**
	(h21)	(h21)
12m	0.76	**0.65**
	(h23)	(h20)

Note: Pass-through coefficients (β_h) are from IV estimates. Bold numbers indicate lower pass-through. Horizons (weeks) are reported in parentheses.

To evaluate whether pass-through differs statistically between mortgage and deposit rates of the same maturity, we report p-values from a t-test of equality of coefficients. For the 1-week horizon, the null of equal pass-through is rejected at the 1% level for the floating mortgage versus 1-month deposit rate comparison, indicating faster short-term adjustment of mortgage rates. At longer horizons, pass-through to 6- and 12-month deposit rates exceeds that of mortgage rates, although equality cannot be rejected at conventional significance levels.

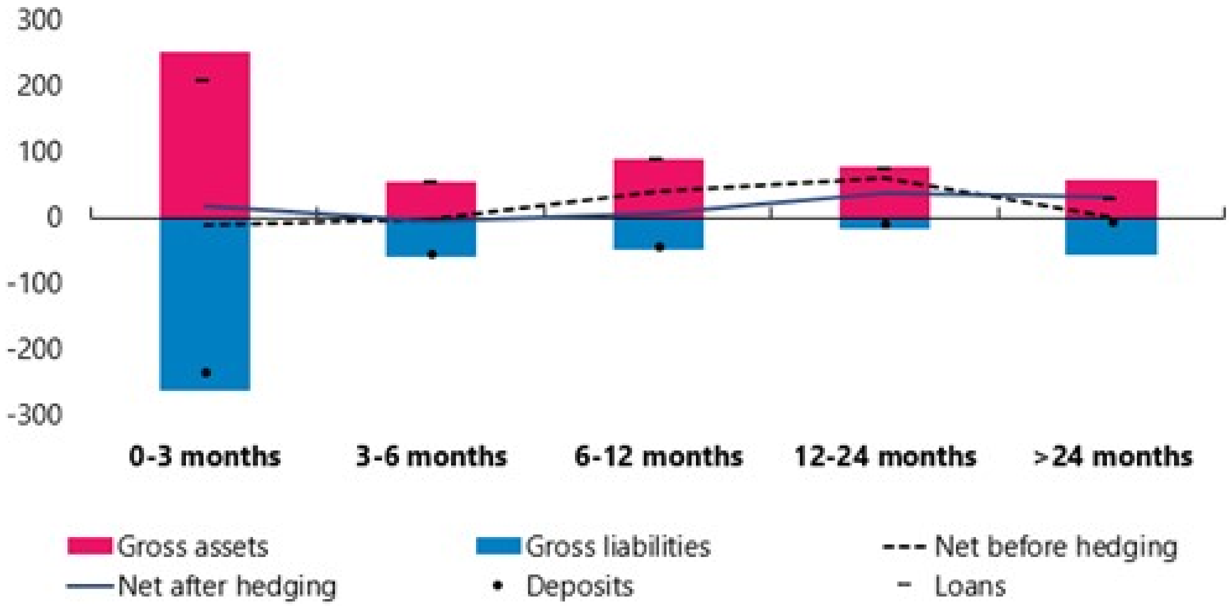
Table 10: Difference in pass-through between mortgages and term deposits

	Horizon: 1-week		Horizon: Longer time-intervals/Peak	
Maturity	t-statistic	p-value	t-statistic	p-value
1m / floating	-2.668	**0.008**	-0.59	0.555
6m	-0.206	0.839	0.290	0.772
12m	-0.776	0.438	0.393	0.694

Note: The table reports tests of equality between mortgage and term-deposit pass-through coefficients at different maturities and horizons. Test statistics are computed as $t = (\beta_{TD} - \beta_{MTG})/\sqrt{SE_{TD}^2 + SE_{MTG}^2}$ under the assumption of independent estimates. P-values are based on a two-tailed t-test with the appropriate degrees of freedom. A negative statistic indicates a higher mortgage pass-through.

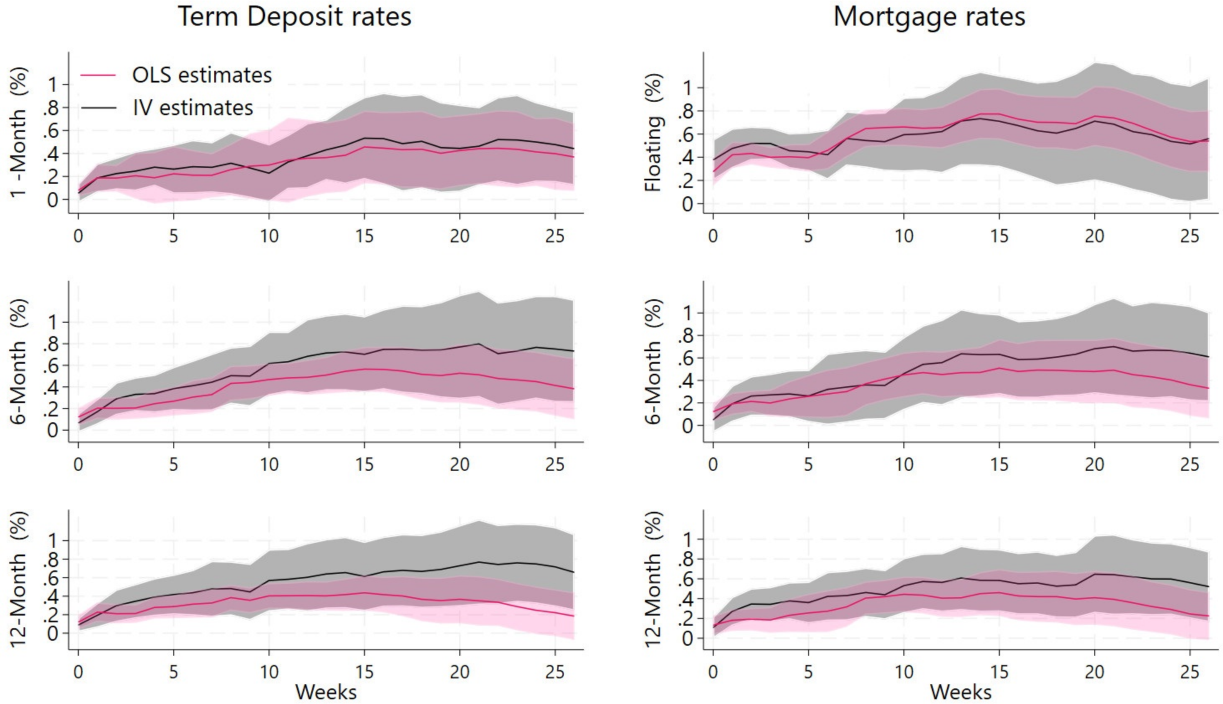
Banks typically hold more assets than liabilities with maturities of around 6 to 12 months (see Figure 7). As the pass-through to mortgage rates (which are on the asset side) is faster, this benefits the banks. However, to attract more deposits and balance liabilities with assets, banks may be incentivised to accelerate the pass-through to term deposit rates later on, allowing these rates to catch up to mortgage rates by the 20–23 week horizon.

Figure 7: New Zealand banks' maturity matching strategy.



Source: March 2024 /Dec 2023 Disclosure Statements of ANZ Bank New Zealand, ASB Bank, BNZ, and Westpac New Zealand and RBNZ Bank surveys. Higher net after hedging for 0-3 months is driven only by Westpac.

Figure 8: Monetary policy pass-through (OLS and IV estimates) and assuming the pass-through is symmetric.



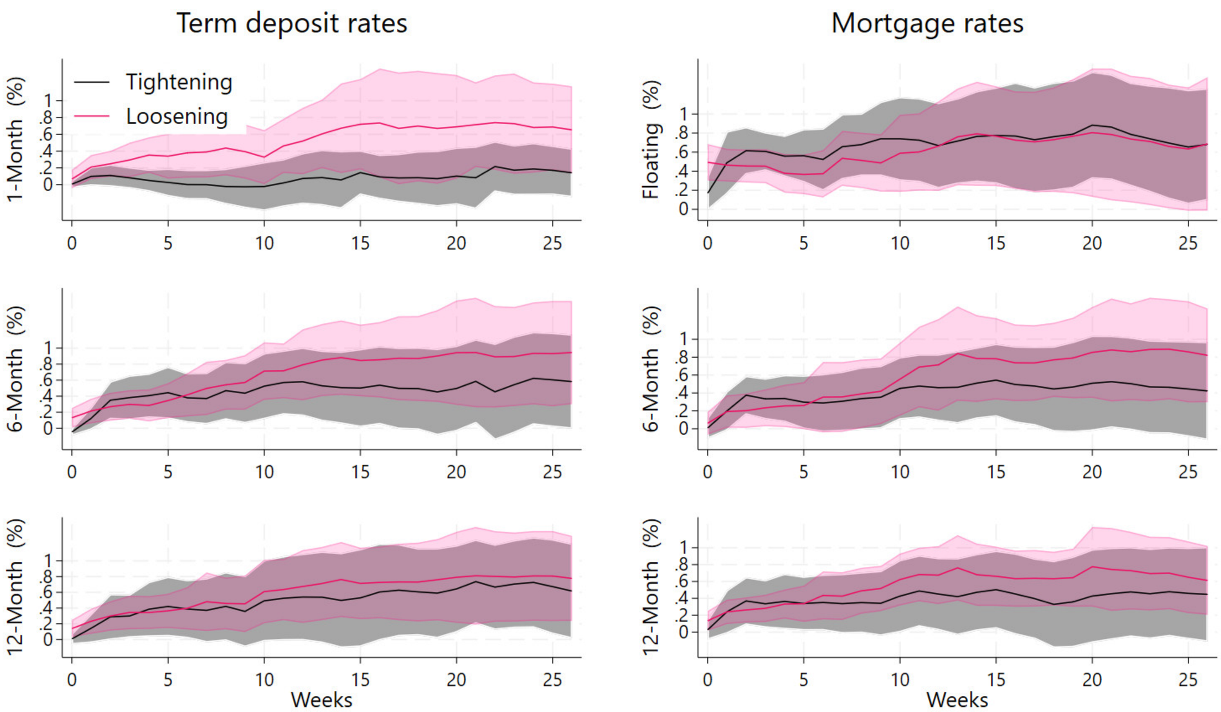
The figures present impulse responses of mortgage and retail rates to a 1 percentage point increase in the OCR. For the IV estimates, we use monetary policy surprises as an instrumental variable for OCR changes. In the OLS estimates, changes in monetary policy are analysed without using monetary policy surprises as an instrumental variable. The shaded area corresponds to 95% confidence interval.

We have argued above that OLS estimates of pass-through might be biased downwards if some pass-through of a (partially) anticipated OCR change occurs before the actual OCR change. In other words, if financial markets predict OCR changes and pass-through happens in advance, OLS will not capture the full effect. By contrast, if all OCR changes were completely unanticipated, OLS estimates would likely be consistent and unbiased. Using our monetary policy surprises as an instrument for the OCR change, we can check the reaction to an unanticipated change. To see if the OLS estimates are below the IV estimates, Figure 8 compares both OLS and IV estimates of IRFs of mortgage rates and term deposit rates. Notably, the reactions based on the OLS estimates are substantially smaller (especially for the maturities of 6 and 12 months, there is little difference for the short maturities). This suggests that indeed OCR changes are to some extent anticipated, and banks may have adjusted interest rates in advance of the official monetary policy announcements, lowering the pass-through after the change.

3.3 Asymmetric pass-through

The monetary policy pass-through might respond differently to loosening and tightening policy changes. Testing for asymmetric pass-through with our dataset is somewhat challenging as we only have 35 tightening events (i.e. increases in the OCR) and 23 loosening events (i.e. decreases in the OCR). Nevertheless, Figure 9 shows the results of estimating Equation 4, allowing for asymmetric effects of increases and decreases in the OCR. The left side of the column shows the impulse response coefficient of β_h^+ following tightening monetary policy and β_h^- following loosening monetary policy for term deposit rates at three different term maturities. The second column shows the same for mortgage rates.

Figure 9: Monetary policy pass-through-if the pass-through is asymmetric.

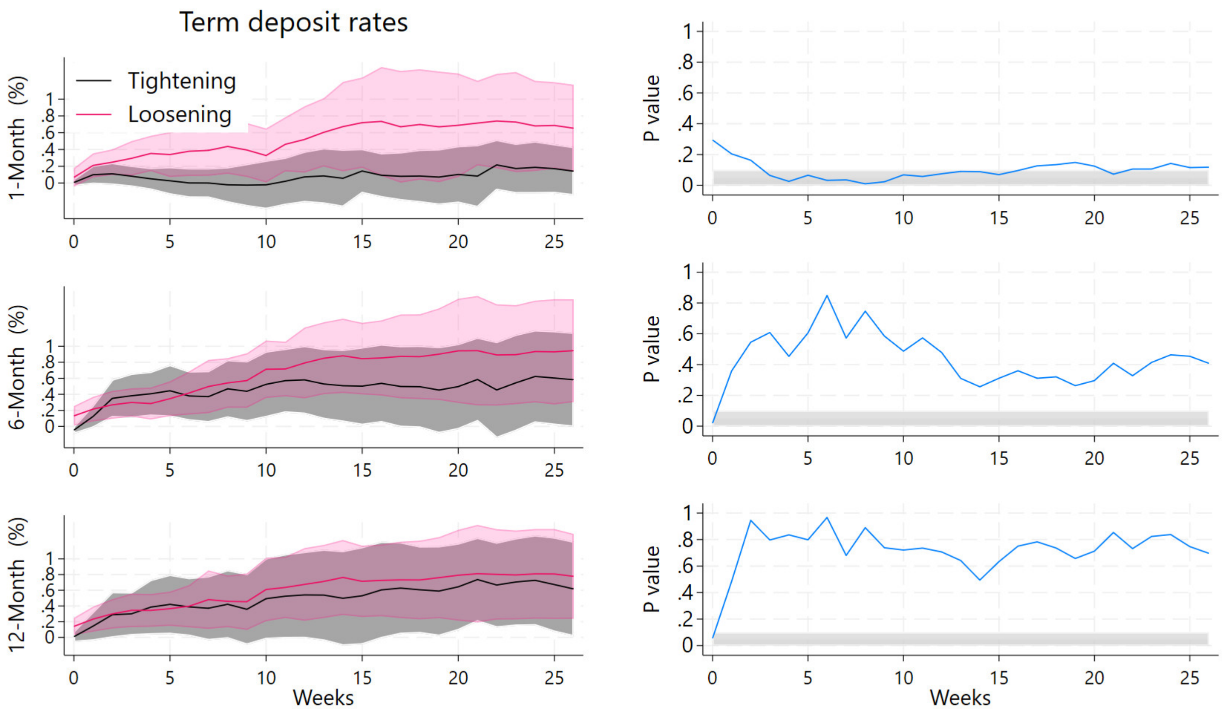


The figures shows the impulse response coefficients of mortgage and retail rates to a 1 percentage point change in the OCR. I.e. β_h^+ (black line) following an increase in the OCR and β_h^- (raspberry line) following a decrease in the OCR. We use monetary policy surprises as an instrumental variable for OCR changes. The shaded area corresponds to 95% confidence interval.

In all cases, i.e. for all maturities and all deposit rates and mortgage rates, the confidence band of the impulse response coefficient after a tightening event shows substantial overlap with the confidence band of the reaction after a loosening event.

We do a formal test to check if the data is informative enough to reject symmetric pass-through. The right columns of Figure 10 and Figure 11 show the p-values of testing the null hypothesis of symmetric pass-through H0: β_h^+ - β_h^- = 0 for horizons = 0, ...,26. The shaded area covers the p-value critical value from 0 up to +10%. Only for the 1-month term deposit can we formally reject

Figure 10: Test for asymmetric monetary policy pass-through to term deposit rates.

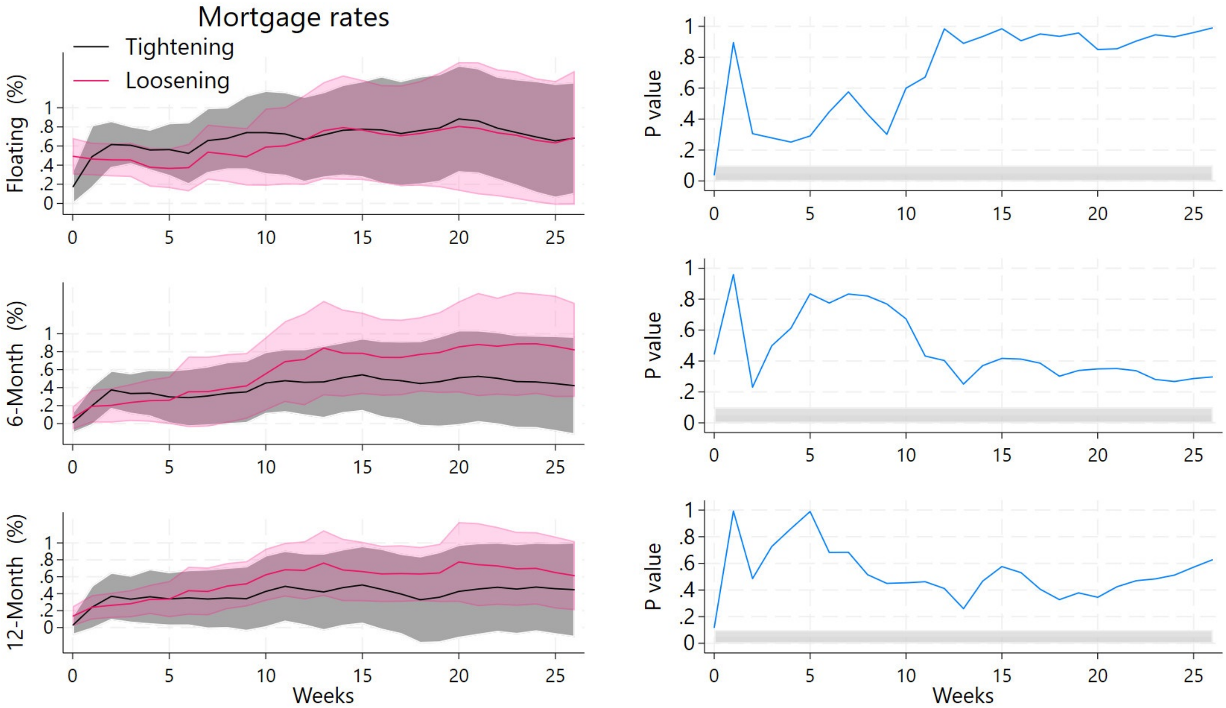


Note: If the p-value (blue line) lies outside the shaded area, we fail to reject the null that the pass-through coefficients after tightening and loosening monetary policy are identical. If the p-value is within the shaded area, we accept the alternative hypothesis that the effect is asymmetric.

the null hypothesis of symmetric pass-through. Our results show that the direction of monetary policy matters for this short-term maturity. The pass-through after a downward OCR change is much stronger than after an increase in the OCR. A difference in pass-through becomes visible after about 4 weeks. In the weeks after, it remains true that the pass-through of a downward change in the OCR is much stronger. Figure 9 top left clearly shows that when the OCR increases banks react very little with increases in term deposit rates with short maturity whereas when the OCR declines, term deposit rates tend to decrease as well.

Table 11 also show the numerical value of Figures 10 and 11 in more detail. It is important to note that 1-month term deposits are not heavily used. As of March 2024, most non-market funding (primarily bank deposits) sits in overnight accounts, which make up around 38% of the total. The second most common category is 6-month term deposits, with a share of roughly 10%, while 1-month term deposits account for only about 5%. These percentage shares are all based on residual maturity, not original maturity, and are sourced from the Reserve Bank of New Zealand liquidity survey.

Figure 11: Test for asymmetric monetary policy pass-through to mortgage rates.



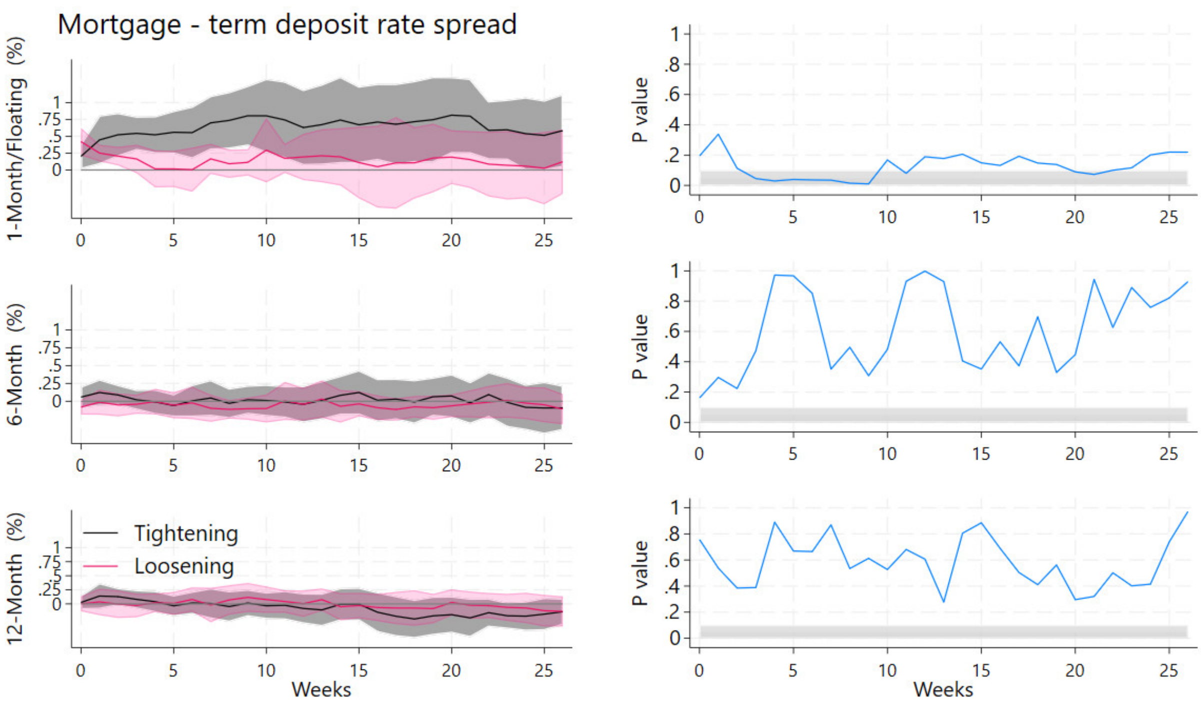
Note: If the p-value (blue line) lies outside the shaded area, we fail to reject the null that the pass-through coefficients after tightening and loosening monetary policy are identical. If the p-value is within the shaded area, we accept the alternative hypothesis that the effect is asymmetric.

Table 11: ***Asymmetry in pass-through to term deposit and mortgage rates***

	Deposit rates			**Mortgage rates**		
Horizon	TD-1m	TD-6m	TD-12m	M-floating	M-6m	M-12m
1m	**- 0.30**	0.12	0.04	0.18	0.08	0.03
2m	**- 0.46**	- 0.07	- 0.04	0.17	-0.05	- 0.14
3m	**- 0.45**	- 0.21	- 0.13	0.01	-0.25	- 0.22
6m	- 0.51	- 0.36	- 0.16	- 0.01	-0.40	- 0.17

Note: The table reports the differences in the pass-through coefficients between increase and decreases in the OCR (β_h^+ - β_h^-) from IV estimates. Bold numbers have a p-value less than 0.10 indicating evidence against the null hypothesis of symmetric effects.

Figure 12: Mortgage - term deposit rates pass-through spread



Note: For IRFs on the left hand side positive pass-through spreads indicate profitable opportunities for banks. In the graphs on the right hand side if the p-value (blue line) lies outside the shaded area, we fail to reject the null that the spread changes with the same amount in the case of OCR increase or decrease. If the p-value is within the shaded area, we accept the alternative hypothesis that the effect is asymmetric.

We began by examining whether increases and decreases in OCR have a symmetrical effect on term deposit and mortgage rates. Figures 10 and 11 indicate that, apart from some asymmetry in the 1-month term deposit rate, there is insufficient evidence to confirm any asymmetry in response to OCR changes.

To further explore this, we also examined whether both mortgage and deposit rates respond similarly to changes in monetary policy after an increase or decrease in OCR. The results of pass-through to spreads at different maturity term are displayed in Figures 12, where positive spreads represent profitable opportunities for banks.

Overall, our findings suggest that the spreads between mortgage and term deposit rates across different states (tightening vs. loosening) do not show consistent patterns of increased profitability, with the exception of the spread between floating mortgage rates and 1-month term deposit rates, particularly during the tightening state. For example, during a tightening state, banks appear to raise floating mortgage rates more quickly than term deposit rates. It is important to note that this observed asymmetry in the shorter-term segment may result from banks' liquidity management practices or shifts in loan and term deposit demand, rather than from a deliberate profit-maximisation strategy.

3.4 Heterogeneous response to monetary policy

Do banks' balance sheet characteristics matter for pass-through? Although this is an important question, our analysis is constrained by the sample, which consists of a cross section of ten banks. This section presents the estimation results of equation (5). We analyse the effect of the non-performing loans (NPLs) ratio, bank size, and the capital ratio. Using equation (5), pass-through at horizon h as a function of the balance sheet characteristic is given by

$$\beta_1^h + \beta_2^h \times bank\ characteristic \tag{6}$$

In the appendix, we graph the p-values (at all horizons) of testing the null hypothesis of a zero coefficient β_2^h. It turns out that β_2^h is often imprecisely estimated[17], so that in most cases we cannot reject the null hypothesis. Nevertheless, below we illustrate the effect of the bank characteristic and depict the pass-through (and the confidence bands) for two levels ("low" and "high") of the bank characteristic. We consider the 20th percentile of the bank characteristic distribution as "low" and consider the 80th percentile as "high".

Non-performing loan ratio:

The literature has found that banks with a higher non-performing loan ratio tend to have lower pass-through. The intuition behind the negative relationship between NPLs and pass-through is that banks with higher levels of impaired loans may face tighter funding constraints, which reduces their willingness or ability to adjust lending rates in response to monetary policy changes. For instance, using an error correction framework Beyer et al. (2024) show that a one percentage point increase in the impairment ratio of banks in euro area reduces the short-run pass-through by 3%. In their analysis, they focus on loans to non-financial corporations with a loan size of up to one million euros and an initial rate fixation of up to one year. Their findings align with those of Altavilla et al. (2020), who demonstrate that banks with a higher share of NPLs exhibit a significantly lower pass-through of monetary policy changes. Using a two-step cross-sectional VAR methodology, Altavilla et al. (2020) analyse bank-level data in the euro area and find after a 100 basis point reduction in the monetary policy rate the pass-through gap between banks with higher levels of impaired loans is 10 basis point lower than banks with lower levels of impaired loans, but the gap can widen to as much as 70 basis points over the long run (three years). Regarding lending rates, Altavilla et al. (2020) did not directly use disaggregated data. Instead, they created a composite measure that aggregates borrowing rates with different maturities and loan sizes for both non-financial corporations and households.

[17]The estimated coefficient has a large standard error relative to its size, so the estimate is statistically uncertain.

Similarly, Holton and d'Acri (2018), using an error correction framework, provides further evidence that banks with higher levels of impaired loans exhibit lower overall pass-through (0.61) compared to those with lower levels of impaired loans (0.70) following a 1% increase in the Euro Overnight Index Average (EONIA). For lending rates, Holton and d'Acri (2018) focuses on loans to non-financial corporations with an initial rate fixation of up to one year.

For our data, the estimates of the interaction effect of the NPLs ratio are imprecise (See Figure 17 in Appendix for p-values). Figure 13 shows the impulse response by share of NPLs. Except for floating mortgage rates, we find that at all horizons, the interaction between OCR changes and the NPLs ratio is statistically insignificant, meaning we cannot reject the null hypothesis that the NPLs ratio does not affect pass-through. For floating mortgage rates, we find, in line with the literature, that banks with a larger share of NPLs tend to have a lower pass-through to lending rates. For deposit rates, we do not find statistically significant effects of the NPLs.

Size: Larger banks tend to have more stable funding sources, diversified portfolios, and possibly greater market power, which can make them slower or less responsive in adjusting lending rates to monetary policy changes. The study by Holton and d'Acri (2018) also investigates the effect of bank size on the pass-through of monetary policy. They find that, regardless of loan size, larger banks exhibit a lower pass-through to lending rates, with an estimated pass-through of 0.67, compared to 0.77 for smaller banks after 1% increase of Euro Overnight Index Average (EONIA). For smaller loans, the pattern persists, with smaller banks showing a higher pass-through of 0.71, compared to 0.56 for larger banks. Holton and d'Acri (2018) focuses only on loans to non-financial corporations, distinguishing between small loans (up to one million euros) and large loans (over one million euros). However, similar to our study, they only consider loan with an initial rate fixation of up to one year.

Gambacorta (2008) examine the effects of a 1% increase in the money market rate on short-term lending rates of Italian banks and show that smaller banks exhibit a higher immediate pass-through compared to larger banks, with pass-through rates of 0.492 for smaller banks and 0.393 for larger banks. However, the long-run pass-through appears nearly identical, at 0.997 for smaller banks and 1.045 for larger banks. They also argue that the distributional effects of bank size must be interpreted carefully. Specifically, the banks categorised as "small" in their study should not be considered small and may be classified as "medium-sized" in the broader population of Italian banks. Gambacorta (2008) also suggests if smaller banks are more liquid and better capitalised than average, this enhanced financial strength allows them to mitigate the impact of cyclical fluctuations on their credit supply. For his analysis of pass-through to lending rates, Gambacorta (2008) use the weighted average of all domestic short-term loan positions for each individual bank.

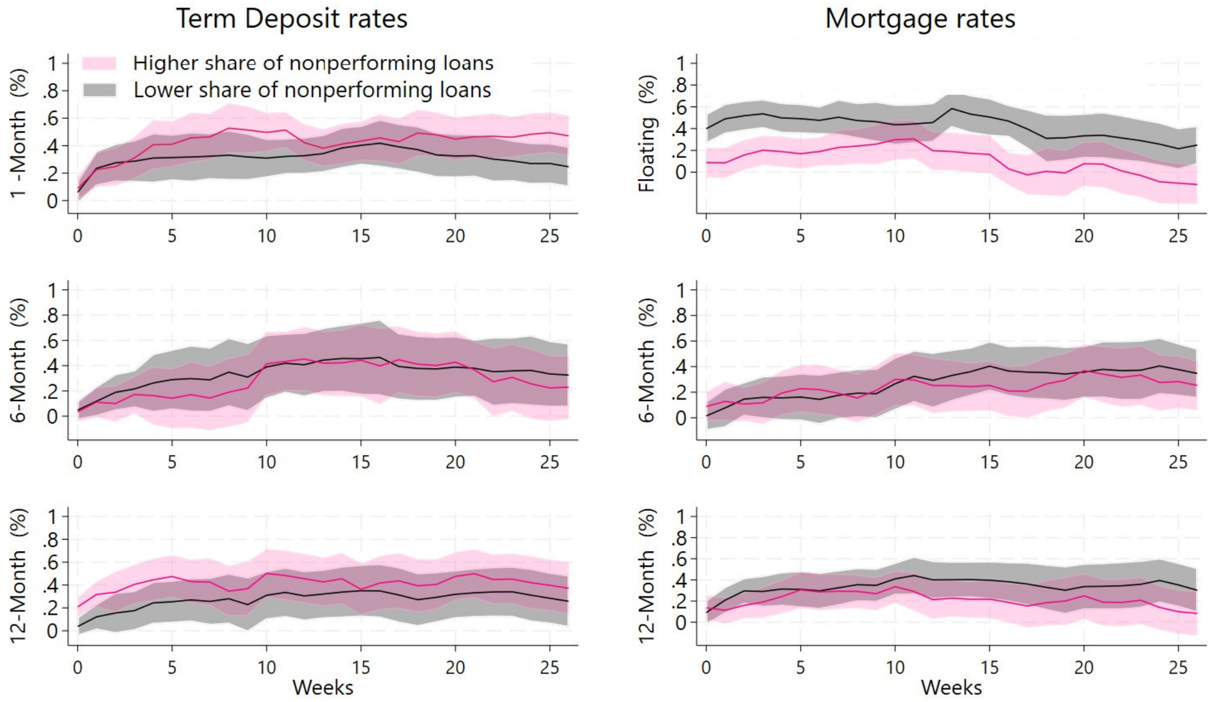
In our analysis, we also explore how pass-through varies by bank size. Our results show that the interaction effect of bank size is statistically insignificant across all horizons, for both mortgage rates and deposit rates meaning we cannot reject the null hypothesis that bank size does not influence pass-through. We report p-values in Figure 18.

Capital ratio: Lastly, studies by De Graeve et al. (2007) , Holton and d'Acri (2018) and Altavilla et al. (2020) look at the effect of the capital ratio on monetary policy pass-through. We find that results can be mixed. For instance, Altavilla et al. (2020) analyse the pass-through to banks' lending rates in the euro area, clustering the distribution by capital ratios. They find that a 100 basis point decline in the monetary policy rate results in an average long-run pass-through of about 0.85 (over 36 months) for highly capitalised banks (84th percentile) compared to just 0.45 for poorly capitalised banks (16th percentile). They conclude that well-capitalised banks show higher pass-through.

In contrast, the findings from De De Graeve et al. (2007), Gambacorta (2008), and Holton and d'Acri (2018) suggest that higher capitalisation reduces banks' responsiveness to monetary policy. De Graeve et al. (2007) demonstrate that banks with larger capital buffers tend to maintain higher loan mark-ups and are less responsive to changes in market conditions. Similarly, Holton and d'Acri (2018) find that for large loans, highly capitalised banks have weaker pass-through, with 32 basis points compared to 46 basis points for poorly capitalised banks. This pattern holds for smaller loans as well, where highly capitalised banks show a pass-through of 28 basis points, compared to 41 basis points for less capitalised banks. Gambacorta (2008) also argues that well-capitalised banks have a greater capacity to shield their clients from the effects of monetary policy changes. He explains that less-capitalised banks are typically perceived as riskier, limiting their ability to protect credit relationships during monetary tightening. Consequently, they are more likely to reduce loan supply and increase interest rates significantly. In their error correction framework, Gambacorta (2008) shows that the immediate pass-through for low-capitalised Italian banks is 0.558, compared to 0.308 for well-capitalised banks. Over the long run, the estimates are approximately 1.017 for low-capitalised banks and 1.001 for well-capitalised banks.

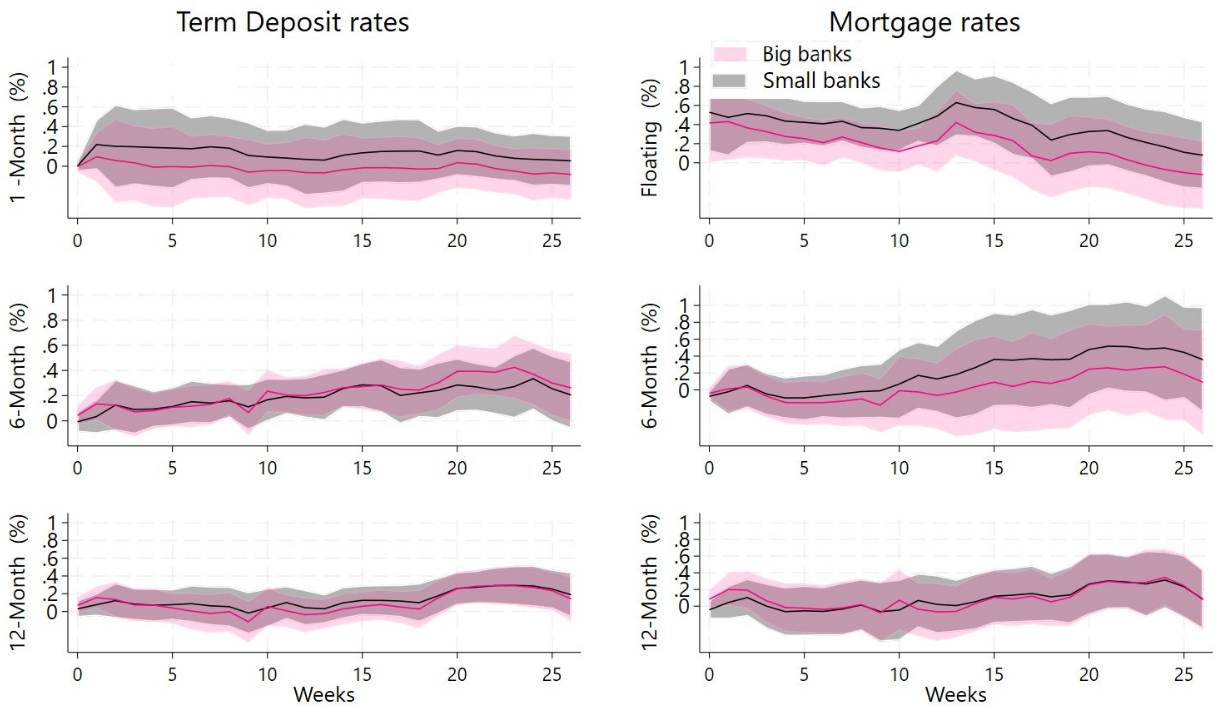
Our analysis aligns with of findings of Holton and d'Acri (2018), and De Graeve et al. (2007), showing that banks with higher capital ratios exhibit a lower pass-through to both mortgage and term deposit rates. On average, the gap between highly capitalised and less capitalised banks is approximately 10.1 basis points for term deposit rates and 8.3 basis points for mortgage rates. However, the wide confidence interval for the capital ratio (shown in Figure 14) and the statistically insignificant interaction effect of the capital ratio and monetary policy surprises (see Figure 19 in Appendix) suggest that these results may not be conclusive and we cannot reject the null hypothesis that the capital ratio does not matter for pass-through.

Figure 13: Heterogeneity response (IV estimates) by share of nonperforming loans



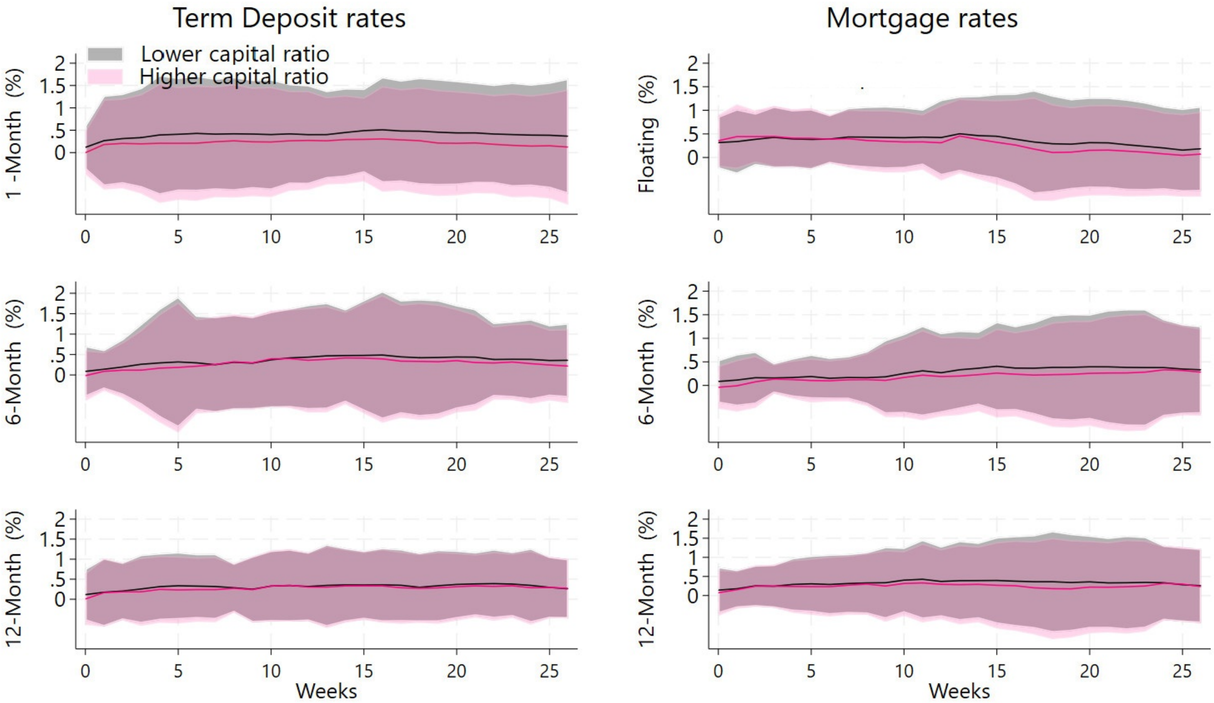
Note: Banks with higher share of nonperforming loans represents the 80th percentile, while banks with lower share of nonperforming loans represents the 20th percentile.

Figure 14: Heterogeneity response (IV estimates) by size (total asset)



Note: Larger banks represents the 80th percentile, while smaller banks represents the 20th percentile. The pass-through is less for bigger banks

Figure 15: Heterogeneity response (IV estimates) by capital ratio



Note: A high capital ratio corresponds to the 80th percentile, while a low capital ratio corresponds to the 20th percentile.

4 Conclusion

We have shed new light on the pass-through of monetary policy rate changes to bank retail rates. First, we find substantial pass-through to mortgage and term deposit rates for all studied retail products. Pass-through materialises gradually but approaches near one-to-one in the long run (20-25 weeks), particularly for 6- and 12-month deposit rates and floating- and 6-month mortgage rates. The 1-month deposit rate is a noteworthy exception to this rule, we can reject full pass-through both in the short and in the long run. We also find that compared to OLS estimates, the estimated pass-through tends to be larger when instrumenting the policy changes with exogenous monetary policy surprises. This likely reflects the actions of forward-looking banks that might change interest rates in anticipation of policy rate changes, leading to downward bias in OLS estimation.

Second, we explore asymmetric effects. We examine whether increases or decreases in the OCR are passed through similarly. Apart from some asymmetry in the 1-month term deposit rate, where we find that it reacts stronger to OCR decreases than to OCR increases, there is insufficient evidence to confirm any consistent asymmetry in response to OCR changes. We also examined whether both mortgage and deposit rates respond similarly to changes in monetary policy. Again, asymmetry appears only in the shorter-term maturity segment (1-month term deposits and floating mortgage rates) and mostly after OCR increases. After such an increase, banks seem to raise floating-rate mortgages more quickly than 1-month deposit rates. It is important to emphasise that 1-month term deposits are not widely used financial products. The asymmetries observed in this short-term segment may result from banks' liquidity management practices or changes in the demand for loan and term deposits, rather than from a deliberate profit-maximisation strategy.

Lastly, our results on the effect of banks' balance sheet characteristics—such as capital ratio, non-performing loan ratio, and size are inconclusive. We only find statistically significant differences between banks with a high or low ratio of NPLs for the pass-through to floating mortgage rates. Consistent with the literature, we find that banks with a higher share of NPLs show a lower pass-through.

Our findings have several key implications for the design and effectiveness of monetary policy. The near-complete long-run pass-through of policy rate changes to most retail lending and deposit rates indicates that the interest rate channel remains a powerful mechanism, especially over longer horizons. This suggests that monetary policy decisions meaningfully influence retail interest rates, but the adjustment occurs with non-negligible lags. Policymakers should account for these delayed pass-through dynamics when timing and calibrating interventions. The fact that OLS estimates tend to understate pass-through underscores the importance of forward-looking behaviour and expectations in the banking sector, highlighting that clear communication and credible policy signalling can enhance the impact of policy even before rates are formally adjusted. Our results also show little systematic difference in banks' responses to policy tightening versus easing, suggesting a broadly uniform transmission across the banking sector. Finally, the lower pass-through observed among banks with higher non-performing loan ratios points to the critical role of bank balance sheet health: weaker banks may dampen the effectiveness of monetary policy, implying that financial stability considerations are essential when assessing policy impact.

Moving forward, there are several avenues for future research to explore. Further examination of different financial products beyond just mortgage rates and term deposit rates could yield valuable insights. For example, researchers could study how personal loans, credit card rates, or corporate lending rates respond to policy changes. This could reveal whether pass-through patterns differ across products.

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Appendix

Figure 16: Scatter plot of monetary policy surprises against OCR changes

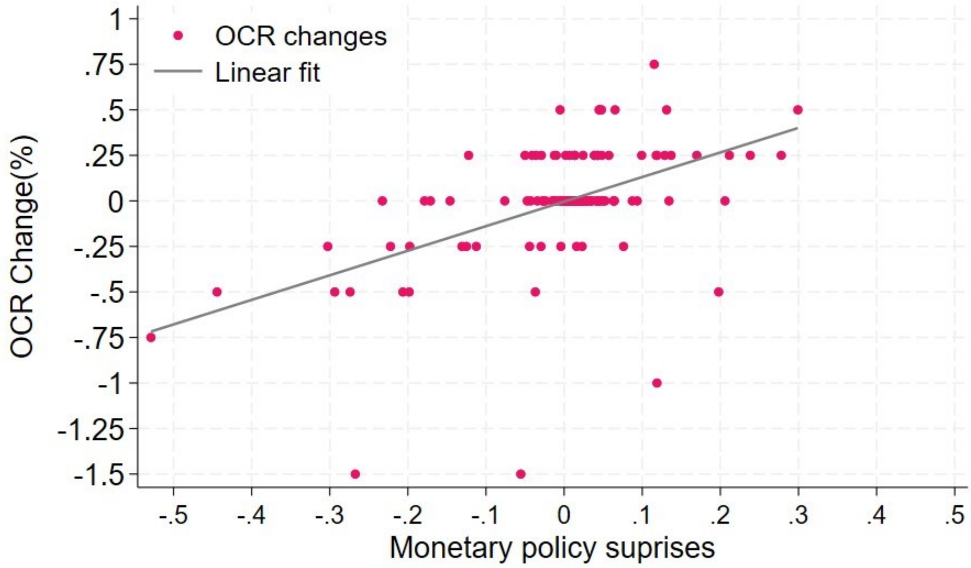
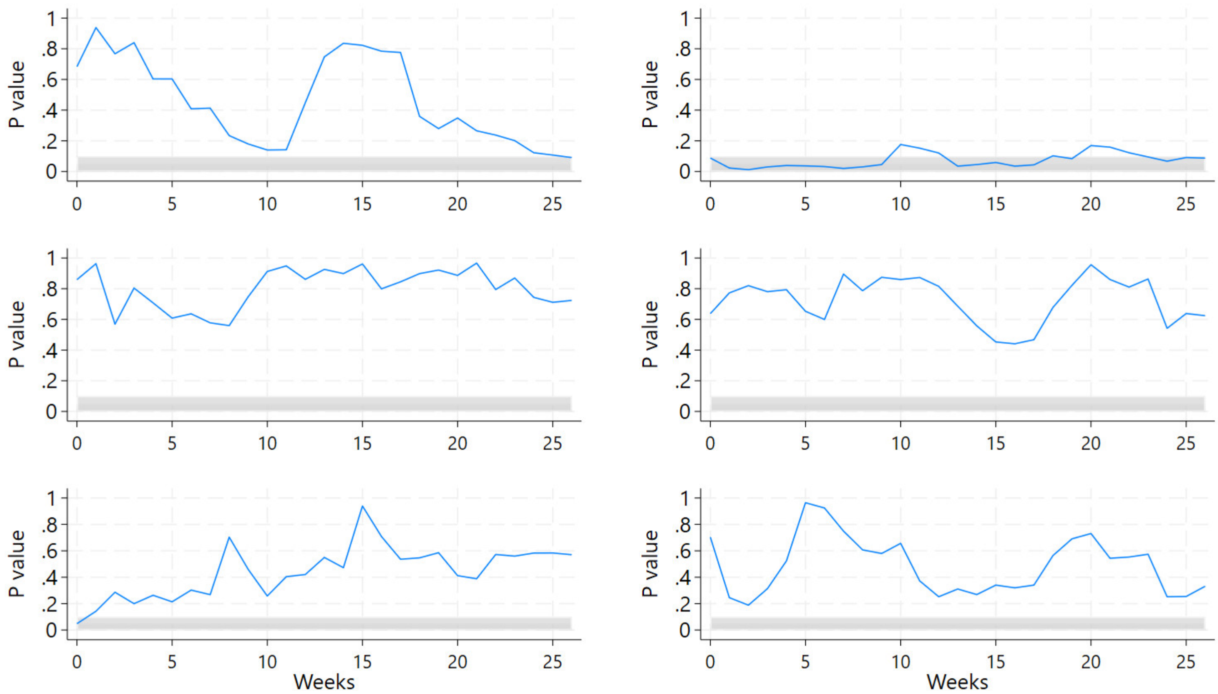
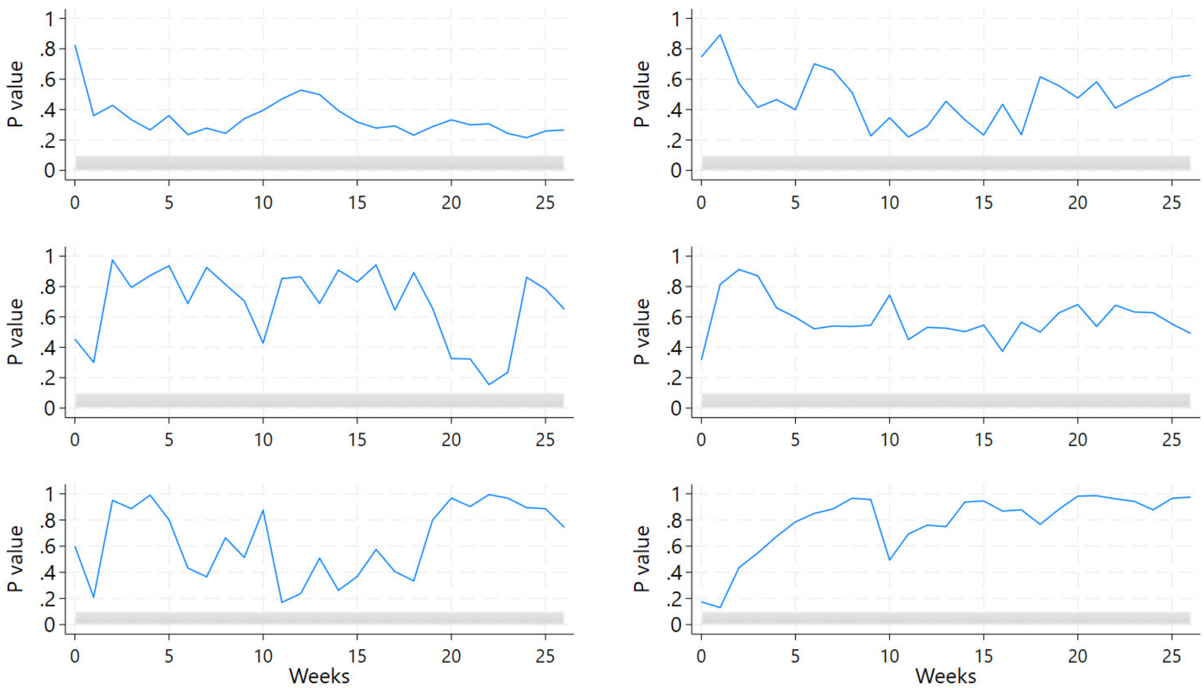


Figure 17: Heterogeneity response (IV estimates) by share of nonperforming loans - estimated p-value of interaction coefficient



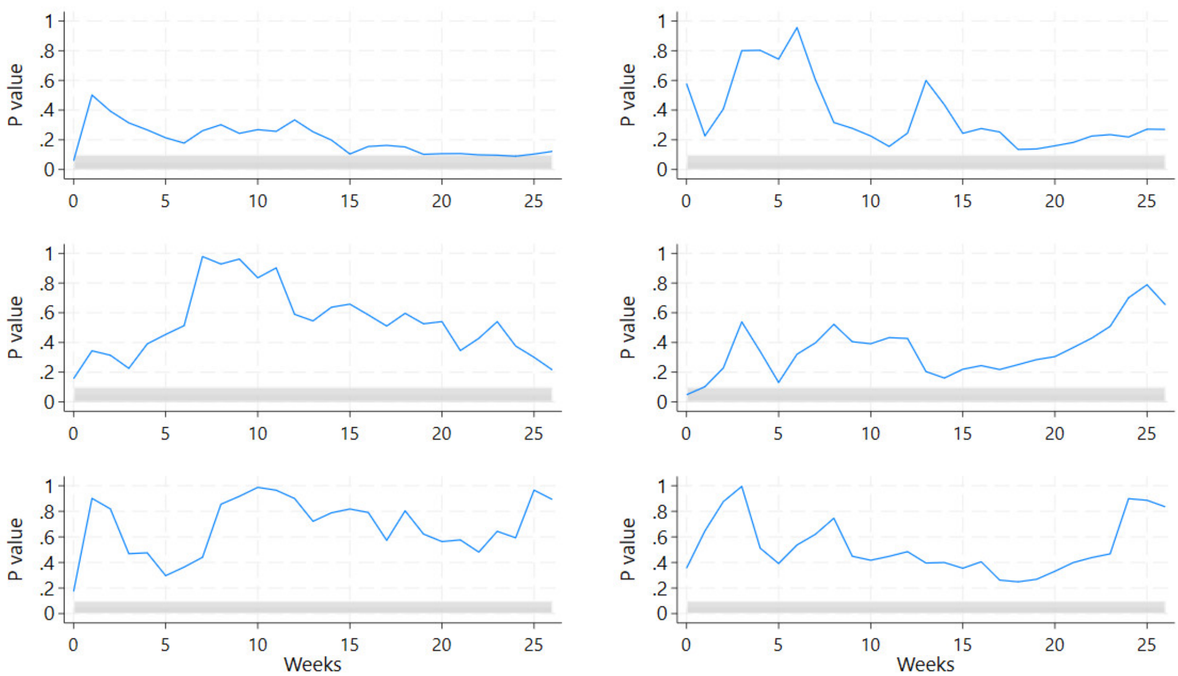
If the p-value (blue line) lies outside the shaded area, we fail to reject the null that the coefficient of interaction is equal to zero.

Figure 18: Heterogeneity response (IV estimates) by size(total asset) - estimated p-value of interaction coefficient



If the p-value (blue line) lies outside the shaded area, we fail to reject the null that the coefficient of interaction is equal to zero.

Figure 19: Heterogeneity response (IV estimates) by capital ratio - estimated p-value of interaction coefficient



If the p-value (blue line) lies outside the shaded area, we fail to reject the null that the coefficient of interaction is equal to zero.