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Quantitative or qualitative forward guidance: Does it matter?

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Abstract

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Keywords

Monetary policy, forward guidance, interest rate forecasts.

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Abstract

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1 Introduction

Many central banks provide information about the expected future path of short-term interest rates, forward guidance. However, the form of the information that is communicated varies significantly across central banks. Some central banks communicate the policy outlook by means of brief qualitative statements. Some central banks use state- or date-dependent forward guidance. For example, in the aftermath of the global financial crisis, when the federal funds rate target reached nearly zero, the FOMC started providing date- and state-dependent forward guidance to provide information about likely future monetary policy.[1] Some central banks on the other hand, such as the Reserve Bank of New Zealand (RBNZ), Norges Bank and Sveriges Riksbank, provide quantitative interest rate forecasts in their communications with the public and financial markets.[2]

The empirical evidence suggests that communication can be an important and powerful part of the central bank's toolkit, since it enables the central bank to manage the expectations of the public and of financial market participants. Central bank communication also has the ability to affect financial market prices, to enhance the predictability of monetary policy decisions, and potentially to help achieve central banks' macroeconomic objectives. However, as Blinder et al. (2008) argue, the large variation in communication strategies across central banks suggests that a consensus has yet to emerge on what constitutes an optimal communication strategy. One aspect of central bank communication which is still being debated is the value of central banks publishing projections of their expected interest rate path. Bernanke (2004) mentions that central bank com-

[1] For example, the FOMC statement issued after the December 2008 decision stated that the Committee anticipated that weak economic conditions were "likely to warrant exceptionally low levels of the federal funds rate for some time." Central bank communication more generally is discussed in Blinder et al.(2008, 2016). For forward guidance more specifically see Campbell et al. (2012), Svensson (2015), and Moessner et al. (2017).

[2] The RBNZ has published regular forecasts of the ninety-day interest rate since June 1997. Norges Bank started publishing its forecasts of the policy rate in 2005, and Sveriges Riksbank in 2007.

munication can help inform the public's expectations of the future course of the policy rate. Rudebusch (2008) argues that this leaves open the question of which kind of central bank communication can best guide the public's expectations. One particular objection to central banks publishing their interest rate forecasts is the risk that the central banks' signals about future policy may be misinterpreted as promises of future policy actions.[3]

In this paper, we exploit the difference in the amount of information the RBNZ communicates with its interest rate decisions to answer the following questions: does the nature of forward guidance matter? More specifically, does it matter for market participants' perception regarding the future monetary policy stance whether the central bank provides quantitative forward guidance by means of interest rate forecasts, or whether it provides qualitative forward guidance in policy statements? Do market participants infer similar information from both? What is the marginal value of publishing quantitative interest rate forecasts, relative to providing qualitative forward guidance in policy statements? Do financial market participants attach a high weight to interest rate forecasts?

Every monetary policy decision by the RBNZ is accompanied by a written statement about the state of the economy and the policy outlook. However, only every second decision includes an interest rate forecast. We exploit this difference in the information content of policy announcements to estimate the marginal contribution of interest rate forecasts to the perceived forward guidance by market participants. This control-treatment approach gives us a better identification of the effects of quantitative interest rate forecasts compared with the earlier literature which analysed the effects of forward guidance on the announcement days with interest rate forecasts.

Although the RBNZ's forward guidance is usually associated with its novel approach of publishing its forecasts for interest rates, the RBNZ also provides qualitative forward guidance in its policy statements. The RBNZ has made eight interest rate decisions a year, four of which are accompanied by a Monetary Policy Statement (MPS) including a quantitative forecast of short-term interest rates. The other four interest rate decisions on Official Cash Rate (OCR) review days include no interest rate forecasts.[4] All eight

[3]See Goodhart (2001) for this view for example.

[4]This changed in 2016, towards the end of our sample. Since 2016, the RBNZ has made four interest rate decisions a year accompanied by Monetary Policy Statements which include interest rate forecasts,

decisions include a media release which summarises the current economic conditions, and also talks about the likely future policy outlook.[5]

Our approach differs from earlier studies by exploiting the difference in the way the RBNZ communicates its interest rate decisions on MPS days and OCR review days. This difference provides us with a treatment and control sample to examine the effects of publishing quantitative interest rate forecasts on market interest rates, over and above the effects of implicit and explicit qualitative forward guidance contained in written monetary policy statements. These control and treatment samples also allow us to estimate the effect of qualitative forward guidance, as far as financial market participants' perceptions are concerned.

We find two main results. First, market participants' reaction to information about the future course of monetary policy provided on the days of the RBNZ's monetary policy decisions is very similar on MPS and OCR review days. More specifically, market participants' interpretation of the RBNZ's interest rate decisions as measured by a target factor and a path factor have similar statistical properties on MPS and OCR review dates. This finding suggests that quantitative interest rate forecasts are not the only information from which market participants infer forward guidance, and the marginal contribution of the RBNZ's interest rate forecasts, over and above that of its qualitative forward guidance, to market participants' perception of forward guidance is small.

Second, we find that the effects of the path factor on the yield curve are very similar on both MPS and OCR Review days. This is interesting because the quantitative interest rate projections provide information about the future path of interest rates. The results suggest that markets infer similar information from a monetary policy announcement whether or not a quantitative forecast accompanies the announcement and the statement. Our result that qualitative forward guidance has a significant effect on market interest rates in New Zealand is consistent with earlier results for the United States (see eg Gürkaynak et al.,

and three interest rate decisions on OCR Review announcement days, which only include a one-page statement but no interest rate forecasts.

[5]Although the MPS is a larger document which includes a very detailed discussion of the economic outlook, the first chapter of the MPS is identical to the OCR review statement. Moreover, on MPS days financial market participants usually focus on this first chapter, as well as on the interest rate forecasts.

2005; Campbell et al., 2012; Moessner, 2013).

Our results have important implications for central bank communication in the form of forward guidance.[6] Our results suggest that financial markets are able to infer similar forward guidance from different forms of forward guidance, qualitative or quantitative. Moreover, market participants appear to understand the conditional nature of quantitative interest rate forecasts. RBNZ speeches and other communication that have emphasized that the RBNZ's published interest rate paths are conditional forecasts, not promises, appear to have been well understood by market participants. This result is also consistent with the results of Moessner and Nelson (2008) and Detmers and Nautz (2012) for New Zealand, and with Moessner et al. (2016) and Ahl (2017) for Sweden, who find that the conditionality of the central bank's interest rate forecasts is understood by market participants.[7] This casts doubt over the concerns raised by some that central bank interest rate forecasts may be interpreted by market participants as unconditional commitments.

Our results on the marginal effect of the interest rate forecasts add to the existing earlier literature. Previous studies, Moessner and Nelson (2008), Ferrero and Secchi (2009) and Detmers and Nautz (2012) for example, only analysed the announcements on MPS days, without distinguishing between the effects of the quantitative interest rate forecasts and the statements. Therefore, their estimates reflected the total influence of both sources of information. Our novel contribution is to use the control-treatment identification to consider separately the effects of just the statements, and of the quantitative forecasts and statements combined.

2 Method

Kuttner (2001) proposed a method for calculating the unexpected component of monetary policy announcements by using short-term interest rate futures. These monetary policy surprises were found to have a significant effect on asset prices (Kuttner, 2001; Bernanke

[6]There are of course other reasons for a central bank to communicate with the public by means of written statements and forecasts, such as transparency and accountability, besides the effect of this communication on market expectations.

[7]See also Iversen and Tysklind (2017) for Sweden.

and Kuttner, 2005).[8] However, Gürkaynak et al. (2005) showed that the responses of asset prices to monetary policy surprises may be inadequately described by a single factor proposed by Kuttner, namely the surprise element of monetary policy or the target factor.[9] They showed for the United States that two factors were needed to adequately capture the responses of asset prices to monetary policy announcements, where the second factor is a path factor that represents the surprise component regarding the future path of monetary policy. This is consistent with the results of Brand et al. (2010) for the euro-area and with Brubakk et al. (2017) for Norway and Sweden, who also find that a second factor representing the future path of monetary policy is required to adequately characterise the responses of asset prices to monetary policy announcements.

2.1 Target and path factors

We use the following approach for estimating the target and path factors for New Zealand, which is approximately equivalent to the approach of Gürkaynak et al. (2005) (see also Gürkaynak, 2005).[10] The target factor, $Z_{1,t}$, is calculated as the daily change in a very short-term market interest rate in New Zealand, r_t^s, on OCR review days and on MPS days,

$$Z_{1,t} = \Delta r_t^s. \tag{1}$$

The path factor, $Z_{2,t}$, is then estimated as the residual ε_t of the following regression of the daily change in a market interest rate of longer maturity in New Zealand, r_t^b, on the target factor, according to

$$\Delta r_t^b = c + \beta_1 Z_{1,t} + \varepsilon_t, \tag{2}$$

$$Z_{2,t} = \hat{\varepsilon}_t, \tag{3}$$

[8] For the related literature for New Zealand see Drew and Karagedikli (2007) and Karagedikli and Siklos (2008).

[9] See also Gürkaynak et al. (2007).

[10] We thank Refet Gürkaynak for pointing this out to us.

with the path factor $Z_{2,t}$ set equal to the estimated residual of regression (2), $\hat{\varepsilon}_t$, which implies that the path factor is orthogonal to the target factor, as is the case for the approach of Gürkaynak et al. (2005).

For our benchmark estimation we use the one-month bank bill rate in New Zealand as the very short-term market interest rate, r_t^s, and we use the one-year interest rate swap in New Zealand as r_t^b.[11]

For robustness, we will also use the approach of Gürkaynak et al. (2005) below to derive the target and path factors, and we will show that our results are robust to using the approach of Gürkaynak et al. (2005).

3 Results

3.1 Target and path factors

The descriptive statistics for the target and path factors estimated for the full sample in our benchmark estimation using the one-month bank bill rate and the one-year interest rate swap in equations (1) to (3) are shown in Table 1. We can see that the summary statistics for the path factor are similar on MPS dates and on OCR review dates, with a slightly higher standard deviation of 6.35 basis points on MPS dates, compared with 5.34 basis points on OCR review dates. The maximum and minimum of the path factor are also similar on MPS and OCR review dates, but slightly higher in magnitude on MPS dates. This suggests that the path factor exhibits similar variability whether the monetary policy announcement is accompanied by an interest rate forecast or not. Our results that the path factor has similar statistical properties on MPS and OCR review dates suggests that what market participants infer about the future course of monetary policy from the RBNZ's decisions is similar on MPS and OCR review days. More specifically, our results suggest that quantitative interest rate forecasts are not the only information from which market participants infer forward guidance in New Zealand, but they also infer forward guidance information from qualitative forward guidance in monetary policy statements,

[11] For robustness tests below, we also use the one-month and one-year OIS rates instead, as well as the one- and six-month bank bill rates.

including on OCR review days when no interest rate forecast is published. Moreover, these results suggest that the marginal contribution of the RBNZ's interest rate forecasts, over and above that of its qualitative forward guidance in monetary policy statements, to market participants' perception of forward guidance is small, as reflected in only a slightly higher standard deviation of the path factor on MPS dates.

We can see that the descriptive statistics for the target factor are similar on MPS dates and on OCR review dates, with a slightly higher standard deviation of 7.61 basis points on MPS dates, compared with 6.47 basis points on OCR review dates.

[Table 1 about here]

The RBNZ has provided explicit qualitative forward guidance on several occasions, and some examples are described in the following. On 29 October 2009, the RBNZ kept the policy interest rate unchanged at 2.5 percent, which had been largely expected by financial market participants. However, the last sentence of the RBNZ's accompanying monetary policy statement mentioned that "[i]n contrast to current market pricing, we see no urgency to begin withdrawing monetary policy stimulus, and we expect to keep the OCR at the current level until the second half of 2010." This was the first time since the introduction of the publication of interest rate forecasts in 1997 that the RBNZ used explicit qualitative forward guidance on interest rates with reference to a particular date, ie date-based qualitative forward guidance. On 25 July 2013, the RBNZ kept the short-term interest rate at 2.5 percent, which was again anticipated by market participants. The monetary policy press release on this day contained implicit, and explicit date-based, qualitative forward guidance, mentioning that inflation was expected to be moving towards the top of the target band over the coming years, and that "[a]lthough removal of monetary stimulus will likely be needed in the future, we expect to keep the OCR unchanged through the end of the year." On 11 March 2010, the RBNZ again kept the OCR unchanged at 2.5 percent. The interest rate path which the RBNZ published on this day (as it was an MPS day), was very similar to the path published in the previous MPS in December 2009. However, the final sentence in the monetary policy press release stated that the RBNZ "continue[d] to expect to begin removing policy stimulus around the middle of 2010." This was another example when the RBNZ used explicit date-based qualitative forward guidance. These examples of qualitative forward guidance suggest that the perceived forward guidance, ie what market participants infer about the future stance of monetary policy from the forward guidance, is not only inferred from the publication of interest rate forecasts, but is also inferred from the wording of the monetary policy statements, ie from implicit and explicit qualitative forward guidance in those statements.

Such date-based explicit qualitative forward guidance was provided by a number of central banks in the wake of the global financial crisis (Woodford, 2013). In the case of the Bank of Canada, for example, the monetary policy statement on 21 April 2009 mentioned that the policy rate would remain the same beyond one year. In the case of the Federal Reserve, the monetary policy statement on 9 August 2011 for example mentioned that "economic conditions [...] are likely to warrant exceptionally low levels for the federal funds rate at least through mid-2013."

3.2 Responses of asset prices

In the previous section we showed that market participants inferred forward guidance on OCR review dates from the monetary policy statements published by the RBNZ, as measured by the estimated path factor on those days, and that the descriptive statistics of this path factor on OCR review days are comparable to those of the path factor estimated on MPS days.

In the following we study the effects of the target and path factors on longer-term market interest rates on MPS and on OCR review days, using the target and path factors estimated over the combined sample of OCR review days and MPS dates. To asses the relative importance of the effects of the path factor on MPS and OCR review days, we estimate the following regression for each maturity j of interest rate swaps,

$$\Delta y_t^j = c + d * D_t^M + (\alpha_1 + \gamma_1 D_t^M) Z_{1,t} + (\alpha_2 + \gamma_2 D_t^M) Z_{2,t} + \varepsilon_t \qquad (4)$$

where Δy_t^j is the daily change in the interest rate swap with a maturity of j years on the day t of the monetary policy announcement, for spot maturities of $j = 2, 3, 4, 5, 10$ years, and for 5-year forward rates 5 years ahead, $j = 5/5$. D_t^M is a dummy variable taking the value of one on MPS days, and zero otherwise. As above, $Z_{2,t}$ is the estimated path factor on day t, and $Z_{1,t}$ is the estimated target factor on day t.

The results are shown in Table 2, using the path and target factors from the benchmark estimation based on one-month bank bill rates and one-year interest rate swaps. We can see from Table 2 that the path factor is significant for all maturities of the swap rates. The target factor is significant for all the spot maturities of 2 to 10 years, but not for the 5-year/5-year forward swap rate, as would be expected.

We can also see from Table 2 that for all maturities of the swap rates, the coefficient on the interaction term of the dummy variable with the path factor is insignificant, implying that the effect of forward guidance on long-term interest rate swaps is the same whether the forward guidance was issued on MPS days or on OCR review days. The coefficient on the interaction term of the dummy variable with the target factor is also insignificant for all maturities. The precision of the coefficient estimates suggests that the gain from intra-day data may be limited, since the previous literature argued that intra-day data can improve the estimation precision.[12]

[Table 2 about here]

Our finding that the effects of the path factor on the yield curve are very similar on MPS and OCR review days suggests that market participants infer very similar information regarding forward guidance from monetary policy announcements whether or not the RBNZ also publishes quantitative interest rate forecasts. This suggests that the marginal

[12] The width of the estimation window is a contentious issue. Gürkaynak et al. (2005), and Drew and Karagedikli (2007) in the case of New Zealand, find that the use of intra-day data significantly increases the estimation precision. However, at the same time Gürkaynak et al. (2005) also find, by regressing the path factor estimated in a 'wide window' of one hour on the path factor estimated in a short-window of 30 minutes, that the R^2 is around 0.83. By contrast when they estimate the same regression for the target factor, the R^2 is 0.98. This suggests that changes in the target factor are immediately observable to market participants, while the news on the path requires some time to digest and is subject to a greater deal of uncertainty. However, as the estimation window is expanded, one runs into the problem of contamination by other information. Therefore, there is a trade-off in the choice of the width of the window.

contribution of the RBNZ's interest rate forecasts, over and above that of its qualitative forward guidance in monetary policy statements, to market participants' perception of forward guidance is small.

Our results also suggest that market participants infer information from the qualitative forward guidance contained in written statements of the RBNZ on OCR review days, which is very similar to the information they infer from the forward guidance on MPS days when statements are accompanied by interest rate forecasts. To our knowledge, our paper is the first study to quantifiy market participants' perception of the qualitative forward guidance contained in the RBNZ's monetary policy statements not accompanied by the publication of interest rate forecasts, and finds that it has a significant effect on market interest rates in New Zealand. Our result that qualitative forward guidance has a significant effect on market interest rates in New Zealand is consistent with earlier results for the United States (see eg Gürkaynak et al., 2005; Campbell et al., 2012; Moessner, 2013).

Our results have important implications for central bank communication in the form of forward guidance. Our results suggest that market participants understand the conditional nature of quantitative interest rate forecasts, since the marginal effect of publishing interest rate forecasts over and above the effects of providing qualitative forward guidance seems to be small. This is consistent with the fact that the RBNZ has emphasized that its published interest rate paths are forecasts, not promises, i.e. they emphasized the conditional nature of their communication about interest rates. For example, the MPS of March 2014 stated that "The Bank's assessment is that the OCR will need to rise by about 2 percentage points over the next two years for inflation to settle around target. That assessment is conditional on the economic outlook, and will be re-assessed over time as new data are released and events unfold." (RBNZ, 2014). This result is also consistent with the results of Moessner and Nelson (2008) and Detmers and Nautz (2012) for New Zealand, and with Moessner et al. (2016) and Ahl (2017) for Sweden, who find that the conditionality of the central bank's interest rate forecasts was understood by market participants. This casts doubt over the concerns raised by some policymakers that central bank interest rate forecasts may be interpreted by market participants as unconditional commitments. For example, Goodhart (2001) argues that "any indication that the MPC is formally indicating a future specific change in rates (e.g., as driven by a 'rule'-based formula) would be taken to indicate some degree of commitment."[13]

We argued that one of the shortcomings of the earlier literature that examined the effects of the RBNZ's interest rate forecasts on asset prices was a difficulty of separating the effects due to the the RBNZ's interest rate forecasts from the effects due to qualitative forward guidance contained in monetary policy statements published at the same time. We argued that the difference in what the RBNZ communicates on MPS days and OCR review days provides us with clear treatment and control samples. However, given that these are not randomly allocated samples, the question arises whether they are really good treatment and control samples, especially given that monetary policy decisions are not independent. But although monetary policy decisions are not independent of each other, with the current decision of the central bank having strong connections with the last decision, the surprise elements of two subsequent announcements are not necessarily related. Financial markets are forward-looking by nature and financial market prices are influenced by information about future expected events and their likelihood. Asset price theory suggests that all available information is reflected in the current price of an asset. Consequently, market prices should only adjust to the new unexpected information that becomes available.

3.3 Robustness tests

Next, for robustness tests below, we use the one-month OIS rate as r_t^s, and the one-year OIS rate as r_t^b instead in equations (1) to (3). The advantage of using OIS rates is that they tend to reflect market interest rate expectations better than bank bill rates or interest rate swaps. The disadvantage of using OIS rates is that they are available only for a shorter sample period starting on 11 September 2003 in New Zealand, since the OIS market in New Zealand was only developed later than the bank bill market or the interest rate swap market. Moreover, we also consider the case using one- and six-month bank bill rates as r_t^s and r_t^b , respectively, for which data is available for the whole sample

[13] See also Kohn (2005).

period starting in March 1999. Finally, we derive the target and path factors based on the approach of Gürkaynak et al. (2005), using bank bill rates in New Zealand with maturites up to one year, and we show that our results are robust to using that approach.

3.3.1 Different market interest rates

The descriptive statistics for the target and path factors estimated for the shorter sample in our alternative estimation using the one-month and one-year OIS rates in equations (1) to (3) are shown in Table 3. We can see that the descriptive statistics for the path factor are again similar on MPS dates and on OCR review dates, with a slightly higher standard deviation of 6.62 basis points on MPS dates, compared with 6.44 basis points on OCR review dates. Again, the maximum and minimum of the path factor are somewhat larger in magnitude on MPS dates than on OCR review dates, suggesting that some small additional information may be provided by the quantitative forward guidance published on MPS dates.

[Tables 3 and 4 about here]

The descriptive statistics for the target and path factors estimated for the full sample in our benchmark estimation using the one-month and six-month bank bill rates in equations (1) to (3) are shown in Table 4. We can see that the summary statistics for the path factor are similar on MPS dates and on OCR review dates, with a slightly higher standard deviation of 4.15 basis points on MPS dates, compared with 3.64 basis points on OCR review dates. This suggests again that the path factor exhibits similar variability whether the monetary policy announcement is accompanied by an interest rate forecast or not. The target factor is the same as in our benchmark case. We therefore find that our results presented in the benchmark estimation of Table 1 are robust to using these different market interest rates.

The results for the effects on asset prices using the path and target factors from the estimation based on one-month and one–year OIS rates for the shorter sample starting in September 2003 are shown in Table 5. We can see from Table 5 that for all maturities of the swap rates, the coefficient on the interaction term of the dummy variable with the path factor is again insignificant, again implying that the effect of forward guidance on long-term interest rate swaps is the same whether the forward guidance was issued on MPS days or on OCR review days.

[Table 5 around here]

The results for the effects on asset prices using the path and target factors from the estimation based on one- and six-month bank bill rates are shown in Table 6. We can see from Table 6 that for all maturities of the swap rates, the coefficient on the interaction term of the dummy variable with the path factor is again insignificant, implying that the effect of forward guidance on long-term interest rate swaps is the same whether the forward guidance was issued on MPS days or on OCR review days.

[Table 6 around here]

We therefore find that our results for the effects of the path factor on asset prices presented in the benchmark estimation of Table 2 are robust to using these different market interest rates.

3.4 Approach based on Gürkaynak et al. (2005)

We also apply the approach of Gürkaynak et al. (2005) to data for New Zealand, and test whether one factor is enough to characterise the responses of asset prices to monetary policy announcements, as described in the following.[14] We test for the number of latent factors, k_0, that underpin the responses of asset prices to monetary policy announcements on MPS days and on OCR review days.

Let X be the matrix (of size $T \times n$) of daily changes in New Zealand interest rates with maturity up to one year on the days of the monetary policy announcements. Let F be the unobserved factors that characterise the data matrix X. The first column of X is a proxy for monetary policy surprises, and for our benchmark estimation we use daily changes in the one-month bank bill yield in New Zealand on the days of the monetary policy announcements. For our benchmark estimation, the other asset prices in the X

[14] See also Gürkaynak et al. (2007).

matrix are the changes in New Zealand bank bill rates, which are the yields available for the longest period corresponding to the 90-day bank bill rate which the RBNZ aims to influence. One can write

$$\underbrace{X}_{Txn} = \underbrace{F}_{Txk}\underbrace{\Lambda}_{kxn} + \underbrace{\varepsilon}_{Txn} \tag{5}$$

where F is a $T \times k$ matrix of unobserved factors (with $k < n$), Λ is a $k \times n$ matrix of factor loadings, and ε is a $T \times n$ matrix of white noise disturbances. We test for the number of significant latent factors, k_0, to understand how many factors can adequately describe the variation in asset price responses to monetary policy announcements. Following Gürkaynak et al. (2005), we use the Cragg and Donald (1997) matrix rank test to test the null hypothesis that X is described by k_0 common principal components against the alternative that X is described by $k > k_0$ principal components.[15]

Table 7 reports the results from the Cragg and Donald (1997) rank test applied separately to two samples, the MPS days and the OCR review days. We also conduct the same tests with different types of market interest rates, namely Overnight Indexed Swap (OIS) rates, which are only available from 2003 in New Zealand. The tests strongly reject the hypothesis that a single factor is enough to characterise the responses of asset prices to monetary policy announcements for both samples.[16] This implies that the surprise changes in short-term interest rates are not enough to explain the responses of market interest rates to monetary policy announcements in New Zealand. This result is consistent with the findings of Gürkaynak et al. (2005) for the United States, Brand et al. (2010) for the euro-area and with Brubakk et al. (2017) for Norway and Sweden.

The factors we estimated are still statistical concepts, and need to be rotated to allow for a structural interpretation. The unobserved factor matrix F is estimated by using the standard principal components method, using bank bill rates with maturities of up to one year in our benchmark estimation. The two factors we estimated above, $F = [F_1, F_2]$, explain a maximum amount of variation in asset price responses, X. We perform a rotation of the factors to allow for a structural interpretation.

[Table 7 around here]

[15] The Matlab code that performs this factor test was kindly provided by EricSwanson.

[16] The tests also reject the presence of no factor, or a white noise structure of the data.

3.4.1 Factor rotation - structural interpretation of factors

We use the approach proposed by Gürkaynak *et al.* (2005) to address the issue of a structural interpretation of the factors. This involves performing a rotation of the two factors F_1 and F_2, resulting in two new factors Z_1 and Z_2. The new factors Z_1 and Z_2 are orthogonal to each other and explain the data X in the same way as F_1 and F_2. The main identifying assumption is that the monetary policy surprise should be correlated with the target factor but not with the path factor, so that the second factor Z_2 has no effect on the current interest rate surprise.[17] This identification assumption is consistent with the first factor being a target factor and the second factor being a path (forward guidance) factor.

As Gürkaynak et al. (2005) state, the estimated target factor should be similar to — but not exactly equal to — the measure of monetary policy surprise on monetary policy announcements days derived from the change in a short-term interest rate, which proxies the interest rate that the policymaker tries to influence. The two measures are generally not identical because the factor estimation procedure strips out white noise from the data. Following Gürkaynak et al. (2005), we check the relationship between these two measures by regressing the monetary policy surprise on the target factor, and find that the target factor is indeed very close to a Kuttner (2001)-type monetary policy surprise with a slope coefficient of 1, and an R^2 of 0.99. As a result, to allow for an interpretation of the target factor as the surprise change in the interest rate, we normalize it so that a change of 1 in Z_1 corresponds to a surprise of 1 basis point in the short-term interest rate. Similarly, to facilitate the interpretation of the second factor, we normalize it so that the effect of the path factor on the one-year interest rate is the same as the effect of the target factor on the same (one-year) interest rate.

Our finding that market participants' interpretation of the RBNZ's interest rate decisions is characterised by two structural factors on both MPS and OCR review dates, namely a target factor and a path factor, suggests that there is a forward guidance dimension to the reaction to monetary policy announcements beyond the surprise element embedded in the decision itself. This finding is consistent with the earlier literature for

[17] See Appendix A for further details on the factor rotation.

the United States (Gürkaynak et al., 2005), with Brand et al. (2010) for the euro area, and with Brubakk et al. (2017) for Norway and Sweden.[18]

[Table 8 around here]

The results for the summary statistics of the path and target factors based on the approach of Gürkaynak et al. (2005) are shown in Table 8. We can see that the descriptive statistics for the path factor are again similar on MPS dates and on OCR review dates, with a somewhat higher standard deviation of 7.14 basis points on MPS dates, compared with 5.60 basis points on OCR review dates. Again, the maximum and minimum of the path factor are somewhat larger in magnitude on MPS dates than on OCR review dates, suggesting that some small additional information may be provided by the quantitative forward guidance published on MPS dates. Moreover, our results that the path factor has similar statistical properties on MPS and OCR review dates suggests that what market participants infer about the future course of monetary policy from the RBNZ's decisions is very similar on MPS and OCR review days. More specifically, our results suggest that quantitative interest rate forecasts are not the only information from which market participants infer forward guidance in New Zealand, but they also infer forward guidance information from qualitative forward guidance in monetary policy statements, including on OCR review days when no interest rate forecast is published. Moreover, these results suggest that the marginal contribution of the RBNZ's interest rate forecasts, over and above that of its qualitative forward guidance in monetary policy statements, to market participants' perception of forward guidance is small.

The results for the effects of the path and target factors on interest rate swaps are shown in Table 9. We can see that when using the approach of Gürkaynak et al. (2005) to derive the factors, the path factor again has a significant on interest rate swaps at all maturities. Moreover, the coefficient on the interaction term of the dummy variable with the path factor is again insignificant, implying that the effect of forward guidance on

[18] In the presence of large-scale asset purchases by the central bank as an unconventional monetary policy measure at the zero lower bound, Swanson (2017) finds evidence for a third factor for the United States, which he interprets as a large-scale asset purchase factor.

long-term interest rate swaps is again the same whether the forward guidance was issued on MPS days or on OCR review days.

Our result that the additional information provided by the interest rate forecasts on MPS dates is small is therefore robust to using this alternative approach for deriving the path and target factors.

[Table 9 about here]

4 Conclusions

An important question in the central bank communications literature is whether publishing interest rate projections is a better way of conditioning market participants' expectations than other forms of communication. To shed light on this specific question, we use a 'quasi-experiment' from the policy announcements of the Reserve Bank of New Zealand (RBNZ). We use the difference in the information revealed by the RBNZ together with its monetary policy decisions and analyse if the quantative forward guidance is perceived differently than the qualitative forward guidance.

Our results suggest that the marginal contribution of the RBNZ's interest rate forecasts, over and above that of its qualitative forward guidance, to market participants' perception of forward guidance is small. We also find that the effect of the path factor on market interest rates on monetary policy announcement days does not depend on whether the RBNZ also publishes a quantitative interest rate forecast that day.

Our results suggests the presence of a significant qualitative forward guidance element in the RBNZ's monetary policy statements, beyond the publication of quantitative interest rate forecasts. Market participants' reactions to information from the qualitative forward guidance contained in written statements of the RBNZ on OCR review days are very similar to the reactions to information from both the qualitative forward guidance contained in written statements of the RBNZ and the interest rate forecasts published on MPS dates.

To our knowledge, our paper is the first study to quantify market participants' perceptions of the qualitative forward guidance contained in the RBNZ's monetary policy statements not accompanied by the publication of interest rate forecasts, and finds that it has a significant effect on market interest rates in New Zealand. Our control-treatment approach also suggests that earlier studies may overstate the effects of publishing interest rate forecasts on market prices. Given only a small additional effect of the RBNZ's interest rate forecasts, market participants seem to understand the conditional nature of the RBNZ interest rate forecasts, and concerns that market participants might interpret these forecasts as binding promises are unwarranted.

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Appendix A: Factor rotation

This section presents the approach for the factor rotation of Gürkaynak et al. (2005), where more details can be found. Define

$$Z = FU$$

where the second column of Z is a vector that is associated on average with no change in the current interest rate decision, U is an orthogonal matrix,

$$U = \begin{bmatrix} \alpha_1 & \beta_1 \\ \alpha_2 & \beta_2 \end{bmatrix}$$

where the columns of U are normalised to have unit length (Z_1 and Z_2 have unit variances). The rotated factors are orthogonal to each other,

$$E(Z_1 Z_2) = \alpha_1\beta_1 + \alpha_2\beta_2 = 0$$

Z_2 does not influence the current policy surprise. Let γ_1 and γ_2 be the loadings of the monetary policy surprise on F_1 and F_2, respectively. Then,

$$F_1 = \frac{1}{\alpha_1\beta_2 - \alpha_2\beta_1}\left[\beta_2 Z_1 - \alpha_2 Z_2\right]$$

$$F_2 = \frac{1}{\alpha_1\beta_2 - \alpha_2\beta_1}\left[\alpha_1 Z_2 - \beta_1 Z_1\right]$$

and

$$\gamma_1\alpha_1 - \gamma_1\alpha_2 = 0$$

Z_1 and Z_2 are rescaled so that Z_1 moves with the current monetary policy surprise one-for-one, and so that Z_2 has the same effect on the one-year ahead future rate as Z_1 has on that rate. These conditions are enough for unique identification.

By performing a suitable rotation of these unobserved factors, Gürkaynak et al. (2005) show that the new factors can be given a structural interpretation as a current policy surprise factor (or target factor), corresponding to surprise changes in the policy rate, and a future path of policy factor (or path factor), corresponding to changes in futures rates at horizons of up to one year which are independent of changes in the current policy rate.

Table 1: Descriptive statistics for target and path factors, benchmark estimation

	MPS target	*OCR target*	*MPS path*	*OCR path*
Mean	-0.96	-0.50	0.87	-0.90
Min	-31	-24	-21.09	-18.23
Max	19	15	15.87	12.07
stdev	7.61	6.47	6.35	5.34
Jarque-Bera	46.2	91.5	24.87	3.78
No. of obs.	74	71	74	71

Sample period: March 1999 to May 2017; benchmark estimation for combined sample using one-month bank bill rate and one-year interest rate swap; in basis points.

Table 2: Reaction of changes in interest rate swaps to target and path factors, benchmark estimation

Dependent variable: Daily changes in interest rate swaps for maturity of *n* years (basis points)						
n years	*2*	*3*	*4*	*5*	*10*	5/5 fwd
constant	0.0806	0.0363	0.0059	-0.0262	-0.0016	0.0210
D^M_t	-0.2271	-0.1953	-0.4233	-0.5206	-0.6525	-0.7986
$Z_{1,t}$	0.8500***	0.7448***	0.6506***	0.5667***	0.3670***	0.1654
$D^M_t*Z_{1,t}$	-0.1304	-0.1078	-0.1189	-0.1238	-0.1327	-0.1478
$Z_{2,t}$	1.0609***	0.9607***	0.8877***	0.8166***	0.5931***	0.3681***
$D^M_t*Z_{2,t}$	-0.0568	-0.0016	-0.0458	-0.0619	-0.0860	-0.1093
Adj. R^2	0.8675	0.8487	0.7973	0.7330	0.4267	0.0687
No. of obs.	145	145	145	145	145	145

***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. White heteroscedasticity-consistent standard errors. Sample period: March 1999 to May 2017. Target and path factors estimated for combined sample using one-month bank bill rate and one-year interest rate swap.

Table 3: Descriptive statistics for target and path factors, using OIS rates

	MPS target	*OCR target*	*MPS path*	*OCR path*
Mean	-0.43	-0.16	0.55	-0.58
Min	-22.25	-19.00	-26.17	-17.17
Max	17.85	19.50	19.60	16.17
stdev	7.25	6.18	6.62	6.44
Jarque-Bera	12.99	19.28	52.39	1.12
No. of obs.	55	53	55	53

Sample period: September 2003 to May 2017; benchmark estimation for combined sample using one- and twelve-month OIS rates; in basis points.

Table 4: Descriptive statistics for target and path factors, using bank bill rates

	MPS target	*OCR target*	*MPS path*	*OCR path*
Mean	-0.96	-0.50	0.46	-0.48
Min	-31	-24	-10.41	-9.42
Max	19	15	9.98	9.83
stdev	7.61	6.47	4.15	3.64
Jarque-Bera	46.2	91.5	0.15	1.84
No. of obs.	74	71	74	71

Sample period: March 1999 to May 2017; benchmark estimation for combined sample using one- and six-month bank bill rates; in basis points.

Table 5: Reaction of changes in interest rate swaps to target and path factors, using OIS rates

Dependent variable: Daily changes in interest rate swaps for maturity of *n* years (basis points)						
n years	*2*	*3*	*4*	*5*	*10*	5/5 fwd
constant	-0.4926	-0.5244	-0.4561	-0.4607	-0.5435	-0.6297
D^M_t	0.4294	0.5961	0.287121	0.2116	0.3072	0.3887
$Z_{1,t}$	0.9185***	0.8169***	0.7249***	0.6391***	0.3740***	0.1066
D^M_t*$Z_{1,t}$	-0.1529	-0.1343	-0.1099	-0.0987	-0.0352	0.0186
$Z_{2,t}$	0.8446***	0.7679***	0.7002***	0.6352***	0.4275***	0.2181*
D^M_t*$Z_{2,t}$	-0.0118	0.0214	-0.0322	-0.0639	-0.0775	-0.0898
Adj. R^2	0.7903	0.7705	0.7217	0.6533	0.3702	0.0150
No. of obs.	108	108	108	108	108	108

***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. White heteroscedasticity-consistent standard errors. Sample period: September 2003 to May 2017. Target and path factors estimated for combined sample using one- and twelve-month OIS rates.

Table 6: Reaction of changes in interest rate swaps to target and path factors, using bank bill rates

Dependent variable: Daily changes in interest rate swaps for maturity of *n* years (basis points)							
n years	*1*	*2*	*3*	*4*	*5*	*10*	5/5 fwd
constant	-0.2959	-0.3827	-0.3945	-0.4027	-0.4164	-0.3290	-0.2431
D^M_t	0.7650	0.5984	0.5795	0.2931	0.1620	-0.0962	-0.3734
$Z_{1,t}$	0.8394***	0.8180***	0.7181***	0.6282***	0.5491***	0.3633***	0.1757
D^M_t*$Z_{1,t}$	0.0692	-0.0644	-0.0483	-0.0685	-0.0835	-0.1184	-0.1590
$Z_{2,t}$	1.0270***	1.0724***	0.9451***	0.8490***	0.7479***	0.4415***	0.1334
D^M_t*$Z_{2,t}$	0.2136	0.1101	0.1890	0.1323	0.0910	0.0416	0.0031
Adj. R^2	0.7969	0.6420	0.6139	0.5555	0.4772	0.2122	-0.0096
No. of obs.	145	145	145	145	145	145	145

***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. White heteroscedasticity-consistent standard errors. Sample period: March 1999 to May 2017. Target and path factors estimated for combined sample using one- and six-month bank bill rates.

Table 7: Test for number of factors

Bank bill rates				OIS rates			
Rank	χ^2	dof	p-value	Rank	χ^2	dof	p-value
0	69.64 (18.3)	10	0.0000	0	53.08 (18.3)	10	0.0000
1	27.24 (11.07)	5	0.0001	1	23.67 (11.07)	5	0.002
2	2.12 (3.84)	1	0.145	2	0.091 (3.84)	1	0.923

Note: Cragg and Donald (1997) test of the null hypothesis of k_0 factors against the alternative of $k > k_0$ factors.

Table 8: Descriptive statistics for target and path factors derived based on Gürkaynak et al. (2005).

	MPS target	*OCR target*	*MPS path*	*OCR path*
Mean	-0.04	0.04	0.77	-0.80
Min	-27.16	-23.95	-25.51	-19.96
Max	20.39	17.58	17.84	11.18
stdev	7.30	6.38	7.14	5.60
Jarque-Bera	33.03	94.33	48.29	3.91
No. of obs.	74	71	74	71

Sample period: March 1999 to May 2017; target and path factors estimated for combined sample using bank bill rates up to one-year maturity; in basis points.

Table 9: Reaction of changes in interest rate swaps to target and path factors derived based on Gürkaynak et al. (2005)

Dependent variable: Daily changes in interest rate swaps for maturity of *n* years (basis points)						
n years	*2*	*3*	*4*	*5*	*10*	5/5 fwd
constant	-0.5481	-0.5186	-0.4851	-0.4581	-0.2834	-0.1095
D^M_t	-0.0814	-0.0546	-0.2714	-0.3571	-0.4913	-0.6336
$Z_{1,t}$	0.8264***	0.7193***	0.6239***	0.5348***	0.3248***	0.1128
$D^M_t*Z_{1,t}$	-0.0811	-0.0593	-0.0735	-0.0765	-0.0934	-0.1146
$Z_{2,t}$	0.9855***	0.8937***	0.8274***	0.7642***	0.5638***	0.3622***
$D^M_t*Z_{2,t}$	-0.0825	-0.0326	-0.0702	-0.0913	-0.1141	-0.1362
Adj. R^2	0.8439	0.8237	0.7739	0.7049	0.4010	0.0633
No. of obs.	145	145	145	145	145	145

***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. White heteroscedasticity-consistent standard errors. Sample period: March 1999 to May 2017. Target and path factors estimated for combined sample using bank bill rates up to one-year maturity.