Reserve Bank of New Zealand Analytical Notes

Monetary Policy and Funding Spreads

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NON-TECHNICAL SUMMARY

Market interest rates can usefully be thought of as a combination of a benchmark component and a spread component. The benchmark component is closely related to the expected path of short-term interbank interest rates which, in turn, largely reflect short-term monetary policy interest rates. The spread component reflects other factors, including credit risk and term premia. Funding spreads are of interest for monetary policy because they directly influence the cost of borrowing. Spreads tend to fall during economic expansions and to rise during recessions, especially during periods of financial stress. That pattern means that they can amplify the business cycle itself. In contrast, policy interest rates tend to rise during expansions and to fall during recessions. A sharp widening in funding spreads - here and abroad – was evident during the financial crisis of 2008/09, and Reserve Bank publications[1] have focused particularly on the changes in the spread between the cost of domestic bank bills and the effective cost to banks of raising foreign wholesale funding.

In this note, we use a small, stylised model to examine the historical relationships between New Zealand benchmark interest rates and funding spreads. For this exercise, we use the 90 day bank bill rate as a proxy for the benchmark rate. As a proxy for the funding spread, we use the indicative cost of raising New Zealand dollars for a year in US dollars and swapping those funds for New Zealand dollars. The model allows us to account for historical relationships among the variables in a parsimonious manner.

We use the model to ask two questions:
  (i)   How much did monetary policy mitigate the economic impact of changes in the funding spread?
  (ii)   How much would policy rates need to have moved to fully offset the effects of the spread shock on the output gap?

The empirical results show that
  • In response to surprises in the funding spread, 90-day bank bill interest rates fell, on average during the sample period, by more than seven times as much. That magnitude is higher than we would expect simply based on the effect on the cost of funds, suggesting that other channels were at work. The strong response of monetary policy was not typically sufficient to fully offset the effect of the spread shock on the output gap.
  • While the historical monetary policy response has considerably moderated the negative impact on the output gap, to fully offset the impact on the output gap (if that were desirable), the model suggests that the monetary policy response would need to have been roughly double its historical magnitude.
  • The model infers that during the Asian financial crisis, funding spread shocks played a material role, something that is not apparent when looking at the data series alone.

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[1]For example, see Wong (2012), and Reserve Bank of New Zealand, *Monetary Policy Statement,* March 2010.

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1 INTRODUCTION

Funding spreads tend to fall to low levels during prolonged expansions, and during recessions they rise, sometimes by a lot, particularly during periods of financial stress. That pattern of credit spreads is well documented (eg. Gertler and Lown 2000), and is exacerbated for lower rated borrowers and for longer-duration funding (see, Donaldson et al 1990, Dotsey 1998 and Cochrane and Piazzesi 2005). That pattern, in isolation, can amplify the business cycle. In contrast, policy interest rates tend to rise during expansions and decline during recessions, and so moderate the business cycle. For a central bank concerned about stabilising inflation, it is not just the benchmark policy rate, but the interest rates (and terms and conditions) faced by final borrowers that matters. In assessing the appropriate level of the policy rate, policymakers need to be conscious of any material developments in spreads.

The most dramatic movements in funding spreads, in recent decades, occurred during the global financial crisis of 2007/08. For example, indicative 3-year domestic funding spreads to swap[2] for an AA New Zealand bank rose sharply in 2007/08, and were about 300 basis points at peak, compared to about 25 basis points during the pre-crisis period. In 2008-9, the New Zealand policy rate was cut by over 500 basis points (Figure 1). Spreads remained much higher than they had been before the crisis for a protracted period. A similar pattern was seen in many other countries.

Figure 1: New Zealand dollar benchmark interest rate and 3 year funding spreads
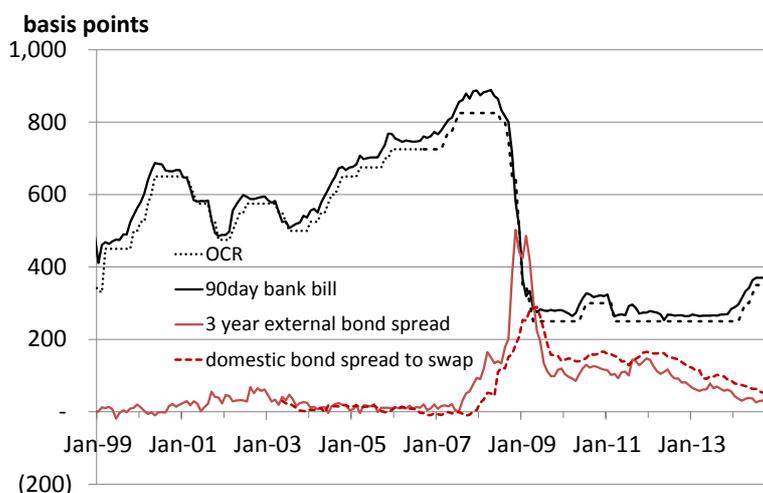
Source: Bloomberg, RBNZ. Notes: The Official Cash Rate (OCR) is the overnight monetary policy rate. The 90 day bank bill is the 90-day interbank rate. The 3-year external bond spread to swap is the USD AA finance bond index spread to the 3-year USD interest rate swap plus the cost of swapping to New Zealand dollars (NZD) via cross-currency swaps. The domestic bond spread to swap is the NZXCAY New Zealand corporate bond index for issuers of rating A and above.

Understanding the relative impacts of movements in the benchmark and spread components of funding costs is important if we are to understand the overall effects on the cost of funding and on the economy during periods of financial stress, when spreads rise by a lot and monetary policy is eased. Shocks to funding spread drive a wedge between the benchmark rate set by monetary policy and the actual cost of

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[2] The swap rate is the expected cost of rolling over short term rates for a particular maturity.

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borrowing. In addition, funding spread shocks may represent factors beyond just the cost of funds such as financial institution balance sheet stress or generalised uncertainty.

Since the financial crisis, there has been discussion of whether monetary policy should respond directly and pre-emptively to credit spreads, beyond responding indirectly to the effects of funding spreads on the economy (see McCulley and Toloui 2008, Taylor 2008, Curdia & Woodford 2009, and Stein 2014). In this note, we simply look at the historical New Zealand relationships between monetary policy, funding spreads and the economy, using a small structural vector auto-regression (VAR) model. The model allows us to account for supply and demand shocks and for the endogenous interaction between benchmark rates and spreads when measuring the monetary policy reaction to funding spreads.

2 MEASURING THE SPREAD

There are many potential measures of funding spreads, based on different financial contracts at different maturities. The focus tends to be on bank funding, but banks have tapped term funding markets only irregularly and there is little secondary market trading, or even indicative pricing, on outstanding issues. Figure 2 depicts some indicative measures of funding spreads for an AA rated New Zealand bank. By all measures, funding spreads for an AA New Zealand bank rose markedly in 2007-8 and again in 2011 at the height of the euro crisis, have declined over the past two years, and remain above pre-crisis levels.

Figure 2: Measures of New Zealand bank funding spreads
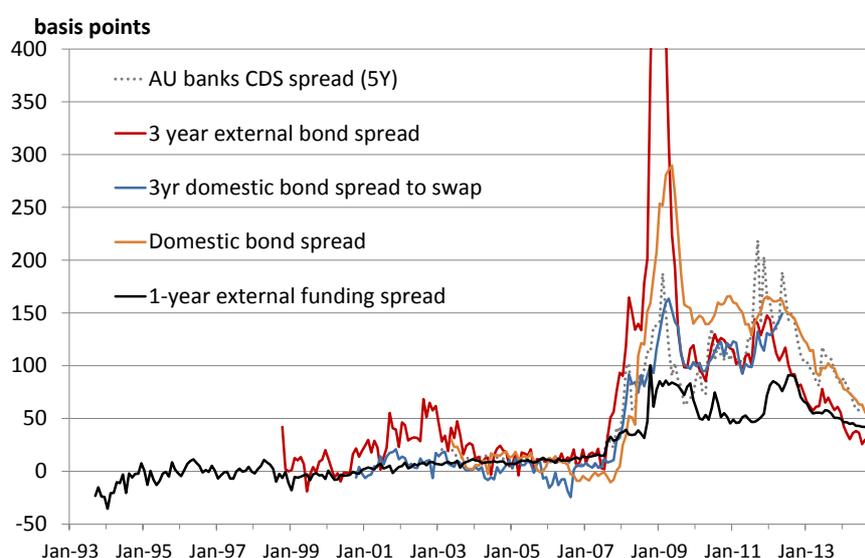
Source: Bloomberg.Note: Three-year external funding spread to swap is calculated from USD AA finance corporate bond spread to USD 3-year interest rate swap plus hedging cost (3-year NZD cross-currency swap). The 3-year domestic bond spread is calculated from the NZD C2603Y AAbond index(discontinued). The domestic spread to swap is calculated from the NZXCAY corporate index for bonds rated A and above and the 3-year interest rate swap. The black line is the NZD cost of 1-year USD Libor funding relative to the 1-year NZD interest rate swap.

Movements in spreads tend to be larger for longer maturities, so the average maturity of bank funding can help guide our choice of a representative spread. As shown in Figure 3, the average residual maturity of

New Zealand banks' wholesale funding (solid red line) is just under four quarters, suggesting an average term at origination of eight quarters. New Zealand banks' wholesale funding with a residual maturity of less than a year (dashed blue line) has had a steady average maturity of less than a quarter. The average maturity of banks' wholesale funding that has a residual maturity of more than a year (dashed green line) is about three years. Overall, the average maturity of banks' wholesale funding has risen since 2009 as the share of short-term funding has fallen.

Figure 3: Weighted average maturity of New Zealand bank funding
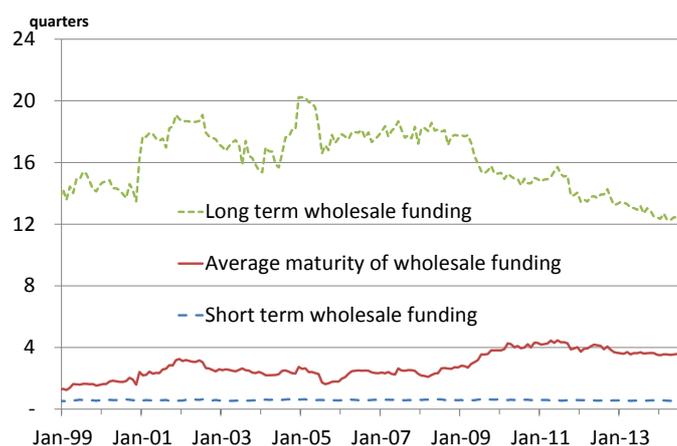
Source: Calculated from RBNZ Registered Bank Standard Statistical Return (SSR) data. Notes: Weighted average maturity is calculated by assigning funding to the mid-point of the SSR maturity bucket. Short-term funding is funding with a residual maturity of less than 1 year.

For the empirical part of this analysis, our measure of banks' average funding cost is the cost of 1-year USD Libor, plus the cost of swapping the proceeds to NZD using an FX swap(black line in Figure 2). We use this measure because it is available for a relatively long period. The longer sample period is important because we are using quarterly variables (GDP and inflation) for our analysis. There are two potential issues with this measure. First, it has a shorter maturity than the two-year origination term we would like. Second, this measure shows a long period of low volatility before 2007, despite the Asian crisis period, and higher volatility since 2007. We revisit that issue in the discussion of the historical decompositions and consider re-estimating the model for the shorter pre-crisis period.

There is no perfect measure of the funding spread. The share of funding from different sources varies over time and, through periods of heightened financial stress, when markets can become very thin, generic indicator rates may not represent the circumstances facing individual borrowers. During the 2008-9 period, markets were, at times, effectively closed, so the indicative funding spreads could understate the extent of the tightening in conditions faced by banks. On the other hand, longer-term external funding spreads could be seen as overstating the effective spread over 2008-2009, when little external bond issuance was occurring and when domestic markets functioned relatively well, and domestic spreads rose by less. Arbitrage should generally equalise domestic and foreign funding costs, but during the stress of 2008-9, there were sizable deviations between domestic and external funding spreads (Figure 1). Domestic bond spreads and parent bank CDS spreads provide potential proxies for New Zealand banks funding costs, but are available for a considerably shorter period. Finally, during the crisis, the New Zealand government

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wholesale guarantee scheme[3] materially lowered term borrowing costs relative to the indicative unsecured spreads. These constraints mean that the results in the remainder of the paper need to be treated as illustrative rather than definitive.

3 BY HOW MUCH DOES MONETARY POLICY EASE IN RESPONSE TO A SPREAD SHOCK? RESULTS FROM A SMALL VAR

We estimate a small VAR model of the New Zealand economy with four variables: the 90-day interest rate (a proxy for monetary policy),[4] the 1-year funding spread, the output gap and inflation, using data from 1993 Q3 to 2013 Q4. We identify four shocks through a mixture of sign restrictions and a zero restriction. Shocks represent deviations of variables, from their predicted values. The shocks are a monetary policy shock, a funding spread shock and a generic demand shock and supply shock. Details of the variables, estimation and identification procedure are in the Appendix. An alternative identification scheme and estimates for the pre-crisis period are also presented in the Appendix. Here our focus is on the spread shock and monetary policy shock. Therefore, we settle for a simple representation of the real economy, with other shocks falling into the general catch-all supply shocks and demand shocks.

Figure 4 presents the impulse response functions to a one standard deviation monetary policy and spread shocks, respectively. The bold line shows the impulse response function for the median model, as suggested by Fry and Pagan (2011), and serves as the point estimate for the subsequent analysis.[5] The impulse response functions show the response to a one standard deviation shock, and are symmetric -- i.e. we can reverse the sign to study expansionary instead of contractionary monetary policy.

Following a one standard deviation contractionary monetary policy shock (top row of Figure 4), the 90-day interest rate rises by about 25 basis points, and stays elevated for quite some time. The output gap falls below trend and inflation initially falls.[6] The impact of a monetary policy shock on the output gap is estimated to be quite persistent: output takes over 20 quarters to return to trend. In response to a rise in the 90-day rate, the funding spread is estimated to fall slightly, by about 5 basis points.

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[3] See http://www.treasury.govt.nz/economy/guarantee/wholesale.

[4] The 90-day bank bill reflects both the expected path of monetary policy and a funding spread component. A better measure would be the Overnight Index Swap (OIS) that provides a measure of the expected cost of rolling over overnight funds. The spread component of the 90-day bank bill, the domestic equivalent of the Libor-OIS spread, was most obvious during 2007-8. OIS rates are only available from about 2003. Estimation using a spliced 90-day rate – OIS series yielded similar results.

[5] There are many model solutions. The point-wise median can provide a misleading interpretation of the model solution, because it combines point estimates from different models. The Fry and Pagan procedure finds the model closest to the point-wise median, providing a response that is consistent across that model (see Fry and Pagan, 2011 and Inoue and Kilian 2013 for more details).

[6] The effect on inflation is short-lived, despite the sustained output gap impact. Normally, we think that monetary policy affects inflation with a lag. The inflation response is more transitory than we expect, but our focus is on other model variables. The response of annual inflation shows a more sustained effect.

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Figure 4: Impulse response functions (percentage point deviation)
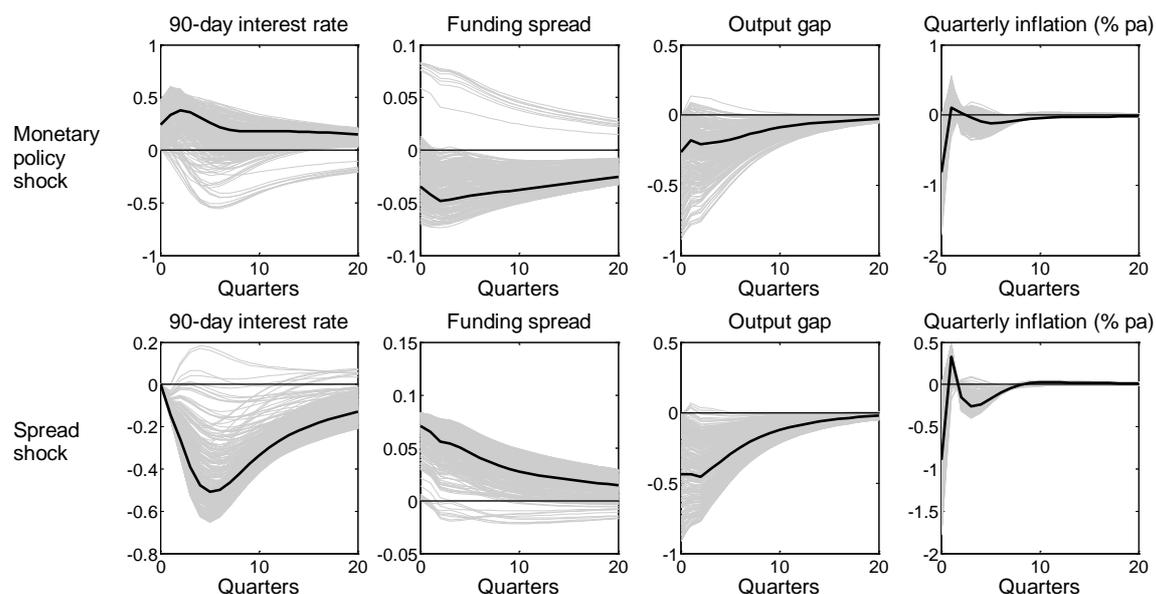
Notes: (a) Bold line represents the median model. Grey lines are the set of impulse response functions that satisfy the sign restriction identification.(b) The top row shows impulse response functions to a one standard deviation monetary policy shock.(c) The bottom row shows impulse response functions to a one standard deviation spread shock.

A one standard deviation spread shock is only about 7 basis points (bottom row of Figure 4, 2nd panel). Following a spread shock, output falls below trend and only returns close to trend after about 20 quarters. Quarterly inflation (per cent per annum) falls by about 1 per cent followed by a small rise, and a small more persistent decline. The range of responses of the output gap and inflation to the spread shock is qualitatively similar to the responses to a monetary policy shock. Here, however, the response is to a considerably smaller, 7 basis point, rise in the spread compared to the 25 basis point rise in the 90-day rate for the monetary policy shock. The monetary policy response to a funding spread shock is large: the 90-day rate is estimated to fall by about 50 basis points in response to the 7 basis point rise in the measured 1-year funding spread. The maximum 90 day rate response is historically estimated to be roughly seven times the initial spread shock. Based on the cost of funds effect alone, one might have expected a one-for-one change. However, it is not inconsistent with the observed behaviour in 2007-2009, when this measure of funding spreads rose by around 70 basis points, and the OCR was cut by 525 basis points (in response not just to the funding shock, but to all else that was going on in New Zealand and abroad) .

In the absence of a monetary policy response, the spread shock would have a larger impact on the economy than shown in Figure 4. To gain a clearer idea of the importance of the spread shock, we conduct a counterfactual experiment in which monetary policy is not allowed to respond to the spread shock. That is, we hold the 90-day interest rate fixed by introducing a sequence of monetary policy shocks to keep the 90-day interest rate fixed at every impulse response horizon. [7] The counterfactual responses are represented with red dotted lines in Figure 5. The original point estimate shown from Figure 4 is shown in black. If monetary policy did not respond to fluctuations induced by the spread shock, the negative impact

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[7] Sims and Zha (2006) describe the procedure on how to implement this type of counterfactual experiment.

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on the New Zealand economy would have been considerably larger. In particular, output would track substantially further below trend. The counterfactual output gap remains below the estimated historical response to spread shocks for around 16 quarters. Inflation is lower, but not very different from the benchmark case.

Figure 5: Response to a one standard deviation spread shock with monetary policy held constant (percentage point deviation)
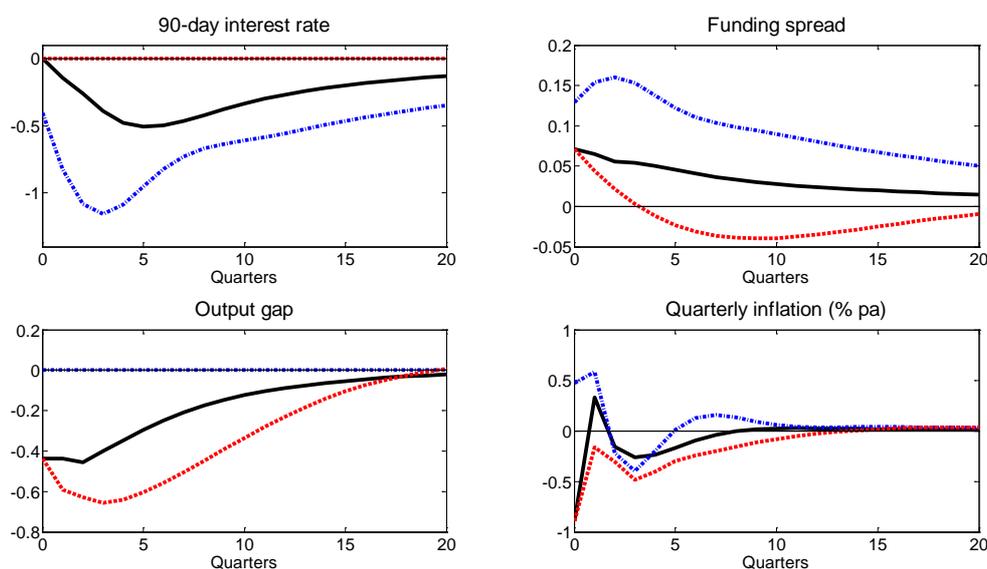
Notes: (a) Black solid line represents the point estimate as per Figure 4.(b) Red dotted line represents a dynamic counterfactual where monetary policy does not respond to a spread shock calculated from the median model.(c) Blue dot dash line represents the dynamic counterfactual where monetary policy is used to close up the output gap in response to a spread shock calculated from the median model.

To fully offset the effect of a spread shock on output (if that were desirable), monetary policy would need to be cut by even more than the estimated 50 basis points. In our second counterfactual experiment, we feed in a sequence of monetary policy shocks to fully close the output gap. The counterfactual path is shown in the blue dashed lines in Figure 5. To fully neutralise the effect of the spread shock on the output gap would require the interest rate track to be 40 to 60 basis points lower than the estimated historical response to the spread shock.[8] The divergence between this counterfactual scenario and the historical experience is not only sizable in terms of magnitude, but needs to stay in place at a horizon for over 20 quarters.

4 HISTORICAL DECOMPOSITION

Historical decompositions of the four observed model variables into the four shocks are shown in Figure 6. Variation in the 90-day rate, including the sharp fall from 2008 Q1 to 2009 Q1, is attributed to all four shocks. Over the early part of the sample, the model backs out a substantial positive role for monetary policy shocks on the 90-day interest rate. The contribution of the benchmark interest rate may reflect both a trend and cyclical component. There has been a downward trend in the neutral interest rate over the

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[8] Here the spread shock is larger (blue dash-dot line) than in the benchmark model due to the endogenous response of the spread to the 90-day rate.

period, and that trend may contribute to the positive contribution of monetary policy shocks to the 90-day rate in the early period and negative contribution over the second half. A positive contribution is also consistent with the view that monetary policy was too tight during over the 1997-98 monetary conditions index (MCI)[9] period. During the 2003-7 pre-crisis boom, a high 90-day rate is attributed to the endogenous response of monetary policy to inflation and output, to compressed spreads, offset somewhat by easy monetary policy, consistent with the Taylor rule numbers presented in Chetwin and Reddell (2012). On average, over the four quarters of 2013, the 90-day rate averaged about 220 basis points below the baseline projection. Of that, about 150 basis points are attributed to spread shocks, which are projected to runoff slowly.

Figure 6: Historical decomposition (percentage point deviation from baseline projection)
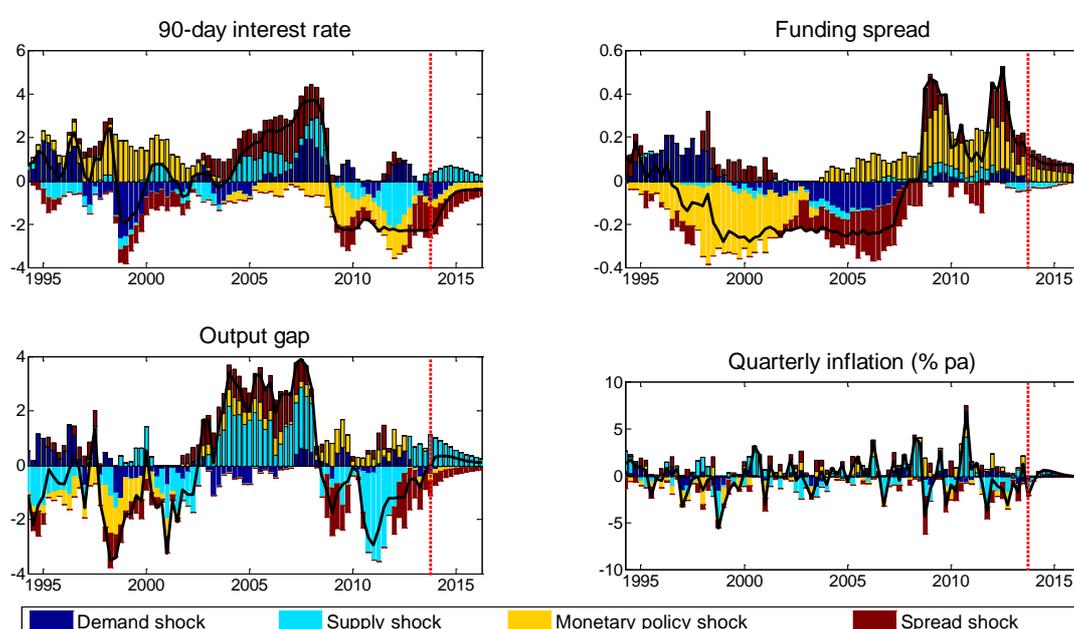
Notes: Bars represent the contribution of particular shocks in explaining deviation of the data from its baseline projection. Red dotted line represents the point where the sample ends; forward projections show the effects of the run-off of earlier shocks.

The observed spread is estimated to have a substantial endogenous component. Over the late 1990s, relatively high benchmark (policy) interest rates contribute to a relatively low measured spread to benchmark. As discussed above, that pattern may partly reflect a decline in the neutral real interest rate over the period. It also helps to explain the low observed spread over the Asian crisis and subsequent period when some other measures of risk, such as the VIX index and some US bonds spreads, were elevated. If the benchmark rate is high, relative to the state of the economy, then the measured spread in the 1-year market interest rate may be low, by construction. Relatively tight monetary policy over the MCI period (1997-98), is estimated to have contributed to the low observed spread (Figure 2), despite positive spread shocks over the period of the Asian crisis and other crises of the late 1990s.

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[9] The Monetary Conditions Index assumed a fixed contribution of interest rates and exchange rates to the tightness of monetary conditions. During the Asian crisis, a falling exchange rate, that - with hindsight - anticipated weaker activity, was interpreted as easing monetary conditions, leading to interest rates being held higher than was warranted by the state of the economy (see Svensson 2001).

Over the 2003-2007 period, the compressed spread is attributed to a combination of demand shocks and a period during which funding spreads were below their model-predicted level, despite the positive contribution of relatively easy monetary policy (a low benchmark rate implies a higher measured spread, for a given 1-year market interest rate). During the crisis and post crisis period, the VAR interprets the high measured spread to benchmark as due to a combination of positive spread shocks and monetary policy rates being below their historical relationship to the economy.

Over the historical sample, spread shocks are estimated to have contributed to the positive output gap over the early 2000s and to the subsequent 2009 recession and slow recovery over 2011-13.Throughout the whole period spread shocks remain much less important than supply shocks. The VAR attributes a large role to negative supply shocks in the large post-crisis fall in output relative to trend. More recently, supply shocks are estimated to have been positive for output, while lingering high funding spreads have had a negative influence on the output gap that is projected to runoff slowly.

5 WHAT CAN EXPLAIN THE STRONG ESTIMATED RESPONSE TO SPREADS?

Since both the benchmark interest rate and the funding spread feed into the observed lending rates facing final borrowers, it might be expected that a rise in the funding spread could be offset by an equal cut in the benchmark interest rate. However, the VAR results suggest that monetary policy needs to respond more strongly to offset the spread shock: the 90 day rate, largely set by monetary policy, falls by about seven times the rise in the spread. If we were to measure the spread by the more variable 5-year CDS spread or a longer-term bond spread, the estimated monetary policy response per basis point of spread shock would be smaller, but likely still greater than a one-for one response.

What can help to explain the relatively large impact of a rise in funding spreads? One possibility is that the strong response reflects the dominant role of the global financial crisis in our data sample. However, estimates for the first half of the sample (which cover a relatively short period) show an even stronger response of monetary policy to the spread shocks (see Appendix). Moreover, the historical decompositions show a significant economic role for spread shocks over the sample period.

Another possibility is that the spread shocks capture other demand shocks - domestic or external - that are correlated with our measured funding spread variable. Funding spreads don't change in a vacuum, but in response to all else that is affecting demand and supply conditions in the relevant funding markets, including uncertainty and attitudes towards risk. The effect of precautionary savings on consumption, and the responses of investment and hiring decisions to generalised uncertainty, is likely to be correlated with the measured spread. There is still a lot we don't know about the effects of risk on the macroeconomy.

Another candidate is the role of bank balance sheet constraints on the effective cost of the rise in spread. In principle, banks would like to substitute away from bonds to shorter-term funding when bond spreads are high. In practice, during periods of financial stress, stable funding requirements tend to be tightened by creditors, rating agencies, banks' internal risk management and regulators. At the same time, ability to

access those markets can become more difficult. As discussed in Bloor et al (2012), a binding balance sheet requirement can amplify the effect of a spread shock. In particular, when stable funding requirements bind, high funding spreads drive up the cost of substitute sources of stable funding, particularly deposits. In New Zealand, as in other countries, deposits spreads have tended to move with bond spreads (Figure 7). When the bond spread rises, the cost of deposit funding can rise by a lot because deposits account for half of all funding (Figure 8), in turn driving up loan rates. The incentive to increase saving and reduce borrowing can have a large effect on consumption and investment.

Figure 7: Bond spread and retail deposit spread
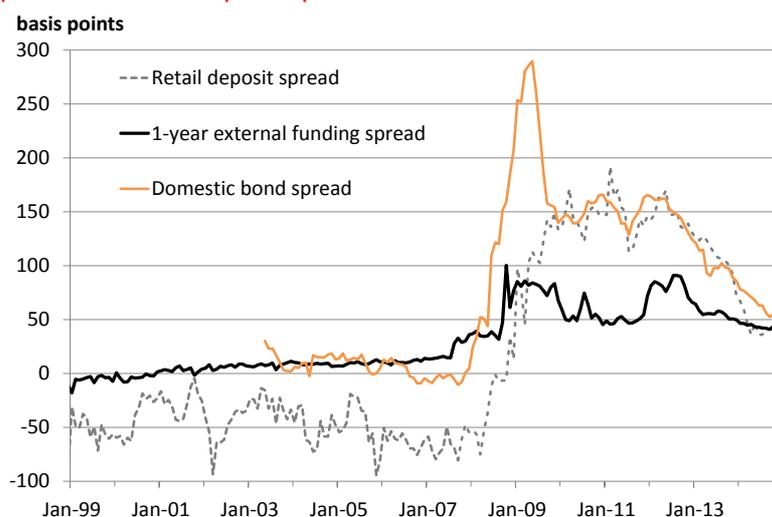
Notes: Deposit spread is 6-month deposit rate less 180-day bank bill. 1-year external funding spread is the NZD cost 1-year USD Libor hedged using an FX swap minus the 1-year NZD interest rate swap. The domestic bond spread is the NZX corporate bond (NZXCAY) index for borrowers rated A and above.

Figure 8: Estimated average funding costs relative to the OCR
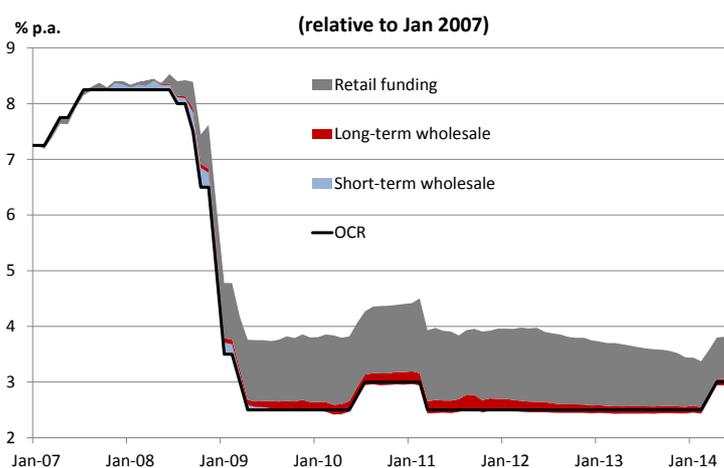
Note: Retail costs based on 6-month term deposit spread to 180 day bank bill (60%) and on-call spread (40%). Long-term wholesale cost based on average of domestic and external 3-year spreads to swap plus bank bill-OIS spread. Short-term costs based on bank-bill-OIS spread.

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6 CONCLUSION

With the caveat that this is a small, stylised model, working with indicative spread data, we can make some general observations about the roles of the benchmark and spread components of funding costs. First, spread shocks (and the things that given rise to them) appear to have been empirically important in New Zealand. Second, monetary policy is estimated to have played an important role in moderating the effects of spread shocks. The biggest change in spreads in our period occurred during the global crisis that began in 2007. Spreads have narrowed since the worst of the crisis, but at the end of our sample (2013 Q4), spread shocks are estimated to still account for a significant drag on the economy. Over the model's 2014-15 projection, the effect of the elevated spread on the output gap is mitigated by the lingering endogenous effect of the spread on the 90-day rate.

This model provides an initial empirical benchmark as a basis for developing thinking on the relationship between monetary policy and funding spreads. Other empirical and more structural models should, over time, shed more light on the issues.

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APPENDIX

Data Sources

The measure of quarterly GDP is the production measure for all industries, seasonally adjusted. Both GDP and the CPI data are sourced from Statistic New Zealand. The 90-day data are from the Reserve Bank of New Zealand.

The spread is calculated as the cost to an AA bank of raising 1-year USD Libor funding and hedging the currency risk with a 1-year FX swap. Source: Bloomberg.

VAR Estimation and Identification

Let y be a vector of four variables, namely the output gap, inflation, the 90-day rate and the spread. The output gap is obtained by regressing the log output on a constant with linear and quadratic time trends and taking the residuals. The VAR of lag order p in reduced form can be written as:

$$y_t = \sum_{i=1}^{p} A_i y_{t-1} + \epsilon_t$$

Where ϵ_t is a 4X1 vector of residuals, with covariance matrix Σ. The VAR is estimated using ordinary least squares. For our exercise, the VAR is estimated on two lags.

To identify the shocks, we use the identification restrictions with guidance from Kapetanios et. al. (2012) and Baumeister and Benati (2013). The restrictions we impose are summarised in the following table:

	Monetary policy shock	Spread shock	Demand shock	Supply shock
90-day rate	+	0	-	?
Spread	?	+	?	?
Output Gap	-	-	-	+
Inflation	-	-	-	-

Where + and – indicates a sign restriction and 0 indicates a zero restriction. ? denotes no restriction is imposed. We use the following algorithm to identify the shocks

1. Populate a 4 x 4 matrix, B with elements drawn from a N(0,1). Take a QR factorisation of B. Denote the orthonormal matrix from the factorisation Q1.

2.   Generate P1 = PQ1. Given P1, generate an orthonormal matrix Q2 to rotate a zero response for the 90-day rate for the candidate spread shock.

3.   Generate P2 = P1Q2. P2 is a candidate solution for the identification problem. Check if P2 satisfies the sign and zero restrictions. Otherwise, discard.

For our exercise, we consider 5000 possible solutions conditional on the least squares estimators. Our procedure yields about 270 solutions, which suggest the identification procedure is extremely informative.

Robustness

We also model the spread as being exogenous in order to check the sensitivity of the sign restriction identification procedure. Treating the spread as exogenous is akin to treating the system as a VAR with exogenous variables. The model can thus be estimated with the spread on the right-hand side of the other three equations through least squares. The spread is then modelled as an exogenous AR(2) process, which relaxes the zero restriction on the 90-day rate to a spread shock. The impulse response functions are shown in Figure A1. Strikingly, the 90-day rate does not respond contemporaneously to a spread shock with the maximum response taking about 5 quarters. Therefore, the imposition of the zero restriction on the 90-day rate in response to a spread shock does not appear to be overly restrictive.

We also redid the analysis up to 2003 Q4 (about half the sample) to consider a sample which includes the Asian crisis, but little movement in the spreads. We present the counterfactuals. The results are qualitatively similar to that for the although with different dynamics. The shorter sample suggests the results in the main text are not purely driven by the Global Financial Crisis. In the shorter sample, when funding spreads were less volatile, unobserved spread shocks still appear to serve as a useful indicator of funding stress in the economy. In the earlier period, those shocks may not be visible in the data, but the framework suggests a similar role for spread shocks as in the later period.

The definition of headline inflation has changes over time. In our final check, we reran the model using a consistent measure of CPI ex interest costs (the current definition of headline inflation). The results were qualitatively similar.

Figure A1: Impulse response functions to a one standard deviation spread shock taking funding spread to be exogenously determined (percentage point deviation).
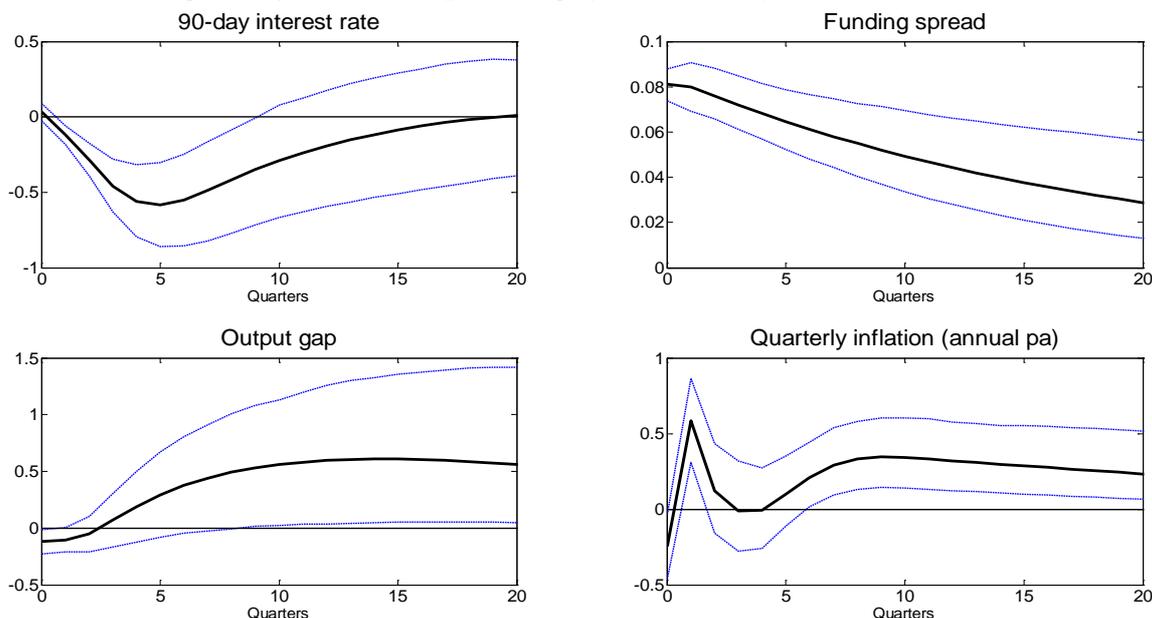
Blue dotted lines represent the 68% (boostrapped) confidence bands.

Figure A2: Dynamic Counterfactuals, sample up to 2003Q4
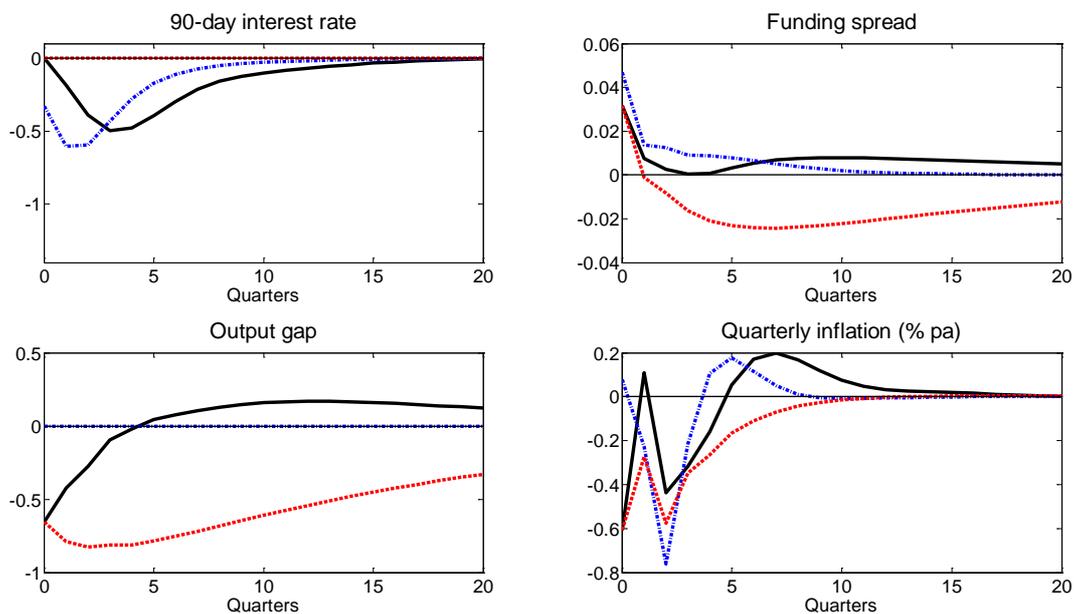
Notes: (a) Black solid old line represents the point estimate to a one standard deviation spread shock. (b) Red dotted line represents a dynamic counterfactual where monetary policy does not respond to a spread shock calculated from the median model. (c) Blue dot dash line represents the dynamic counterfactual where monetary policy is used to close up the output gap in response to a spread shock calculated from the median model.