

Technical appendix: Empirical evidence for the Reserve Bank's impact on market functioning.

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In the Bulletin article, we largely refrain from providing quantitative estimates of the impact of the Reserve Bank's efforts to support market functioning in 2020. The key reason for this is an identification problem. In March 2020, the speed of events meant the Reserve Bank announced its facilities and operations to support market functioning around the same time as many key international central banks. Governments were simultaneously announcing health and economic policies and seeking funding to implement them. This overlap makes it very challenging to attribute daily moves in asset prices to individual actions by the Reserve Bank.

In this appendix, we attempt to gauge the impact of the Reserve Bank's announcements on financial markets in 2020. We find evidence of a significant announcement effect from the Reserve Bank's actions, but the empirical analysis does not allow strong claims to be made about the precise contribution of the Reserve Bank's actions versus global central bank announcements to domestic financial conditions. Nevertheless, there was a strong view amongst market participants we interviewed that many of the Reserve Bank's actions, in particular the FX swaps and LSAP, had large and direct positive impacts on the functioning of New Zealand financial markets.

Event study

One way of trying to tease out the impact of central bank asset purchases (such as the LSAP programme) is via event studies. Financial markets are forward-looking, which means the impact from asset purchase programmes has two key effects – an announcement effect, and a flow effect. The largest impact of asset purchase programmes tends to be the announcement effect, as market participants anticipate the future effect of the (previously unknown) programme, and incorporate it into asset prices, today.¹ The flow effect refers to the impact of actual purchases of assets by central banks, and tends to be most active in the early stages of a crisis (when financial market functioning is most impaired).² Our event study focuses on assessing the announcement effect. The flow effect would be an area for further investigation in the New Zealand context.

The event study methodology involves analysing the moves in asset prices (or in our context, bond yields) in short windows around an announcement. As outlined in [Rebucci et al. \(2022\)](#), the validity of the event study methodology depends on three standard assumptions:

1. The event is unexpected;
2. There are no confounding factors; and
3. Markets are efficient.³

We follow the approach of [Rebucci et al. \(2022\)](#) who conduct an event study looking at quantitative easing announcements made by central banks (including the Reserve Bank of New Zealand) in March and April 2020. They focus on the benchmark ten-year sovereign bond yield for each country in their sample. They find that, for developed markets, the announcement of asset purchases programmes during March 2020 reduced the ten-year sovereign bond yield by an average of 13 basis points for the single-day event window. New Zealand's LSAP announcement stands out as particularly powerful, with the ten-year sovereign bond yield falling 52 basis points

¹ See [Krishnamurthy and Vissing-Jorgensen \(2011\)](#), [CGFS \(2023\)](#) and [Finlay et al. \(2023\)](#) for a review of the channels quantitative easing operates through.

² [CGFS \(2023\)](#).

³ It is questionable to what extent these assumptions held in March 2020. Even in New Zealand, where 23 March was the first time a large scale asset purchase programme had been announced by the Reserve Bank, market participants still anticipated that one would be delivered. However, both the timing and large size of the initial LSAP announcement were a surprise to the market. [Rebucci et al. \(2022\)](#) argue that because the timing of quantitative easing announcements could not have been exactly predicted, analysing the announcement of the quantitative easing intervention remains appropriate. The extremely large move in NZGB yields on 23 March 2020 would certainly point towards the LSAP announcement having a significant surprise element (noting that the US Federal Reserve's unlimited quantitative easing announcement occurred after market close in New Zealand on 23 March, so any impact from that would have been observed upon market open on 24 March).

on the day. The authors attributed this to the fact was the first time the Reserve Bank had announced an LSAP.⁴

We replicate the approach of [Rebucci et al. \(2022\)](#), but focus only on New Zealand. We consider a wider range of government and local government securities (specifically those on issue over 2020),⁵ and include additional policy announcement dates in March and April 2020.⁶ We choose a one-day event window for the event study (given the sheer number of announcements made in very quick succession), and calculate the change in bond yields on the day of the announcement (from close to close).

Four announcement days are selected:

1. **Friday, 20 March 2020** – the Reserve Bank published a [Media Release](#) and [Domestic Markets Media Release](#) which contained information about the TAF, removal of credit tiers on ESAS balances, FX swap activity, the US dollar swap line with the US Federal Reserve, and the BMLS programme;
2. **Monday, 23 March 2020** – the Monetary Policy Committee [announced](#) that they had decided to deploy an LSAP programme;
3. **Monday, 6 April 2020** – the Reserve Bank published a [Domestic Markets Media Release](#) announcing the addition of LGFA bonds to the BMLS programme; and
4. **Tuesday, 7 April 2020** – the Reserve Bank released a [Media Release](#) announcing the addition of LGFA bonds to the LSAP programme.

Announcement impact on yields

Table 1 shows the change in yields on each announcement date.

On 20 March, there was sharp drop in bond yields across nominal NZGBs, inflation indexed NZGBs, and LGFA bonds. For nominal NZGBs, the fall in yields observed on 20 March ranged from 20 basis points for the May 2021 bond to 36 basis points for the April 2037 bond.

However, it is not possible to interpret these falls as being caused by the Reserve Bank's announcement. On 19 March, at the same time as market close in New Zealand, the RBA [announced](#) it would purchase government securities. Spillovers from the RBA's announcement to New Zealand markets would have been observed on 20 March. The US Federal Reserve also [announced](#) the establishment of temporary US dollar swap lines with various central banks (including the Reserve Bank of New Zealand) on 19 March EST. Any domestic effect of these swap lines would be seen on New Zealand market open on 20 March. In our interviews, market participants viewed the Reserve Bank's facilities and operations announced on 20 March as quite impactful, but it is not possible to identify how much of the move in yields was caused by the Reserve Bank's announcement.

On 23 March, when the LSAP was announced, the falls in bond yields were particularly large – ranging from 8 basis points for the May 2021 bond to 69 basis points for the April 2037 bond (Table 1). This move occurred immediately after the (already) large drop in yields seen on 20 March.⁷ The yield on the April 2037 nominal NZGB fell 105 basis points over the course of those two trading days. The yields on inflation indexed NZGBs and LGFA bonds also declined rapidly on

⁴ See table 2 in [Rebucci et al. \(2022\)](#) for the full set of results.

⁵ We do not consider bonds maturing in early 2020.

⁶ We do not consider the changes to the LSAP made in May and August 2020 in the event study. The timing was extremely predictable since these announcements were made on Monetary Policy Statement days, and market participants also anticipated further increases to the size of the LSAP at each date. So the event study methodology would be inappropriate for analysing these later (and highly anticipated) LSAP announcements.

⁷ As 20 March 2020 was a Friday, Monday 23 March 2020 was the following trading day.

the day the LSAP was announced, despite these bonds initially being excluded from the programme.

Again, it is difficult to determine how much of the fall in bond yields on 23 March 2020 can be attributed to the Reserve Bank's LSAP announcement. The fall in yields recorded on 23 March could also reflect any global announcements that happened over the weekend. However, discussions with market participants indicate that, in the view of people who were in the market at the time, the LSAP had a very large and direct impact on New Zealand markets on the day it was announced. There were some smaller announcements by the US Federal Reserve between New Zealand market close on 20 March and the open on 23 March, but the Federal Reserve's next big announcement removing the cap on asset purchases was not made until after the New Zealand market had closed on 23 March. Combined with feedback from market participants, we think most of the move in yields seen 23 March reflected the Reserve Bank's LSAP announcement.⁸

We also examined 6 and 7 April 2020, when it was announced that LGFA bonds were to be added to the BMLS and LSAP programmes (respectively). There was no evidence of a broad impact on nominal or inflation indexed NZGB yields, but most LGFA bonds saw a statistically significant reduction in yields on 6 April (that is, on announcement of their addition to the BMLS). This gives us confidence that the move in LGFA yields was a response to the Reserve Bank's actions, rather than simply reflecting a more general move in financial market pricing.

Announcement impact on bid-ask spreads⁹

Repeating the exercise in Table 2 but using the change in bid-ask spreads instead of the change in yields, provides some useful results. On 23 March, bid-ask spreads of nominal NZGBs fell modestly, while bid-ask spreads on most inflation indexed NZGBs and LGFA bonds increased.¹⁰ This could reflect disappointment that inflation indexed NZGB and LGFA bonds were excluded from the initial LSAP purchases.

Table 2 also shows there was a large and statistically significant fall in bid-ask spreads for LGFA bonds on 6 and 7 April 2020, suggesting a strong market functioning impact of these announcements from the Reserve Bank. Again, the size of the move for LGFA bonds relative to nominal NZGBs suggests the drop in bid-ask spreads reflected the Reserve Bank's announcements, rather than a more generalised shift in market sentiment.

These results are consistent with feedback from market participants that adding LGFA bonds to the Reserve Bank's asset purchases was a key turning point in restoring liquidity in the market for LGFA bonds. Market participants noted that improved liquidity in LGFA bonds then filtered down into the corporate bond market.

⁸ [Rebucci et al. \(2022\)](#) also note the possibility that the moves they observe in sovereign bond yields are the result of spillovers from large economies like the US or euro area. They provide GVAR evidence that domestic factors still matter for domestic interest rates, even when allowing for the influence of global interest rates.

⁹ One caveat with the bid-ask spread data is the published spreads may not always reflect what gets executed for customers. [NZFBE](#) also sets maximum bid-ask spreads when calculating closing rates. While there are some allowances for stressed market conditions, it is possible these limits could reduce the published width of the bid-ask spread during fast-moving crisis periods, thereby understating the loss of liquidity experienced by the market.

¹⁰ The bid-ask spread on the 2027s and 2029s increased significantly on 20 March, but that could simply reflect a retracement of the large fall observed on 19 March. The increase in bid-ask spread for the 2027s and 2029s on 20 March brought their spread back up to the level seen across other nominal NZGB lines on 20 March.

Table 1. Event study results – change in yields on announcement days in 2020

Bond	Date			
	20-Mar	23-Mar	6-Apr	7-Apr
Nominal May 2021	-19.6***	-7.9***	0.0	0.7
Nominal Apr 2023	-35.2***	-27.5***	-1.8	4.1
Nominal Apr 2025	-34.0***	-45.4***	-1.7	4.4
Nominal Apr 2027	-30.8***	-48.2***	-0.8	5.7
Nominal Apr 2029	-30.6***	-50.6***	0.3	7.3**
Nominal May 2031	-30.4***	-56.7***	4.0	4.5
Nominal Apr 2033	-32.6***	-63.3***	2.5	4.4
Nominal Apr 2037	-36.4***	-68.9***	2.2	4.3
IIB Sep 2025	-13.1***	-31.7***	0.2	4.3
IIB Sep 2030	-4.8*	-34.2***	0.3	3.6
IIB Sep 2035	-18.8***	-37.1***	0.7	2.9
IIB Sep 2040	-15.0***	-39.7***	1.1	3.4
LGFA May 2021	-9.2***	-7.6***	-7.3***	-1.8
LGFA Apr 2022	-14.2***	-14.0***	-7.7***	-6.0**
LGFA Apr 2023	-15.1***	-17.2***	-6.6**	-3.9
LGFA Apr 2024	-19.9***	-25.1***	-7.6**	-1.2
LGFA Apr 2025	-22.4***	-31.0***	-8.4***	-2.9
LGFA Apr 2027	-21.9***	-33.7***	-9.8***	0.0
LGFA Apr 2029	-24.0***	-38.2***	-7.2	-0.7
LGFA Apr 2033	-24.3***	-31.5***	-6.9*	-3.2

Note: Table shows the one-day change in yields (expressed as basis points) on key RBNZ announcement days in March and April 2020. The calculation compares the closing yield on the day of the announcement with the previous trading day's closing yield. *, **, and *** indicate significance at the 10%, 5%, and 1% significance level. Test statistic is a two-sided Z-test calculated using the unconditional standard deviation of the daily change in the bond yield between 2017 and the end of February 2020, following the approach in [Rebucci et al. \(2022\)](#). IIB refers to inflation-indexed bonds, and LGFA refers to the Local Government Funding Agency.

Source: Bloomberg, RBNZ estimates.

Table 2. Event study results - change in bid-ask spreads on announcement days in 2020

Bond	Date			
	20-Mar	23-Mar	6-Apr	7-Apr
Nominal May 2021	-2.6***	0.0	-0.2	0.3
Nominal Apr 2023	-3.2***	0.1	-0.2	-0.6**
Nominal Apr 2025	-3.1***	-0.1	-0.9***	0.3
Nominal Apr 2027	5.6***	-0.5*	-0.5*	0.4
Nominal Apr 2029	3.6***	-1.2***	0.5**	-0.4*
Nominal May 2031	-3.1***	-1.2***	-0.5**	0.4*
Nominal Apr 2033	-4.6***	-0.8**	0.5	-0.5
Nominal Apr 2037	-6.9***	-0.1	-0.1	0.0
IIB Sep 2025	2.8***	5.3***	2.0***	-0.1
IIB Sep 2030	-0.2	5.5***	2.1***	0.0
IIB Sep 2035	1.5***	5.5***	2.2***	-0.1
IIB Sep 2040	1.4*	4.0***	-0.1	0.8
LGFA May 2021	0.4	-2.2***	-16.7***	-4.0***
LGFA Apr 2022	-3.3***	-3.6***	-11.7***	-6.5***
LGFA Apr 2023	-1.5***	2.7***	-12.7***	-5.5***
LGFA Apr 2024	-3.8***	3.7***	-10.7***	-8.2***
LGFA Apr 2025	0.0	3.5**	-14.1***	-10.3***
LGFA Apr 2027	0.8***	-0.6**	-15.8***	-2.2***
LGFA Apr 2029	-5.2***	5.6***	-13.2***	-6.0***
LGFA Apr 2033	-5.0***	2.8***	-10.2***	-11.9***

Note: The table shows the one-day change in bid-ask spreads (expressed as basis points) on key RBNZ announcement days in March and April 2020. The calculation compares the closing bid-ask spread on the day of the announcement with the previous trading day's closing bid-ask spread. *, **, and *** indicate significance at the 10%, 5%, and 1% significance level. The test statistic is a two-sided Z-test calculated using the unconditional standard deviation of the daily change in the bond yield between 2017 and the end of February 2020, following the approach in [Rebucci et al. \(2022\)](#).

IIB refers to inflation-indexed bonds, and LGFA refers to the Local Government Funding Agency.

Source: Bloomberg, RBNZ estimates.

In summary, these event study results, when combined with insights from our interviews with market participants, provide evidence of a powerful announcement effect of the LSAP and other Reserve Bank facilities and operations to support market functioning in 2020. However, we are unable to precisely decompose the change in bond yields and bid-ask spreads into contributions from the Reserve Bank and other central banks due to the simultaneous announcements from central banks and fiscal authorities globally. Table 2 also provides strong evidence for the positive impact that the Reserve Bank's bond purchases had on market functioning through the impact on the LGFA bond market.

Regression analysis

A second approach to empirically assessing the Reserve Bank's impact on financial market functioning in 2020 is using regression analysis. This helps identify if the Reserve Bank's announcements are correlated with statistically significant improvements in measures of financial market stress. [Cassino and Yao \(2011\)](#) apply this approach to estimate the impact of the Reserve Bank's emergency liquidity measures during the GFC, following [Wu \(2010\)](#)'s analysis of the US Term Auction Facility from 2007-2009. Cassino and Yao (2011) find that the Reserve Bank's liquidity announcements during the GFC were correlated with a 7.3 basis point reduction in the three-month BKBM-OIS spread.

We follow the specification of [McAndrews et al. \(2017\)](#) because it allows us to distinguish between the temporary and persistent impacts of the Reserve Bank's announcements. We analyse the impact of the Reserve Bank's announcements on the daily change in the three-month BKBM-OIS spread, controlling for moves in equivalent Australian and US spreads. The announcements we consider are listed in table 4. We estimate the following baseline regression:

$$\begin{aligned} \Delta NZspread_t = & \beta_0 + \beta_1 \Delta NZspread_{t-1} + \beta_2 \Delta NZspread_{t-2} + \beta_3 \Delta AUSpread_t \\ & + \beta_4 \Delta USspread_{t-1} + \beta_5 RBNZ\ Announcement_t + \beta_6 RBNZ\ Announcement_{t-1} \\ & + \varepsilon_t \end{aligned}$$

where $\Delta NZspread_t$ is the daily change in BKBM-OIS spread (in basis points), $\Delta AUSpread_t$ is the daily change in the Australian Bank Bill Swap Rate spread to OIS, and $\Delta USspread_{t-1}$ is the daily change in USD LIBOR-OIS spread (lagged by one day to account for the different time zones). Using the spread to OIS means we account for changes to monetary policy expectations.

The coefficients β_5 and β_6 give the estimated impact of RBNZ announcements on BKBM-OIS spreads. The announcements are listed in table 4 and capture significant new information (such as the announcement or extension of a major programme).¹¹ This regression model allows us to distinguish between permanent and temporary impacts from these announcements. If the impact is temporary, then $\beta_5 = -\beta_6$. This implies a drop in the BKBM-OIS spread on announcement day (β_5) will subsequently be reversed (β_6). If RBNZ announcements persistently reduce BKBM-OIS spreads, then β_6 should either be statistically insignificant, or even negative and significant.

We report the results of this regression in table 3 below. Our sample period spans January to May 2020, since daily volumes traded in BKBM essentially dropped to zero for several months after May (meaning in those months, BKBM rates would have been mostly based on executable bids and offers, rather than actual trades).¹² Robust standard errors are report in parentheses, and the stars next to the coefficients denote the level of statistical significance.

¹¹ Which announcement events are considered significant enough to include as an indicator is a judgement call. Our indicator series accounts for new "signals" and "announcements", while excluding daily "operations". For example, the NZ\$60b expansion of the LSAP is included, while clarifications to operational details of tools are excluded.

¹² For robustness, we repeated the analysis using the full year of data from January to December 2020. Very similar results were obtained.

The first column of table 3 shows the results from our baseline specification. The results have the expected sign, with the Reserve Bank's announcements correlated with a two basis-point reduction in the three-month BKBM-OIS spread (with a one-day lag).¹³ This lag may reflect that BKBM rates are set daily in a short window at 10:20am on trading days, so it could take longer for the Reserve Bank's announcements to be reflected. We tried other specifications with more lags of the Reserve Bank's announcements, and these lags were not statistically significant (which indicates the Reserve Bank's announcements contributed to a persistent decline in the level of the BKBM-OIS spread over this period).

Our finding of an average two-basis point reduction in the three-month BKBM-OIS spread per Reserve Bank announcement is smaller than Cassino and Yao (2011)'s finding. However, we use a different specification, and BKBM-OIS spreads simply did not increase by that much in 2020 compared to the GFC. The three-month BKBM-OIS spread peaked at 116 basis points in 2008 before the TAF was deployed, versus the peak of 45 basis points in 2020.

In the second column of table 3, we add dummy variables to capture fiscal policy (including a one day lag). The fiscal variable captures the announcement of new fiscal spending packages, while the NZDM variable captures announced increases in the NZGB borrowing programme (see table 4). Fiscal announcements are correlated with a 1.3 basis point reduction in BKBM-OIS spreads (consistent with feedback from market participants that announcements like the wage subsidy helped support the liquidity of New Zealand households and businesses). Expansions to the borrowing programme are correlated with a roughly two basis point increase in BKBM-OIS spreads, consistent with spillover from market participants being concerned about the ability of the market to absorb increased issuance.

The final column splits the Reserve Bank's announcements into LSAP and non-LSAP announcements. All the Reserve Bank announcement dummy variables continue to have negative signs on their coefficients, but only the LSAP announcements are statistically significant. This may simply be a result of the coefficients being imprecisely estimated (the robust standard errors are large), but it is also consistent with the view of market participants that the LSAP played a dominant role in stabilising New Zealand's financial markets.

¹³ Results obtained using the one-, two-, and six-month tenors were very similar.

Table 3. Regression results, Dependent variable: Daily change in 3-month BKBM-OIS spread

	Baseline	Fiscal variables included	LSAP announcements separate
<i>Intercept</i>	-0.03 (0.149)	-0.02 (0.165)	-0.02 (0.165)
<i>ΔNZspread (t-1)</i>	0.25** (0.123)	0.25** (0.128)	0.24* (0.129)
<i>ΔNZspread (t-2)</i>	-0.07 (0.069)	-0.13** (0.064)	-0.13* (0.067)
<i>ΔAUs spread (t)</i>	0.06 (0.073)	0.07 (0.081)	0.08 (0.091)
<i>ΔUS spread (t-1)</i>	0.08 (0.057)	0.09 (0.058)	0.09 (0.058)
<i>RBNZ announcements (t)</i>	-0.69 (0.989)	-0.7 (0.976)	
<i>RBNZ announcements (t-1)</i>	-1.97* (1.006)	-2.08* (1.112)	
<i>LSAP announcement (t)</i>			-1.46 (1.695)
<i>LSAP announcement (t-1)</i>			-2.47*** (0.715)
<i>RBNZ announcements, excl. LSAP (t)</i>			-0.33 (0.872)
<i>RBNZ announcements, excl. LSAP (t-1)</i>			-1.43 (1.343)
<i>Fiscal announcements (t)</i>		-1.32** (0.593)	-1.26* (0.644)
<i>Fiscal announcements (t-1)</i>		-0.97 (1.058)	-0.91 (1.015)
<i>NZDM announcements (t)</i>		2.14* (1.101)	2.26** (1.069)
<i>NZDM announcements (t-1)</i>		0.36 (0.727)	0.21 (0.648)
Adjusted R-squared	0.20	0.19	0.18
No. Obs.	108	108	108

Note: Sample runs from January to May 2020 (inclusive), robust standard errors are report in parentheses.
Source: Bloomberg, RBNZ estimates

Table 4. Key dates used for dummy variables in regression analysis

Date	RBNZ Announcement	Fiscal Announcement	NZDM Announcement
17/03/2020		Economic Response Package	NZGB programme increased (by NZ\$3b)
20/03/2020	BMLS, TAF announced, ESAS credit tiers removed		
23/03/2020	LSAP announced (NZ\$30b)		
25/03/2020		Imprest Supply Act (Third for 2019/20) passes, spending later called CRRF	
30/03/2020	COMO announced		
01/04/2020			NZGB programme increased (by NZ\$12b)
02/04/2020	TLF announced		
06/04/2020	BMLS expanded to LGFAs		
07/04/2020	LSAP expansion to LGFAs announced		
13/05/2020	LSAP expanded to NZ\$60b, plus IIBs		
14/05/2020		CRRF Foundational Package announced (NZ\$50b total, incl. prev. funding)	NZGB programme increased (by NZ\$35b)