Quantitative or qualitative forward guidance: Does it matter?*

Gunda-Alexandra Detmers
TU Dresden and National Bank of Hungary

Özer Karagedikli
Reserve Bank of New Zealand

Richhild Moessner
Bank for International Settlements

January 2018

Abstract

Every monetary policy decision by the Reserve Bank of New Zealand (RBNZ) is accompanied by a written statement about the state of the economy and the policy outlook, but only every second decision includes an interest rate forecast. We exploit this difference in the information content of decisions, to estimate the relative effectiveness of 'qualitative' and 'quantitative' forward guidance to the perceived forward guidance by the markets. We find that the information releases have significant effects on asset prices, but the additional information provided by the interest rate forecasts is very small. This control-treatment approach suggests that earlier studies overstate the effects of publishing interest rate forecasts on market prices. We interpret our results as implying that communication is important, but that the exact form of that communication is less critical. Our results also suggest that market participants understand the conditional nature of the RBNZ interest rate forecasts, and that concerns that markets read these forecasts as binding promises are unwarranted.

*The views expressed here are the views of the authors and do not necessarily represent the views of our employers, the Hungarian National Bank, the Reserve Bank of New Zealand, and the Bank for International Settlements. We would like to thank Refet Gürkaynak, Dean Hyslop, Leo Krippner, Anella Munro, Bill Nelson, Christie Smith, Lars Svensson and seminar participants at the Reserve Bank of New Zealand, the Bank for International Settlements, the Workshop in Empirical Monetary Economics, Bilkent University and the Riksbank for valuable comments and discussions. Correspondence: ozer.karagedikli@rbnz.govt.nz.

JEL classification: E43; E44; E52; E58; G12
Key words: Monetary policy, forward guidance, interest rate forecasts

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 banks to manage the expectations of the public and 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 communication 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 misin-

[1]For example, the FOMC statement issued after 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.

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

[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, 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.

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 three 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 is characterised by two latent factors on both MPS and OCR review dates, namely a target (jump) factor and a path factor, which have similar statistical properties on MPS and OCR review dates. The finding of two latent factors is consistent with the earlier literature for the United States (Gürkaynak et al., 2005). 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 or negligible.

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

Third, we find that on five occasions when the RBNZ provided explicit date-based qualitative forward guidance, the yield curve responded more to the path factor than on any other monetary policy decision date. This is independent of whether the explicit date-based qualitative forward guidance was associated with MPS or OCR Review days. Again, it does not matter whether the decisions included quantitative interest rate projections. These results suggest the presence of a significant explicit qualitative forward guid-

ance element in the RBNZ's monetary policy announcements, beyond the publication of quantitative interest rate forecasts.

Our results have important implications for central bank communication in the form of forward guidance.[6] Our results suggest that the marginal effect of publishing interest rate forecasts over and above the effects of providing qualitative forward guidance seems to be very small. 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), 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 separate out these two effects. Our estimates of the effect of qualitative forward guidance are similar to the estimates from these earlier studies.

Our results are also consistent with some of the largest changes of medium-term yields on days of monetary policy decisions occurring on OCR review days (when no interest rate forecasts are published). For example, on 29 October 2009, the RBNZ announced its interest rate decision that left its policy instrument, the OCR, unchanged at 2.5 percent. This decision was widely anticipated by market participants, and consequently short-term interest rates hardly moved following the announcement. However, one-, two- and three-year swap rates fell by between 15 and 20 basis points. On 25 July 2013, the RBNZ also left its policy rate unchanged at 2.5 percent. This

[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.

decision was also largely expected by financial market participants, and short-term interest rates increased by only 2 basis points. However, one-, two- and three-year swap rates increased by around 10 basis points on the day. These two announcements did not happen on MPS days when the RBNZ also published an interest rate forecast. Instead, they happened on OCR monetary policy announcement days, when only a monetary policy press statement was released, but no interest rate forecast. These two episodes suggest that the RBNZ's forward guidance, or at least the perceived forward guidance, i.e what market participants infer about the future stance of monetary policy from the forward guidance, extends beyond the announcements associated with the publication of interest rate forecasts.

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 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. 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. However, identifying the unexpected changes in the path component of monetary policy is not straightforward, and the method is described in the following.

2.1 Number of factors

We 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.[9] We do this for MPS and OCR review days separately. We test for the number

[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).

of latent factors, k_0, that underpin the responses of asset prices to monetary policy announcements on MPS days and on OCR review days.[10]

Let X be the matrix (of size $T \times n$) of daily changes in New Zealand futures 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 matrix are New Zealand bank bill futures rates, which are the longest available yields corresponding to the 90-day bank bill rate which the RBNZ aims to influence. One can write

$$\underbrace{X}_{Txn} = \underbrace{F}_{Txk}\underbrace{\Lambda}_{kxn} + \underbrace{\varepsilon}_{Txn} \tag{1}$$

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.[11]

Table 1 reports the results from the Cragg and Donald (1997) rank test applied separately to two samples, the MPS days and the OCR review days.[12] 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.[13] 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 on both MPS and the OCR review days. So on both MPS and OCR review days, two factors are required

[10]We also combine the sample into a single matrix of 145 rows corresponding to all the monetary policy announcements (except for the emergency announcement following 9/11 on 11 September 2001), and estimate the factors. The estimated factors in the full sample are very similar to the ones we estimate in the eparate samples, suggesting that the combined data have a factor structure.

[11]The Matlab code that performs this factor test was kindly provided by Eric Swanson.

[12]For robustness, we also conduct the same tests with different types of market interest rates, namely Overnight Indexed Swap (OIS) rates, which are only available fom 2003 in New Zealand, interest rate swaps, as well as bank bill futures. They all give the same results of two latent factors. Those results are available upon request.

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

to adequately characterise the responses of asset prices to monetary policy announcements.[14] 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 finding that the asset price responses to monetary policy announcements in New Zealand are characterised by two latent factors on both MPS and the OCR review days suggests that there is an additional dimension to the reaction to monetary policy announcements beyond the surprise element embedded in the decision itself. More interestingly, this is the case for both the MPS and the OCR review samples, which indicates an additional dimension to monetary policy even on OCR review days when the RBNZ does not publish interest rate forecasts.

But the factors we estimated are still statistical concepts, and need to be rotated to allow for a structural interpretation, in particular for the second factor. The unobserved factor matrix F is estimated by using the standard principal components method, using bank bill futures 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. However, these factors do not have structural interpretations, since both factors are correlated with the current surprises in short-term interest rates. Consequently, we cannot interpret one factor as the change in the short-term interest rate, and the other factor as some other dimension of monetary policy. In the next section we perform a rotation of the factors to allow for a structural interpretation.

[Table 1 around here]

2.2 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 (jump) factor but not with the path factor, so that the second factor Z_2 has no effect on the

[14] The same results are obtained when the MPS and the OCR review days are combined in a single sample. The results from this combined sample are available on request.

current interest rate surprise.[15] This identification assumption is consistent with the first factor being a target (jump) 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 four-quarter-ahead bank bill futures rate is the same as the effect of the target factor on the four-quarter-ahead futures rate.

3 Results

3.1 Target and path factors

Table 2 summarises the descriptive statistics for the structural target and path factors obtained after the factor rotation for the MPS and the OCR review samples. The mean and standard deviation of each factor are comparable for the MPS and the OCR review samples. This suggests that the path factor exhibits similar variability whether the announcement is accompanied by an interest rate forecast or not.

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.

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

This finding is consistent with the earlier literature for 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.[16]

[Table 2 around here]

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.

[Figure 1 around here]

Figure 1 shows a time series of the target and path factors on MPS and OCR review days. Figure 2 shows the path factor based on all the monetary policy announcements by the RBNZ, by estimating the path factor for the combined sample including both MPS and OCR review days. Figure 2 suggests that market participants perceived substantial forward guidance on monetary policy announcement days between 2008 and 2010, and again in 2013.

[Figure 2 around here]

3.2 Path factor and RBNZ forecasts

The path factor Z_2 reflects the component of the monetary policy announcements that affects futures rates for the coming year, but not the current interest rate. Therefore it is a residual and open to a number of interpretations. In this section we provide two pieces of evidence that show that the estimated path factor Z_2 is indeed related to the forward guidance provided by the RBNZ.

[16] 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.

The first piece of evidence is the correlation between the path factor Z_2 and proxy measures of surprises in the interest rate forecasts published by the RBNZ on MPS days. Since the RBNZ publishes its interest rate forecasts on MPS days, we can test if the estimated path factor on these days is correlated with surprises in the RBNZ's interest rate forecasts. There may be differences between the two, since the path factor Z_2 we estimate is the forward guidance inferred by market participants on MPS announcement days, ie the perceived forward guidance. If market participants are not convinced by a particular path published by the RBNZ, the correlation may be weak. Moreover, some of the change in the RBNZ's interest rate forecast may have been anticipated by market participants.

Four proxy measures for the forecast surprises are described in Table 3. They are constructed as the difference between the RBNZ interest rate forecasts and the previous forecasts or the current interest rate. Table 3 also shows the correlation between the estimated path factor on MPS days, $Z^M_{2,t}$, and these four different proxy measures of the surprise in the interest rate forecasts published by the RBNZ. The correlation coefficients of around 0.4 to 0.5 suggest that the path factor on MPS dates, $Z^M_{2,t}$, is indeed correlated with surprises in the RBNZ's published interest rate forecasts. Although these measures are only proxies for the surprises embedded in the RBNZ's published interest rate forecasts, they are indicative.[17] Figure 3 shows the path factor together with two measures of surprises in the RBNZ's quantitative interest rate forecasts, $rfg_{1,t}$ and $rfg_{2,t}$, which also suggests that market particpants' perception of forward guidance is related to information the RBNZ is trying to convey in its interest rate forecasts.

We next estimate the following equation, regressing the estimated path factor on MPS days, $Z^M_{2,t}$, on a constant and a measure of the surprise in the RBNZ's forward guidance,

$$Z^M_{2,t} = c + \alpha * rfg_{m,t} + \varepsilon_t \tag{2}$$

where $Z^M_{2,t}$ is the estimated path factor on MPS day t, $rfg_{m,t}$ is the measure m of the surprise in the interest rate forecast published by the RBNZ on MPS announcement day t as described in Table 3, for which we consider four different measures in separate regressions.

[Table 3 around here]

[17] Moessner and Nelson (2008), Detmers and Nautz (2012) and Ferrero and Secchi (2009) use more sophisticated proxy measures of central bank policy rate forecast surprises. However, those measures may suffer from other problems, such as term premia in market interest rates used to construct them, and possible differences in views between market participants and monetary policymakers.

[Figure 3 around here]

Table 4 shows the results of the regressions of the estimated path factor on MPS days on different measures of surprises in the interest rate forecast published by the RBNZ. Up to 28 percent of the variation in the path factor can be explained by measures of surprises in the RBNZ's interest rate forecasts, which suggests that the path factor is indeed correlated with the forward guidance that the RBNZ aims to provide in its interest rate forecasts. However, the regressions also suggest that there is still a large unexplained variation in the path factor, which could partly be due to the qualitative forward guidance contained in the monetary policy statements, or some genuine differences between what the central bank tries to convey and what market participants perceive about the future policy outlook.

[Table 4 around here]

The second piece of evidence is to look more closely at those days when the magnitude of the estimated path factor is particularly large. As we can observe from Figure 1 above, the largest magnitude of the path factor occurs on an OCR review day, namely on 29 October 2009, with a value of -47. On this day, the RBNZ kept the policy interest rate unchanged at 2.5 percent, which had been largely expected by financial market participants, since the surprise element of the decision was only 2 basis points. 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.

The largest positive value of the path factor among OCR days occurred on 25 July 2013. On that day, the RBNZ kept the short-term interest rate at 2.5 percent, which was again anticipated by market participants. One-, two- and three-year swap rates increased by around 10 basis points on the day. 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."

The largest positive value of the path factor occurred on an MPS day. 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 suggest that explicit qualitative date-based forward guidance was associated with large magnitudes of the path factors. They therefore 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.

We find that on five occasions when the RBNZ provided explicit date-based qualitative forward guidance, the yield curve responded more to the path factor than on any other monetary policy decision date. This is independent of whether the explicit date-based qualitative forward guidance was associated with MPS or OCR review days, so again it does not matter whether the decisions included quantitative interest rate projections. This suggest the presence of a significant explicit qualitative forward guidance element in the RBNZ's monetary policy announcements, beyond the publication of quantitative interest rate forecast.

Such date-based explicit 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."

3.3 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 path factor on longer-term market interest rate on MPS and on OCR review days. 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,

$$\Delta y_t^j = c + d * D_t^M + \alpha_1 Z_{1,t}^M + \alpha_2 Z_{2,t}^M + \beta_1 Z_{1,t}^O + \beta_2 Z_{2,t}^O + \varepsilon_t \qquad (3)$$

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 $j = 1, 2, 3, 4, 5, 10$ years, and for 5-year forward rates 5 years ahead, $j = 5y5y$. D_t^M is a dummy variable taking the value of one on MPS days, and zero otherwise, so that its coefficient d measures the average treatment effect. As above, $Z_{2,t}^M$ is the estimated path factor on MPS day t, $Z_{1,t}^M$ is the estimated target factor on MPS day t. Similarly, $Z_{2,t}^O$ is the estimated path factor on OCR review day t, and $Z_{1,t}^O$ is the estimated target factor on OCR review day t. Results from these regressions are reported in Table 5.

We can see from Table 5 that the average treatment effect measured by the coefficient d is not statistically significant, suggesting that the path factor estimated on MPS days does not have a systematically larger effect on asset prices than that estimated on OCR days. Moreover, the coefficients for the path factor on MPS and OCR review days, α_2 and β_2, are very similar. For example, for the change in the one-year swap yield, the coefficient on the path factor is estimated to be 0.26 on MPS days, and 0.25 on OCR review days. Both these coefficients are precisely estimated and are significant at the 1 percent level. 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.[18]

We test for equality of the path factor on MPS and OCR review days, α_2

[18]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.

and β_2, and for every maturity of the interest rate swaps in Table 5 we cannot reject the null hypothesis of equality at the 1 percent level.[19] The path factor explains around 30-40 percent of total explainable variation in the yield curve. Although this is lower than what is reported in Gürkaynak et al. (2005), it is still a large contribution over and above the one-dimensional monetary policy surprises. Brubakk et al. (2017) find that the path factor explains between 31-35 percent of the total explainable variation in two-, five- and ten-year swap rates in Sweden, and around 42-56 percent in Norway.[20]

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 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 very small. This

[19]Based on the rejection of coefficient equality, we estimate the equation with a single coefficient governing the effect of the path factor for the combined sample including both MPS and OCR review days. These regressions yield almost identical results, and they are available upon request.

[20]Authors' calculations by comparing the R^2s in Tables 4 and 5, and 9 and 10 in the June 2017 version of the working paper of Brubakk et al. (2017).

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."[21]

[Table 5 around here]

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.

[21] See also Kohn (2005).

4 Conclusions

In this paper, we make a novel use of the difference in the information revealed by the RBNZ together with its monetary policy decisions to identify the marginal effect of the RBNZ's interest rate forecasts on market participants' perceived forward guidance. The RBNZ has made eight interest rate decisions a year, four of which on days which include the publication of an interest rate forecast, and the other four on days which do not.

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 very small. We also found that the effect of the path factor derived following Gürkaynak et al. (2005) 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 forecast. 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 OCR review dates. To our knowledge, our paper is the first study to quantifiy the 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. This control-treatment approach also suggests that earlier studies may overstate the effects of publishing interest rate forecasts on market prices. Given this very small additional response to 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.

References

[1] Ahl, M. (2017). How big is the toolbox of a central banker? Managing expectations with policy-rate forecasts: Evidence from Sweden? Sveriges Riksbank Working Paper No. 339.

[2] Archer, D. (2005). Central bank communication and the publication of interest rate projections. In Sveriges Riksbank conference,"Inflation Targeting: Implementation, Communication, and Effectiveness", Stockholm, June.

[3] Bergstrom, K. and Ö. Karagedikli (2013). The Interest Rate Conditioning Assumption: Investigating the Effects of Central Bank Communication in New Zealand. Reserve Bank of New Zealand, manuscript. http://docs.business.auckland.ac.nz/Doc/Paper-11_Bergstrom.pdf.

[4] Bernanke, B. and K. Kuttner (2005). What Explains the Stock Market's Reaction to Federal Reserve Policy? *The Journal of Finance*, LX (3), 1221-1257.

[5] Blinder, A., Ehrmann, M., Fratzscher, M., De Haan, J., Jansen, D.-J. (2008). Central Bank Communication and Monetary Policy: A Survey of Theory and Evidence. *Journal of Economic Literature*, 46 (4), 910-45, December.

[6] Blinder, A., Ehrmann, M., De Haan, J., Jansen, D.-J. (2016). Necessity as the Mother of Invention: Monetary Policy after the Crisis. NBER Working Paper No. 22735.

[7] Brand, B., Buncic, D. and J. Turunen (2010). The impact of ECB monetary policy decisions and communication on the yield curve. *Journal of the European Economic Association*, 8 (6), 1266–1298.

[8] Brubakk, L., ter Ellen, S. and H. Xu (2017). Forward guidance through interest rate projections: does it work? Norges Bank Working Paper No. 6/2017.

[9] Campbell, J., Evans, C., J. Fisher and A. Justiniano (2012). Macroeconomic Effects of FOMC Forward Guidance. *Brookings Papers on Economic Activity*, Spring.

[10] Detmers, G.-A. and D. Nautz (2012). The Information Content of Central Bank Interest Rate Projections: Evidence from New Zealand. *The Economic Record*, 88 (282), 323–329.

[11] Detmers, G.-A. and D. Nautz (2014). Stale Forward Guidance. *Economics Letters*, 124, 358-361.

[12] Drew, A. and Ö. Karagedikli (2007). Some Benefits of Monetary-Policy Transparency in New Zealand. Czech Journal of Economics and Finance, 57(11-12), 521-539.

[13] Ferrero, G. and Secchi, A. (2009). The announcement of monetary policy intentions. Bank of Italy Temi di Discussione (Working Paper) No, 720.

[14] Goodhart, C. (2001). Monetary Transmission Lags and the Formulation of the Policy Decision on Interest Rates. *Federal Reserve Bank of St. Louis Review* 83 (4), 165–82.

[15] Gürkaynak, R., B. Sack, and E. Swanson (2005). Do Actions Speak Louder than Words? The Response of Asset Prices to Monetary Policy Actions and Statements. *International Journal of Central Banking* 1(1), 55-93.

[16] Gürkaynak, R., Sack, B., and E. Swanson, E. (2007). Market-Based Measures of Monetary Policy Expectations. *Journal of Business & Economic Statistics*, 25(2), 201–212.

[17] Iversen, J. and O. Tysklind (2017). The effect of repo rate path changes on asset prices. Sveriges Riksbank Staff memo, June.

[18] Karagedikli, Ö. and P. Siklos (2008). Explaining Movements in the NZ Dollar: Central Bank Communication and the Surprise Element in Monetary Policy? Reserve Bank of New Zealand DP2008/02.

[19] Kohn, D. (2005). Central Bank Communications." Remarks at the annual meeting of the American Economic Association, Philadelphia, PA, January 9.

[20] Kuttner, K. (2001). Monetary policy surprises and interest rates: evidence from the Fed funds futures market, Journal of Monetary Economics, 47, 523–44.

[21] Moessner, R. (2013). Effects of explicit FOMC policy rate guidance on interest rate expectations. *Economics Letters,* 121 (2), 170–173.

[22] Moessner, R., de Haan, J. and Jansen, D.-J. (2016). Effectiveness of monetary policy in Sweden. *Contemporary Economic Policy*, 24 (4), 698-709.

[23] Moessner, R., Jansen, D.-J. and J. de Haan (2017). Communication about future policy rates in theory and practice. *Journal of Economic Surveys,* 31 (3), 678-711.

[24] Moessner, R. and W. Nelson (2008). Central bank policy rate guidance and financial market functioning. *International Journal of Central Banking,* 4 (4), 193–226.

[25] Reserve Bank of New Zealand (2014). Monetary Policy Statement, March, available at http://www.rbnz.govt.nz/monetary_policy/monetary_policy_statement/2014/MPSmar14.pdf.

[26] Svensson, L. (2015). Forward Guidance. *International Journal of Central Banking*, 11(S1), 19-64.

[27] Swanson, E. (2017). Measuring the Effects of Federal Reserve Forward Guidance and Asset Purchases on Financial Markets. NBER Working Paper No. 23311.

[28] Woodford, M. (2013). Forward Guidance by Inflation-Targeting Central Banks. Columbia University, manuscript.

http://www.columbia.edu/~mw2230/RiksbankIT.pdf.

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.

Appendix B: Tables and figures

Table 1: Test for number of factors

			MPS				OCR
Rank	χ^2	df	p-value	Rank	χ^2	df	p-value
0	42.55	10	0.00001	0	37.3	10	0.0005
	(18.3)				(18.3)		
1	14.68	5	0.011	1	13.46	5	0.019
	(11.07)				(11.07)		
2	1.92	1	0.164	2	1.12	1	0.289
	(3.84)				(3.84)		

Note: Cragg and Donald (1997) test of the null hypothesis of k_0 factors against the alternative of $k > k_0$ factor; using bank bill futures rates one, two, three, and four quarters ahead.

Table 2: Descriptive Statistics

	OCR	OCR	MPS	MPS
	Target	Path	Target	Path
Abs Mean	4.1	9.0	5.5	7.0
Abs Median	1.9	6.3	3.4	3.9
Min	-26	-47	-27	-24
Max	27	25	29	36
Std	7.2	12.6	8.3	10.5
Normality	87.8	36.7	25.5	18.8
Obs	71	71	74	74

Table 3: Correlations of path factor with different measures of surprises in RBNZ's forecasts

Variable	Measurement	Definition	$Corr(Z_2^M, rfg_m)$
$rfg_{1,t}$	$i^f_{t+4,t} - i_t$	Four quarter ahead RBNZ forecast on MPS t minus current interest rate	0.45
$rfg_{2,t}$	$i^f_{t+8,t} - i_t$	Eight quarter ahead RBNZ forecast on MPS t minus current interest rate	0.40
$rfg_{3,t}$	$i^f_{t+8,t} - i^f_{t+4,t}$	Eight quarter ahead RBNZ forecast on MPS t minus four quarter ahead forecast	0.53
$rfg_{4,t}$	$i^f_{t+4,t} - i^f_{t+5,t-1}$	Four quarter ahead RBNZ forecast on MPS t minus five quarter ahead forecast on previous MPS $t-1$	0.37

Table 4: Regression of path factor on different measures of surprises in RBNZ's interest rate forecasts

Measure	rfg_1	rfg_2	rfg_3	rfg_4
c	-1.990	2.914**	-1.770	0.297
	(1.174)	(1.158)	(1.202)	(1.126)
α	0.079***	0.061***	0.080***	0.067***
	(0.018)	(0.011)	(0.021)	(0.019)
R^2	0.20	0.28	0.16	0.13

Note: *, ** and *** denote significance at the 10%, 5% and 1% level, respectively. Huber-White standard errors are given in brackets.

Figure 1: Factors on MPS, and OCR Review days

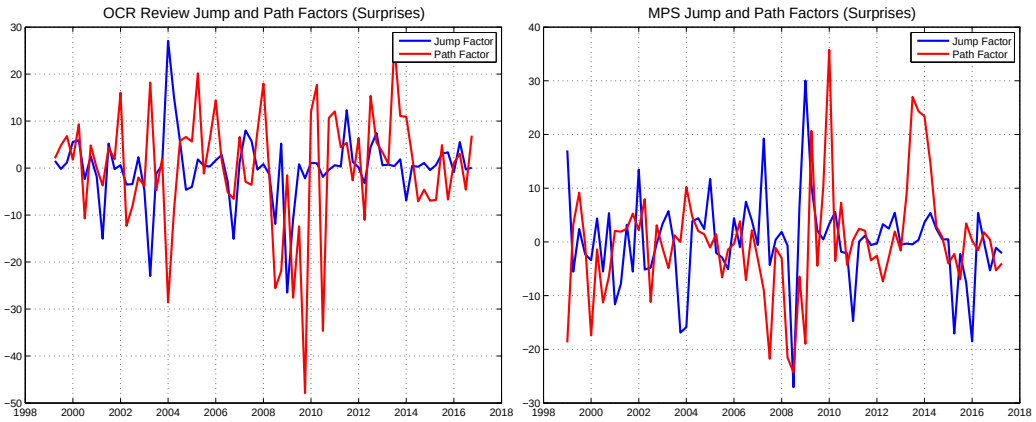

Figure 2: Path factor for the combined sample

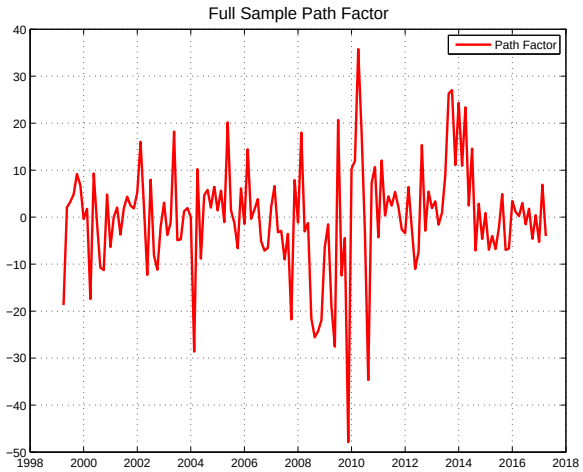

Figure 3: Path Factor and the RBNZ Interest rate forecasts 1- and 2- year ahead

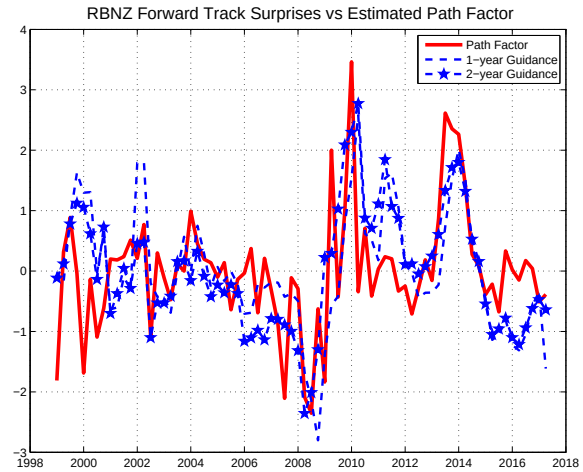

Table 5: Responses of market interest rates

	1-year swap	2-year swap	3-year swap	4-year swap	5-year swap	10-year swap	5y5y forward
c	-1.204***	-1.301	-1.203	-1.120	-1.046	-0.720	-0.787
	(0.214)	(0.587)	(0.416)	(0.431)	(0.440)	(0.535)	(0.672)
d	1.368**	1.335*	1.264	0.922	0.729	0.281	-0.132
	(0.643)	(0.822)	(0.783)	(0.746)	(0.740)	(0.798)	(1.072)
α_1	0.824***	0.653***	0.585***	0.487***	0.409***	0.201***	0.073
	(0.063)	(0.069)	(0.076)	(0.071)	(0.071)	(0.065)	(0.106)
α_2	0.255***	0.353***	0.333***	0.315***	0.284***	0.202***	0.126***
	(0.098)	(0.056)	(0.100)	(0.092)	(0.087)	(0.072)	(0.049)
β_1	0.995***	0.962***	0.845***	0.753***	0.664***	0.440***	0.265**
	(0.045)	(0.082)	(0.076)	(0.077)	(0.081)	(0.071)	(0.118)
β_2	0.247***	0.315***	0.294***	0.263***	0.239***	0.167**	0.148*
	(0.024)	(0.046)	(0.031)	(0.032)	(0.034)	(0.039)	(0.086)
Adj. R^2	0.79	0.68	0.66	0.63	0.55	0.32	0.09
$\alpha_2 = \beta_2$	$\surd$	$\surd$	$\surd$	$\surd$	$\surd$	$\surd$	$\surd$

Note: Coefficients are the least squares coefficients with daily changes in yields. *, ** and *** denote significance at 10%, 5% and 1% respectively. Huber-White standard errors are given in brackets.