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A Bridge Too Far? RBNZ Communication and the Forward Interest Rate Track

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A BRIDGE TOO FAR?
RBNZ COMMUNINCATION AND
THE FORWARD INTEREST RATE TRACK*

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ABSTRACT

We conduct a high frequency event study to estimate the impact of monetary policy surprises, data surprises, and central bank written statements on the New Zealand-US dollar and the New Zealand-Australian dollar exchange rates. Of particular interest is the measurement of the impact of the published forward interest rate track on the exchange rate. We find that it has a small impact of exchange rate changes. We argue that the release of this information does not represent transparency gone too far. However, other data surprises and monetary policy surprises are found to have significant effects on exchange rate movements. In general, it does appear that 'bad news' about inflation translates into 'good news' for the exchange rate.

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1. Introduction

The Reserve Bank of New Zealand (RBNZ) began relying on an overnight lending rate as the instrument of monetary policy in March 1999. Moreover, until 2007, the RBNZ had not intervened in foreign exchange markets since 1985. As shown in Figure 1, since 1999, there have been large movements, in foreign exchange rate levels of the New Zealand dollar (NZD) in foreign currency unit, measured either in Australian (AUD) or U.S. dollar (USD) terms. Changes in the official cash rate (OCR), the formal name given to the RBNZ's instrument of monetary policy[1], represent one of several means the central bank has at its disposal to inform markets about the current and possible future stance of monetary policy. Indeed, the RBNZ is arguably not only the most transparent central bank in the world but it has become even more so in recent years (e.g., see Dincer and Eichengreen 2007, Siklos 2010).

Presumably, these developments serve to reduce, but not necessarily eliminate, the surprise element of monetary policy. The objective of this paper is to estimate the size of the exchange rate response to the surprise component of New Zealand monetary policy and the role that central bank communication has in this outcome. Why might different forms of central bank communication influence exchange rate movements beyond any surprise element, if any, in the change in the instrument of monetary policy? Consider the following illustration. On July 26, 2007 the RBNZ increased the OCR by 25 basis points, a move that was believed to have been broadly anticipated by financial markets. Nevertheless, by the end of the day, the NZD depreciated by just under a half a percent against the AUD and US dollars. Was there anything possibly newsworthy in the RBNZ's announcement? The RBNZ explained its

[1] New Zealand banks can borrow from the RBNZ at the OCR rate plus 25 basis points (bp) and lend at the OCR less 25 bp.

decision stating that "…we think the four successive OCR increases we have delivered will be sufficient to contain inflation." Hence, even if the OCR move was widely expected, the forward looking sentiment in the wording of the RBNZ's statement may have independently influenced market expectations of the direction of change in the exchange rate.

Ours is not, of course, the first study to quantify how the surprise component of monetary policy affects the exchange rate, although a great deal of the literature has focused on the US experience. Nevertheless, as explained below, we have constructed a dataset with several unique characteristics. In addition, the New Zealand experience holds particular interest since it is one of the few central banks in the world to provide quantitative guidance about the interest rate track.[2]

The RBNZ's Monetary Policy Statement (MPS) represents the focal point of the central bank's communications strategy because the publication aims to inform the public about its views concerning the current and anticipated future state of the economy and the external factors that might influence them. In the present study, we also attempt to quantify the impact of any surprises this document might contain, especially as successive MPSs reflect revisions in the RBNZ's stance about the appropriate direction of future monetary policy. There are potentially other sources of surprises that may influence exchange rate movements. Some have a direct connection to monetary policy but others stem from announcements related to domestic economic activity as well as, and possibly more importantly, announcements from abroad with a potential impact on exchange rate movements

[2] The Norges Bank, the Bank of England, and the Riksbank now also provide this kind of market guidance but they have only done so fairly recently and it is too early to estimate their impact on asset price movements.

around the time monetary policy decisions are made. All of these types of surprises are also taken into account. Kearns and Manners' (2006) estimates of the surprise element of monetary policy on exchange rates in four countries, including New Zealand, comes closest to our study. There are, however, several differences between their study and ours. Their data is coarser, and they do not estimate the separate impact on exchange rates from all sources of news, most notably the role of the forward interest rate track. Since there is considerable discussion about the advisability of releasing a forward interest rate track (e.g., see Woodford 2005), separately estimating the potential effect of this kind of information has direct policy implications. In particular, we are also interested in the question whether 'bad news' for inflation is 'good news' for the exchange rate, or vice-versa. Clarida and Waldman (2008), for example, report that a 1% inflation surprise in New Zealand results in a 0.7% appreciation of the USD-NZD exchange rate in a 10 minute window around data announcements (i.e., 5 minutes before or after the announcement). Our estimates are not only considerably larger, albeit for a slightly longer window, but we also find that certain elements of the RBNZ communication strategy move the NZD while others do not (e.g., MPSs versus speeches by the Governor). Equally important is our finding that the release of a forward interest rate track, an element of RBNZ transparency not explicitly considered by them, adds only a modest amount to the surprise component of monetary policy. We believe that fears expressed by some (e.g., see Blinder et. al. 2007 for a discussion of the issues), that releasing this type of information is tantamount to transparency gone too far, are overblown.

The rest of the paper is organized as follows. The next section briefly reviews the relevant literature on the connection between surprises and exchange rate movements. Section 3 describes the various channels used by the RBNZ to communicate monetary policy with special emphasis on the role of the forward interest rate track and the MPS. Section 4 describes the data and the principal results of the paper are also presented. Section 5 concludes.

2. Central Bank Communication, News, and Asset Prices

There exists an extensive literature dealing with the impact of surprises on asset prices. What follows then is a selective survey.[3] The early literature in this field focused primarily on the effects of news releases, typically originating from financial markets, on stock returns. More recently, attention has turned to estimating the effects from these sources on other asset prices, such as exchange rates and interest rates.

Lately, there has been considerably more interest shown in exploring how asset prices react to announcements and other forms of communication emanating from the monetary authorities. What explains this development? First, many central banks now rely on an overnight interest rate, or a similar instrument, to guide the general level of interest rates. Furthermore, interest rate announcement dates are scheduled well in advance and, unless there is an emergency or crisis of some kind (e.g., as in the case of the terrorist attacks on 9/11), central banks do not deviate from the pre-announced schedule.[4] Naturally, this prompts financial market participants to form expectations at pre-determined intervals of time. Second, central banks in several countries are now more formally independent, transparent, and accountable

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[3] Andersen, Bollerslev, Diebold, and Vega (2007), and Faust, Rogers, Wang, and Wright (2007) also provide a comprehensive bibliography of the relevant literature.

[4] Many central banks publish interest rate announcements once a month while others, including the RBNZ, make eight such announcements per year. See http://www.rbnz.govt.nz/monpol/statements/0090630.html.

to their governments.[5] Third, there is a possibility that, at times, the words of central banks can substitute for direct action (Gürkaynak, Sack, and Swanson 2005a, 2005b). Bernanke (2004) argues that the central bank can use this device to influence the likely future path of short rates as well as long rates. Indeed, central banks have generally become more talkative. As a result, there is recognition that the monetary authority can influence markets on a daily basis.

Since financial market participants are also forward-looking, any monetary policy surprise can potentially have a deleterious impact on asset price movements. Yet, monetary policy transparency is precisely about minimizing such occurrences, unless the objectives of monetary policy are jeopardized as a result.[6] Indeed, in an attempt to provide even more guidance about the current and future stance of monetary policy, some central banks, notably the RBNZ, began to publish a forward track for short-term interest rates. In addition, the RBNZ publishes interest rate projections based on different scenarios about inflation pressure, and it is the first central bank that did so.[7] In the case of the US and the euro area, where there is arguably less central bank transparency according to some metrics (e.g., Dincer and Eichengreen 2007, Eijffinger and Geraats 2006), recent studies use interest rate futures, or forward exchange rates, to proxy future sentiment in financial markets (e.g., Connolly and Kohler 2004, Rigobon and Sack 2004, Kearns and Manner 2006, Brand, Buncic, and Turunen 2006). Whether it is possible to be too transparent is open for debate

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[5] There is an extensive literature on the sources and state of transparency among central banks worldwide. Siklos (2002) is one survey, while more recent surveys, together with empirical evidence, can be found in Dincer and Eichengreen (2007), and van der Cruijsen and Eijffinger (2010), and Siklos (2010).

[6] Blinder, Goodhart, Hildebrand, Lipton, and Wyplosz (2001) find that the 'quality' of inflation reports can lead to smaller reactions to monetary policy actions.

[7] As previously noted, there is an ongoing debate about the benefits and risks from this kind of transparency. See, for example, Woodford (2005), and Blinder et. al. (2007).

but is not the focus of this paper (see, however, Mishkin 2004, and Cukierman 2009).

A frequently used measure of 'news', or surprise, is given by the following expression:

$$s_{i,t} = \frac{A_{i,t} - E[A_{i,t}]}{\sigma_{i,t}} \qquad (1)$$

where $s_{i,t}$ is the surprise component of for announcement *i*, at time *t*, and is defined as the difference between the announced value of some economic indicator, A, and its median expected value based on a forecast or a survey, given by $E[A_{i,t}]$. Equation (1) is divided by the sample standard error, $\sigma_{i,t}$, to standardize the measure of surprise rendering them comparable across different types of announcements.[8] Once the surprise indicator is evaluated it enters a regression as a determinant of some return. Denoting *q* as the (log) level value for a particular financial asset (in the present study an exchange rate), a simple test of the impact of surprises consists in estimating the following regression

$$\Delta q_t = \alpha + \beta \Delta MP_t^i + \varepsilon_t \qquad (2)$$

where Δq_t is the return on the asset in question, here the rate of appreciation or depreciation in the nominal exchange rate, ΔMP_t^i is a proxy for unexpected monetary policy with the superscript highlighting the fact that such surprises may originate from several sources as will be detailed below, while ε_t is the error term. Since the relationship between news and the exchange rate is a function of how shocks to the economy influence expectations, with either good news for inflation

[8] Monetary policy announcements (see below for the definitions used in this study) are usually expressed in percent (or basis points) and hence need not be standardized. We follow this practice here as well.

representing bad news for the exchange rate (Clarida and Waldman 2008) whereas standard economic theory (e.g., a relative PPP view) would suggest otherwise, namely lower domestic inflation should, ceteris paribus, lead to a currency appreciation, the resulting asymmetry can also be examined by replacing ΔMP_t^i with $\Delta MP_t^+, \Delta MP_t^-$ where the former represents positive surprises while the latter are interpreted as negative surprises.

In any given week, various private and public sector institutions release announcements that compare actual and projected values for a large number of economic variables. In the US alone, the number of such announcements is large with perhaps as many as 83 data related announcements (e.g, see Siklos and Bohl 2008). With so many announcements, researchers typically have either arbitrarily chosen a subset of them, because the extant empirical literature suggests them to be statistically important, or they rely on a systematic technique such as principal components analysis to reduce the number of statistically meaningful announcements. In the case of New Zealand, there are comparatively fewer data releases. However, an important consideration for a small open economy, often under-appreciated in the literature, is that both domestic and foreign surprises (viz., from the US and Australia) are likely to be potentially relevant sources of shocks that can impact domestic asset price movements.

Consistent with the increased emphasis on estimating the impact of central bank policies on asset prices, researchers have also quantified statements, press releases, speeches, and other announcements emanating from the monetary authorities. Whether it is possible to objectively quantify the words of central bankers remains in question (Sebestyen 2005, Andersson 2010). Nevertheless, there have been promising efforts so far, with many studies suggesting that ‘verbal interventions’ do move markets (e.g., Ehrmann and Fratzscher 2003). However, a difficulty with the interpretations of verbal announcements is that statements by central bankers may obscure the monetary authority’s likely course of action, or mask the inherent uncertainty about the future course of monetary policy.[9] Yet, there is also widespread acceptance of the notion that what the central bank communicates, and how, influences financial markets. This is especially true of inflation targeting central banks whose credibility depends on meeting statutory inflation objectives.

One of the biggest challenges is identifying asset price reactions to market news from central bank announcements. For example, Gürkaynak, Sack, and Swanson (2005a) investigate whether the impact of monetary policy announcements on asset prices is adequately characterized by a single factor, the surprise component of the change in the current policy rate setting, a hypothesis that is rejected by the data. As a result, their study calls into question many single factor studies such as Cook and Hahn (1989), Kuttner (2001), Cochrane and Piazzesi (2002), Rigobon and Sack (2003), Ellingsen and Söderstrom (2003), and Bernanke and Kuttner (2005). Gürkaynak et.al. (2005a, 2005b, 2007) argue that central bank communication can account for more than three-fourths of variation in movements of 5 and 10 year Treasury yields, around FOMC meeting days. Indeed, there is, arguably, an even more important factor to consider when investigating asset price movements, namely what the Fed might do in future. In the case of ECB’s monetary policy yet another factor is also present due to the short time delay that exists between the ECB’s interest rate

[9] This is the principle of ‘constructive ambiguity’ associated with Alan Greenspan’s strategy of communicating US monetary policy in public.

announcement and the ECB President's news conference (see Brand, Buncic, and Turunen 2006).

Given the multiplicity of factors stemming from monetary policy announcements it is not surprising that a crucial issue is the sampling frequency. Some researchers have reported that news events can dissipate within a matter of minutes (Goodhart et.al. 1993, Andersen et.al. 2005). Therefore, using daily data may underestimate the short-run effects of unexpected events on asset prices whose impact may peak within minutes of the arrival of new information, only to be reversed later the same day. Ehrmann and Fratzscher (2004, 2007) counter that intra-daily data capture market overreactions, and they defend the use of daily data. Not all market participants necessarily react within a few hours. Moreover, with intra-daily data, the results may be sensitive to the chosen window.

Because there may be both transitory and permanent effects as a result of central bank interest rate announcements, advocates of intra-daily data have devised new strategies to overcome some of the criticisms levelled at their estimation strategy. On balance, however, it would seem that adequately estimating the impact of the release of information by a central bank around the time of a monetary policy announcement favours an event study approach.[10] This is perhaps the most fruitful way to proceed under the circumstances. Indeed, as we shall see, the available data permits us to isolate the effects we are seeking to identify with a fair amount of precision.

3. Proxying Monetary Policy Surprises in New Zealand

The RBNZ communicates with the public relying on a variety of announcements

[10] See, however, Lahaye, Laurent, and Neely (2009) for a time series approach applied to intra-daily data.

and publications. These include: Monetary Policy Statements (MPS) and Interim OCR Reviews, speeches by the Governor and the senior management, Finance and Expenditure Select Committee testimonies, and press releases.

By far the most important means of communication about monetary policy decisions in New Zealand is the MPS. The other forms of communication listed above are likely to have played a lesser role simply because the precision and quantity of information provided by the MPS, as well as advance knowledge of the timing of the release of the MPS are known in advance. There are eight official cash rate (OCR) reviews a year: four are accompanied by an MPS which represents a detailed discussion and assessment of the state of the New Zealand economy and is accompanied by a short statement that provides a general overview of its contents, ordinarily one page in length. The MPS is publically available on the RBNZ website at 9:00am New Zealand time (e.g., http://www.rbnz.govt.nz/news/2009/3724989.html; 3:00pm, the previous day in the Eastern US time zone). The dates when these statements are released can be found at http://www.rbnz.gov.nz/statements/0090630.html. Each MPS also contains forecasts for a wide variety of economic time series. While considerable attention is devoted to inflation, exchange rate, and economic growth forecasts, there has been considerable publicity given to the RBNZ's publication of alternative scenarios for 90-day bank bills, conditional on different hypothesized future paths for inflation. The result is published as the forward track for short term interest rates. The publication of the MPS is also accompanied by the data set used in its preparation. All of these documents can be readily downloaded from the RBNZ's website.

The surprise element of monetary policy in New Zealand can be estimated from a few sources. One can simply look at the change in 90 day interest rates around policy announcements, as did Gürkaynak et al (2005a, 2005b). A surprise can also be derived from the change in futures contracts prices relative to the day prior to the policy action. Kuttner (2001) proposes the use of the futures market data to gauge the unanticipated component of monetary policy, and this approach has been typically followed in the subsequent literature. For US data, fed funds futures have been found to have good predictive content for the realized fed funds rate (Krueger and Kuttner 1996, Gürkaynak 2005, and Hamilton 2009). In the case of New Zealand, a proxy is futures on 90 day bank bills (also see Kearns and Manners 2006), or Overnight Index Swaps (OIS; Choy 2003, Gordon and Krippner 2001).[11]

Bank bills futures are not directly comparable to fed funds, since the 90 day bank bills rate is not the actual policy rate. However, it is generally agreed that bank bills represent the instrument which the OCR aims to influence. First, second, third, and fourth contracts for the 90 day bank bills futures can be used to calculate different components of a monetary policy surprise in a manner described in Gürkaynak (2005; also see below). Finally, Reuters surveys market participants about the probability they attach to likely policy outcomes. A week or so before the Monetary Policy Committee of the RBNZ meets, the weighted median market expectation of the OCR is provided to the committee. This survey may or may not influence the Governor’s OCR decision.[12] In any event, the survey provides yet another potential source of monetary policy surprises.

[11] Bank bills are bills of exchange issued or accepted by banks. OIS were introduced in 2003 and represent exchanges of obligations for short periods. They have proved useful to the RBNZ as a means of deriving market expectations about the OCR. See Choy (2003).

[12] The Governor is the only person statutorily responsible for the OCR decision.

Table 1 summarizes the surprise measures employed in this study[13] while Table 2 provides descriptive statistics for the three different monetary policy surprise measures defined above. Note that a positive surprise implies a higher than expected interest rate, hence 'bad' new for inflation, while a negative surprise is, of course, the reverse and is interpreted as 'good' news for inflation. Depending on the definition of the monetary policy surprise proxy, our sample begins in 2000, 2001, or 2002 and always ends in 2007. The summary statistics reveal that the three surprise series are broadly comparable (a plot of the actual surprises, not shown, is relegated to an appendix). Nevertheless, the correlation coefficients between types of monetary policy surprises, while high, vary from a low of 0.72 to a high of 0.87. An additional feature of the data is also worthy of some additional comment. There is the possibility of a term premium. As suggested in the extant literature (Kuttner 2001, Bernanke and Kuttner 2005, Gürkaynak et.al. 2005a, 2005b, Gürkaynak 2005), while the term premium exists and could be time varying, the resort to high frequency data, namely a window of 30 minutes around policy announcements, should result in very small variations of the term premium. Piazzesi and Swanson (2008), for example, show that one day changes in the fed funds rate futures around FOMC announcements are very small. As a result, defining a relatively narrow window around such announcements likely represents the 'cleanest' way to calculate surprises, as term premia that are primarily influenced by lower business cycle frequency movements are effectively removed (also, see Gürkaynak 2005). Note also that during the first two thirds of the period covered in this study there was a worldwide decline in long rates. This too can be problematic since it is unclear

[13] That is, the numerator in equation (1). Also see n 9 above.

whether differencing of interest rates would be sensible under the circumstances. However, in an event study, this stylized feature of the data is less likely to pose a problem. We believe it is fairly safe to assume that, at the intra-daily frequency, the impact of these kinds of trends would be negligible.

Figure 2 plots the three proxies for monetary policy surprises in a 30 minute window, together with a 95% confidence ellipse. As expected, surprises are positively related to interest rate movements. A positive surprise implies an expectation that future interest rates will also rise, and by an almost equivalent amount.[14]

The literature has adopted several approaches to extracting information contained in monetary policy announcements. Gürkaynak et al (2005), and Brand, Buncic, and Turumen (2006) employ a recursive type approach to estimating the size of the reaction to news announcements. Assume that the relevant time window is 10 minutes (denoted Δf_t^{10}). This refers to the length of time over which the implied forward rate is evaluated, and define the reaction of the market to a central bank interest rate setting decision as taking place over a 30 minute period (denoted Δf_t^{30}). We can write the relationship between these two measures as follows:

$$\Delta f_t^{10} = \lambda_0 + \lambda_1 \Delta f_t^{30} + resid_t \qquad (3)$$

Equation (3) hypothesizes that the size of the reaction to the setting of the interest rate is given by λ_1 and is referred to as the 'jump' factor by Band et.al. (2006).[15] The residuals in the regression (*resid*) represent changes in the market's expectations

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[14] A simple regression of the change in the interest rate against the three surprises yields slope coefficients of 0.85 (MP^1), 0.92 (MP^2), and 0.89 (MP^3). These are close to one but the null that the slope is equal to one can be rejected at the 5% level.

[15] Gürkaynak (2005) refers to 'jumps' which may be somewhat misleading terminology. For example, Dungey et.al. (2009).

about the future path of interest rates referred to as the 'path' factor.[16] In a second stage, equation (3) is re-estimated by adding a second factor derived from the first stage regression. Setting aside the generated regressor problem, restrictions need to be imposed to identify the sources of the shocks to interest rates not only to facilitate comparisons with the existing literature but, as pointed out in Gürkaynak (2005), because this approach also permits us to use a unique dataset from New Zealand permitting the decomposition of the sources of surprises to the NZ dollar exchange rate.

4. The Impact of Monetary Policy Surprises on the NZ Dollar

4.1 *The Response to Monetary Policy Surprises*

We begin with the following regression reminiscent of the one used in Kuttner (2001), Bernanke and Kuttner (2005), and Gürkaynak et al (2005a, 2005b):

$$\Delta q_t = \alpha + \beta MP_t^u + \varepsilon_t \qquad (4)$$

where Δq_t is the rate of change in the nominal exchange rate of the NZD, expressed as previously noted, in foreign currency units (i.e., either in USD or AUD terms), collected at various intervals. Consequently, a negative value represents a depreciation of the NZD currency. The variable MP_t^u represents monetary policy surprises previously defined. The proxy can either be a single variable or a vector of proxies for the unexpected component of monetary policy decisions. It is important to recognize the possibility that the NZD currency will also be influenced by announcements abroad, especially from the US and Australia.

Most of the major US macroeconomic data announcements are released at

[16] In the case of the ECB considered by Brand, Buncic, and Turumen (2006) there is a third factor, called the timing factor, previously described.

8:30am Eastern time in the US (viz., the Consumer Price Index, Gross Domestic Product, Housing starts, Jobless claims, non-farm payrolls, etc…). Other announcements (e.g., Industrial production) are released at 9:15am Eastern time. All US data announcements correspond to early morning in New Zealand, the following day. Hence, by the time an OCR announcement is made, it is unlikely that this type of news would further impact the NZD exchange rate. The FOMC releases its announcements at 2:15pm Eastern time and, depending on the time of year, this corresponds either to 6:15am, 7:15am, or 8:15am the next day local New Zealand time. New Zealand markets open at 8:00am local time[17], and RBNZ announcements are made at 9:00am local time. Since our window calculations begin at 8:50am New Zealand time, we can safely assume that markets react to US news within 35 to 50 minutes from the releases, and between 35 to 50 minutes for FOMC announcements, depending on the time of year. As a result, we must also control for certain US monetary policy surprises that would overlap the 30 minute window (and, therefore, the 60 minutes and one day windows as well), our preferred choice, on the following days: 24-25 October 2006, 27-28 January 2004, 13 August 2002, 19 March 2002, 2 October 2001, 15 May 2001, 18 April 2001, 3 October 2000, 16 May 2000, 16 November 1999, and 18 May 1999. FOMC announcements on these days are temporally close to RBNZ OCR announcements. We use the Bernanke and Kuttner (2005) measure of the FOMC surprises to control for the unexpected portion of FOMC decisions.[18]

New Zealand data also pose problems on five other occasions because monthly

[17] See www.nzx.com/markets/key-dates/trading-hours.

[18] We are grateful to Ken Kuttner for providing us with the US fed funds surprise data. For details on the construction of the series, see Bernanke and Kuttner (2005).

releases of Trade Balance figures were announced on the same day as an OCR decision, namely 27 April 2006, 28 April 2005, 28 October 2004, 29 April 2004, and 29 January 2004. Trade balance data are announced at 10:45am local time in New Zealand. Hence, they do not coincide with the 30 and 60 minutes window employed in our regressions. Nevertheless, the mere anticipation of the release of an important piece of New Zealand economic news may well have a separate influence on exchange rate movements.

In order to ascertain the sensitivity of our results to the choice of window size we also present results for a 60 minutes window. The results for the 30 minutes window are based on an interval timed to begin at 8:10am (instead of 8:50am) and 9:10 am (instead of 9:20am). All times are local. For the 60 minutes window, we define the window to begin at 8:10am (instead of 8:50am) to 10:10am (instead of 9:50am), again New Zealand time. In the results reported below the impact of adding these results is negligible, in part because the net effect is to add only 5 additional observations. Finally, on one occasion (March 2002), Statistics New Zealand published the GDP release on its website well before the normal announcement time of 10:45am local time.[19] We also exclude from our data the OCR announcement following the September 11, 2001 terrorist attacks on the US, as this was obviously not a scheduled announcement by the RBNZ.

Table 3a shows the results from estimating equation (4), relying on the three different proxies for MP_t^u, for both the NZD-USD and NZD-AUD exchange rates while Table 3b permits an asymmetric response of exchange rates to positive or

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[19] The early release concerned the December 2001 GDP figure released in early 2002. See Statistics New Zealand “GDP Inadvertently Released Before Embargo Time”, http://www.stats.gov.nz/, March 2002 Quarterly Report.

negative surprises in monetary policy. The former represents an unexpected interest rate increase while the latter measures an unexpected decrease in the policy rate. To conserve space, estimates of the constant term are omitted but they are all statistically insignificant and economically uninteresting. Slope coefficients are highly significant and positive for bank bills futures (MP_t^1) and the OIS based surprise (MP_t^3) measures. Therefore, the NZD appreciates in the face of a positive monetary policy surprise. If the latter is interpreted as 'bad news' about inflation, this translates into 'good news' for nominal exchange rate movements. For example, a 100 basis point unanticipated monetary policy results in an 3.3% appreciation of the NZD-AUD exchange rates for the 30 minutes window. A similar sized surprise produces an even larger effect on the US dollar, at 4.1%. Differences in the USD and AUD reactions are not, however, statistically significant. It is notable that the Reuters based surprise measure (MP_t^2) is not statistically significant in any of the NZD-AUD regressions and is only significant at either the 5 and 10 percent levels in only a few of the NZD-USD regressions at the 60 minutes and 1 day windows. Since Reuters in New Zealand does not survey market participants on a regular basis, the lag between a particular survey and the actual RBNZ decision can, at times, stretch up to two weeks. Alternatively, it may be that the resort to a weighted estimate of the expectation of future OCR changes may be misleading if the weights do not properly reflect the relative accuracy or knowledge of the survey participants. Finally, also note that monetary policy surprises remain largely unchanged as the window is widened from 30 minutes to a full day. When positive and negative surprises are separately considered then, as shown in Table 3b, the impact of good news on the inflation front on the exchange rate is seen to be even larger than shown in Table 3a at least for the 30 minute window while effects are roughly comparable for the 60 and one day windows.[20] In a few cases there is some evidence of bad news for inflation leading to a currency appreciation at the 30 minute window but the coefficients are significantly offset by the impact of good inflation news (test results not shown).

To summarize, the results in Table 3 highlight two other important implications. First, monetary policy surprises have large effects on the exchange rate. Second, more precise estimates of the impact of these surprises are indeed obtained from reliance on intra-day data. Notice that the standard errors are roughly 40% larger when equation (4) is estimated using daily data and this, of course, is also reflected in the R^2 estimates shown in Table 3 which tend to fall as the window becomes wider. Third, the fact that monetary policy surprises are able to explain almost half of the variation in the exchange rate at the 30 and even 60 minutes windows in several instances in quite impressive.

Decomposition of Surprises Into Level and Timing Effects

The foregoing results assume that monetary policy surprises have a single dimension, following the traditional approach used the extant literature. However, since central banks are believed to act gradually, there is some uncertainty about whether the necessary easing or tightening will be carried out at once or over time. This implies that a surprise can carry over to more than one monetary policy decision date. In principle then, there is potentially a transitory and a permanent component to any monetary policy surprise. These effects are referred to as path and timing

[20] Recursive estimates (not shown) reveal that the 'good news – bad news' link reported here is statistically significant for virtually all possible sample. We cannot compare our results with those of Clarida and Waldman (2008) who only show the combined effect of asymmetric monetary surprises across the sample of all countries considered in their study.

effects, respectively. For example, a surprise in the timing of a policy decision is one that leaves the expected OCR unchanged following a monetary policy announcement. In what follows, and for reasons previously discussed, we consider only surprises generated from bank bills and OIS data.[21]

To fix ideas, suppose that a futures contract expires around the time of the next monetary policy announcement date and that this yields surprise denoted by MP_t^i . Assuming there are no further expectations of an OCR change, the impact of the surprise is a permanent one. Therefore, we can write:

$$MP_t^i = level_t \tag{5}$$

Next, suppose that that current OCR announcement contains both a transitory and a permanent component. Assuming they are additive, we can treat the transitory portion as akin to an error term in a regression of the form:

$$MP_t^u = \theta\, level_t + timing_t \tag{6}$$

where MP_t^u was previously defined. Substituting the right hand side of equation (6) into equation (4) we estimate the impact of a monetary policy surprise on the exchange rate as follows:[22]

$$\Delta q_t = \beta_0 + \beta_1\, level_t + \beta_2\, timing_t + \varepsilon_t \tag{7}$$

In equation (7), the regressors are separately estimated leading to a generated regressor problem to which we return below when we discuss the possibility of bias in the coefficients. Results from the estimation of equation (6) are given in Table 4.

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[21] We rely on the second contract for bank bills futures and the 3 month OIS, as these correspond to a three month horizon following an OCR decision. There is one decision during that period. Hence, there is the possibility that markets may expect a change in interest rates. Using the third contract for bank bills and the 90 day OIS yielded very similar results (not shown).

[22] Gürkaynak (2005) also introduces the notion of a 'slope' effect to account for the pace of interest rat changes. We examine below the significance of this effect in the New Zealand context when we estimate the impact of the release of the forward track for the interest rate.

The coefficient on the level variable is not far from unity, implying a parallel shift in short-term interest rates.[23] Moreover, the level effect explains between 69 and 80% of the variation in surprises. Therefore, the level effect represents a much smaller fraction of New Zealand surprises than for the US (see Gürkaynak 2005). This finding is noteworthy as the RBNZ has routinely tried to de-emphasize the importance of the surprise element of monetary policy announcements. It would seem that this effort has been successful.

Table 5 presents the results of the response of exchange rate changes to both the level and timing of surprises (equation (7)). The results clearly show that level effects dominate. Since timing effects appear inconsequential, this suggests that the RBNZ has successfully mitigated the transitory effects from monetary policy surprises. This result contrasts with the US evidence where timing effects are found to be significant for both interest rate and stock returns (e.g., see Gürkaynak 2005). An obvious problem with the foregoing estimation approach is that market prices may incorporate some idiosyncratic noise. In essence this is akin to an 'errors in variables' problem. If the errors are of the classical variety, they can bias coefficient estimates toward zero. This is known as the attenuation bias problem.[24] An appendix (not shown) demonstrates that this type of bias is a problem for survey-based measures rather than for the other proxies considered in the results just presented.

The Impact of the Forward Interest Rate Track

Since 1994, the RBNZ has published interest rate forecasts. The forecasting process has since gone through various changes (e.g., see McCaw and Ranchhod 2002,

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[23] Wald test shown in Table 4 reject the null that $\theta=1$ at only the 6 to 8% levels of significance.

[24] This is a somewhat neglected issue in the literature. The errors may, or may not, be random, and since we look at asset prices, these may also be correlated with the right hand side errors. Typically, however, the measurement error problem focuses on the independent variable(s) in a regression.

Ranchhod 2003). For example, until 1997, interest rate forecasts were presented without taking into account the effects of changing future interest rates on key macroeconomic aggregates. During the 1997-1999 period, when the monetary conditions index (MCI) became an instrument of policy, the RBNZ began to forecast future interest rates conditional on the impact of these rates on key variables such as inflation. The resulting interest rate forecasts came to be called endogenous policy forecast interest rate tracks.[25] The practice continues since the OCR became the instrument of monetary policy beginning in June 1999. Interest rates are forecast generated following several iterations or calibrations of the RBNZ's formal economic model called the FPS (Forecasting and Policy System; see http://www.rbnz.gov.nz/research/fps/). Perhaps most germane to this study, assumptions about the exchange rate, as well as external forecasts of the foreign economic environment, represent significant inputs into the process (see McCaw and Ranchhod 2002, Figure 2). The RBNZ publishes an endogenous interest rate track four times a year. Therefore, since our earlier proxies for MP_t^u assume eight events per year, consistent with the total number of monetary policy announcements in a year, the series of interest rate track surprises contains missing values for every second observation. As a result, the sample employed here consists only of data published in successive MPS since August 2000.[26] We calculate the implied 90 day interest rates at 9 and 12 month horizons before the release of an MPS and take the

[25] The RBNZ also publishes scenarios for the 90-day bank bills rate conditional on different assumptions about the future course of key macroeconomic aggregates (e.g., inflation).

[26] In principle, we could go back to 1997 when interest rate forecasts first appeared in the MPS. However, we then encounter the problem of some missing intra-daily data, as previously discussed. The RBNZ also releases from time to time an endogenous interest rate track beyond the next monetary policy announcement. However, there were too few such observations. Hence, only surprises based on the next monetary policy announcement are employed in the present study.

difference between them and the RBNZ's published 90 day interest rates at the same horizons. We call the relevant series *fs9m* and *fsm12m*, respectively.

Figure 3a plots the size of monetary policy surprises estimated from the forward interest rate track. The surprises, measured in basis points, can be quite large. However, what is especially noteworthy is that, during the second half of the sample, markets consistently over-estimated the direction of future interest rates. Figure 3b highlights the fact that positive monetary policy surprises, namely interest rates that exceed even the RBNZ's forward interest rate track, result in a small appreciation of the NZD vis-á-vis the USD.[27] Nevertheless, the confidence ellipse suggests a small likelihood that the relationship will be statistically significant. We now turn to a more formal examination of the role of these surprises.

Tables 6a and 6b report the regression results.[28] The surprise variable, MP_t^1, is statistically significant in every regression. However, *fs9m* and *fs12m* are statistically significant at least at the 5% levels for the 30 minutes window and only for the Reuters based surprise measure (MP_t^2) earlier deemed problematic. The variable *fs12m* is statistically significant, again for the 30 minutes window, but only for the OIS based monetary surprise proxy (MP_t^3). This means that the additional information content in the forward track dissipates fairly quickly. Nevertheless, during that interval of time, there is a further appreciation in the nominal exchange rate over and above the one due to the surprise element in monetary policy. Notice that for the 60 minutes window the results differ as between the USD-NZD and AUD-NZD

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[27] The results are the same for the AUD-NZD case.

[28] We also generated series for the 3 and 6 months ahead horizons implied 90 day interest rates. The results were statistically and economically comparable to the results shown in Table 6. In addition, the results are practically identical when we use instead positive and negative monetary policy surprises. Versions of Table 6 that permit an asymmetric response are relegated to the appendix (not shown).

reactions to the interest rate track announcement. Hence, distinguishing between the two currencies can impact the interpretation of results.

In general, the size of the effect stemming from the forward track suggests that its impact is modest to insignificant. It should be emphasized, however, that the significance of the forward track is a function of how the monetary surprise variable is proxied. Indeed, interest rate forecasts affect the exchange rate only when the survey based measure is used. Since it was suggested earlier that this measure was problematic for a variety of reasons this suggests that a forward interest rate track does no independent harm to the exchange rate. Of course, it is not at all straightforward to separately identify the contribution of the forward track from other information contained in the monetary policy surprise variable due to the fact that the forecasts are contained in the MPS which itself contains potentially many sources of surprise. In any event, the notion that releasing such information represents too much transparency – a bridge too far so to speak – is not borne out in the data.

Other Surprises, Monetary or Otherwise

Finally, we wish to determine whether the existing specifications may have omitted other types of surprises. Here we consider an additional source, namely a quantification of the *language* used by the RBNZ to communicate its views through the MPS. To do so we interpret the commentary in the MPS according to whether the discussion focuses on output, interest rates, inflation, or exchange rate developments, as well as developments from abroad which may be seen as having a potential impact on domestic monetary policy. For example, when the outlook for each one of these variables is favourable (e.g., lower inflation) according to the RBNZ we assign a

+1 while a -1 is assigned if the sentiment for any one of these variables is interpreted as being negative.[29] We also attempt to assign a value according to whether there is a *bias* of some kind in the statement. That is, we separately identify commentary that explicitly indicates, following a discussion of the outlook for a particular series, whether monetary policy is likely to tighten, in which case we assign a +1 to the resulting dummy variable or -1 in the event that a loosening of policy is anticipated. Once again we are careful not to try and read into the MPS. Hence, the report must explicitly state whether there is tendency or likelihood that monetary policy will change course if some aspects of the outlook come true. This is viewed as being a statement of a change in the stance of monetary policy conditional on what is known and is projected at the time the MPS is published. Otherwise, that is, when the statement is deemed neutral, the dummy is assigned a zero. *Reversal* is a 0-1 dummy that captures whether there is a change in the bias over time, as in whether a change in the RBNZ's sentiment about the appropriate stance of monetary policy shifts from one release of the MPS to the next. For example, a shift in emphasis from tightening in the previous MPS to a loosening in the most recent MPS, or vice-versa, would be assigned a +1. When there is no reversal in the discussion about the appropriate stance of monetary policy a zero is assigned. Hence, equation (4) is modified as follows:

$$\Delta q_t = \alpha + \beta MP_t^u + \gamma_i comm_t^i + \phi bias_t + \sigma reversal_t + \varepsilon_t \qquad (8)$$

where all variables, except *comm, bias* and *reversal*, were previously defined. *Comm* and *bias* are dummy variables taking on the values described above, while *i* refers to

[29] We are careful not to impose our own interpretation of the direction of change in a particular indicator. Rather the MPS is usually clear about whether developments are considered to be favourable or not in order to meet the objectives of monetary policy.

whether the commentary specifically deals with output (y), interest rates (rs), inflation (p), exchange rate (q), or international developments (int). The results previously discussed are unchanged. Hence, to conserve space they are not discussed.[30] However, it is worthwhile noting that the *reversal* variable is statistically significant when either the Reuters survey or OIS are used to construct the proxy for MP_t^u. Therefore, there is a little bit of evidence that the foreign exchange market pays attention to the changing views of the RBNZ.

Exchange rates can, of course, also be influenced by surprises contained in regular macroeconomic announcements that are released during any of the windows defined above. To illustrate, Figure 4 plots surprises defined as in equation (1) for 4 of the 6 available surprises constructed from New Zealand macroeconomic data releases against interest rate changes across different windows. In general, positive surprises in inflation, GDP growth, and the Trade Balance, lead as expected, to positive interest rate changes. The opposite, again as one would expect, holds for a surprise unemployment rate release. Comparing actual data on these announcements against surveys from Reuters and Bloomberg we obtain an estimate of the surprise based on the median expectation. It should be noted that expectations are based on a sample of anywhere from 9 to 15 individuals surveyed, with a mean of around 13 people surveyed. We are able to construct the resulting surprise variable for the full sample of OCR announcements. Finally, Table 7 presents the results of equation (4) augmented with the additional macroeconomic announcement surprises, omitting the coefficient estimates for the constant and MP_t^u terms to conserve space. As shown, the estimates of β are unchanged

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[30] They are, however, available on request.

relative to the earlier evidence discussed. Notice, however, that the explanatory power of the regressions is improved considerably suggesting that such announcements have a sizeable impact on exchange rate movements. In particular, as in Clarida and Waldman (2008) report, bad news stemming from CPI announcements, that is a negative surprise, represents good news for the exchange rate, a reflection of the credibility of the central bank.

5. Conclusions

This paper estimates the impact of monetary surprises on the behaviour of the USD-NZD and AUD-NZD exchange rates since the Official Cash Rate (OCR) became the instrument of monetary policy in New Zealand. We were especially interested in separately estimating the impact from the release of an endogenously determined forward interest rate track by the Reserve Bank of New Zealand (RBNZ). Although some view the release of this kind of information as an illustration of a central bank taking transparency too far, the results of this paper suggest otherwise. The forward interest rate track, a device now published by a few inflation targeting central banks, does not represent 'a bridge too far'. It is likely that this information is digested simultaneously together with other pieces of information emanating from the central bank. For example, both the temporary and permanent surprise components of all OCR decisions are considerably smaller for New Zealand than for comparable U.S. estimates. Nevertheless, it is the case that financial markets consistently overestimate the future direction of short term interest rates after 2003. As a result, the release of an endogenous interest rate track does result in a modest appreciation of the New Zealand currency vis-à-vis the U.S. dollar. Therefore, one cannot entirely rule out that the release of such information reflects some residual lack of credibility in the future interest rate path. Perhaps, as is now widely believed, markets expected a tighter monetary policy than was actually delivered from 2003 to 2007. Many observers now believe that policy was too loose in many parts of the industrial world. Other forms of information contained in the RBNZ's Monetary Policy Statement (MPS), as well as general macroeconomic data releases aslo contain quantitatively more newsworthy information that affects the exchange rate. Our results are also consistent with Clarida and Waldman's (2007) finding that bad news for inflation is good news for the exchange rate. In spite of the fact that the RBNZ appears to have done a reasonably good job at minimizing monetary policy surprises the results based on the Reuters survey does suggest room for improvement in how monetary policy is communicated. What the present study is unable to determine is the degree to which our estimates are influenced my the manner in which the Reuters-based monetary policy surprise variable is estimated, or the relative value of the survey and its timing, relative to other market derived monetary policy surprise indicators used in this study. Also, the fact that we rely on an event study raises some problems. It is conceivable that a time series approach might yield additional insights into the high frequency determinants of the exchange rate and the newsworthiness and credibility associated with an endogenous interest rate track. We leave extensions for future research.

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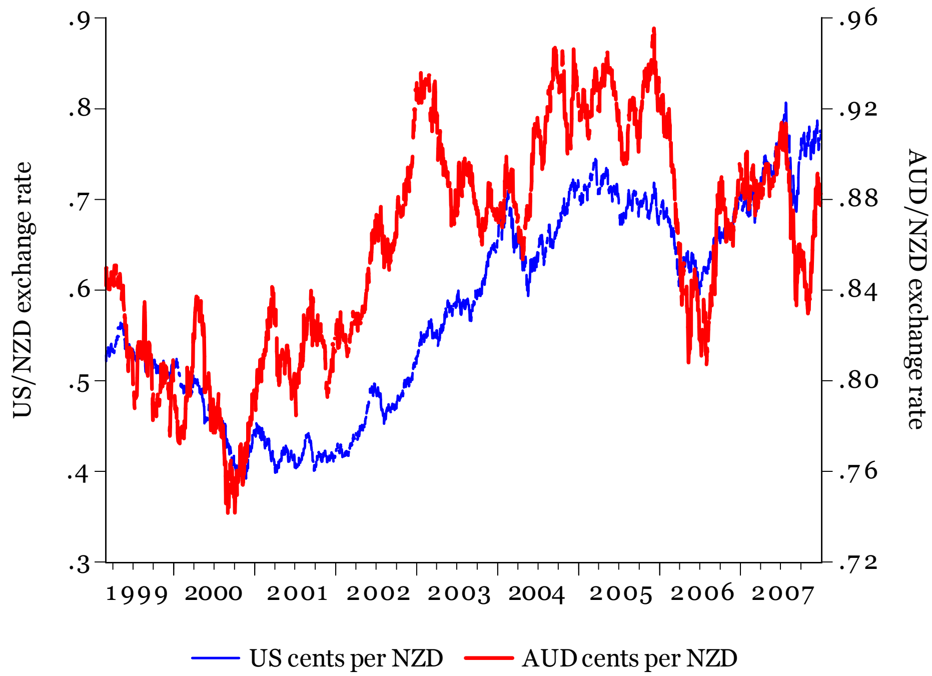
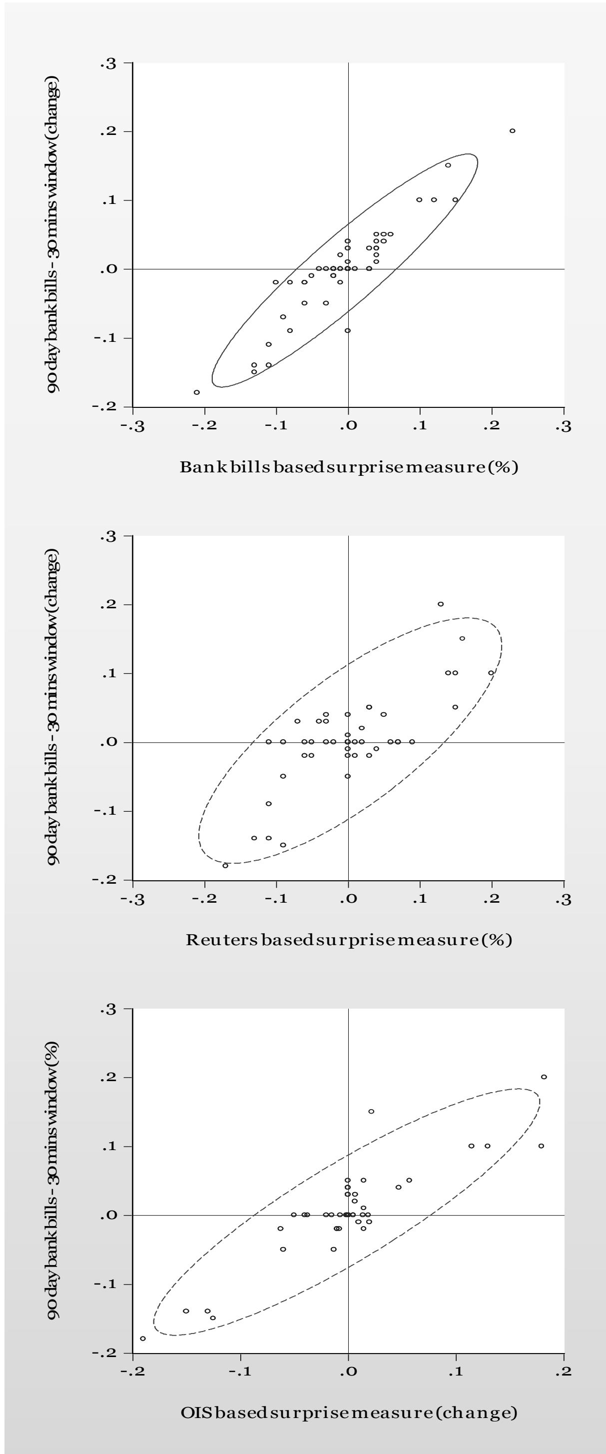
Figure 1 USD-NZD and AUD-NZD Nominal Exchange Rates



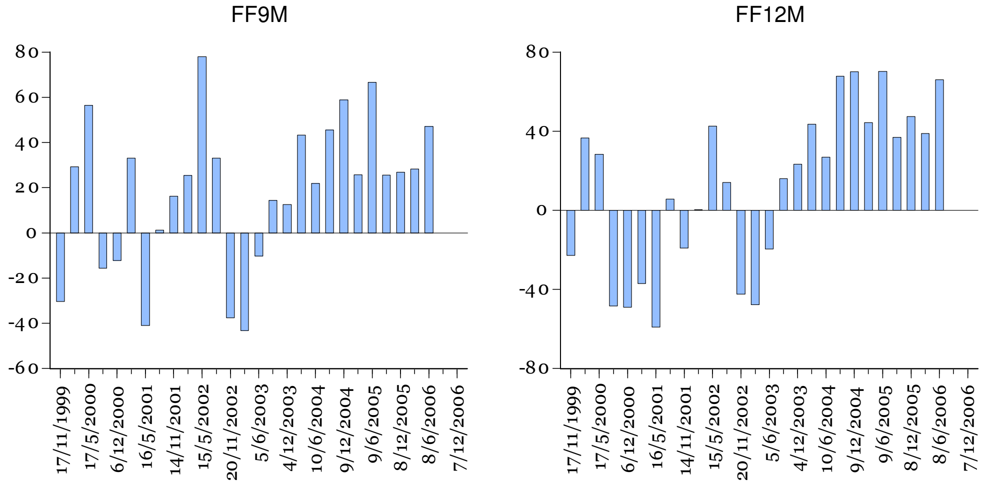
Source: Reserve Bank of New Zealand. Data are at the daily frequency (7 days a week). The exchange rate is defined in terms of the foreign currency (USD or AUD).

Figure 2 Monetary Policy Surprises and Interest Rate Changes



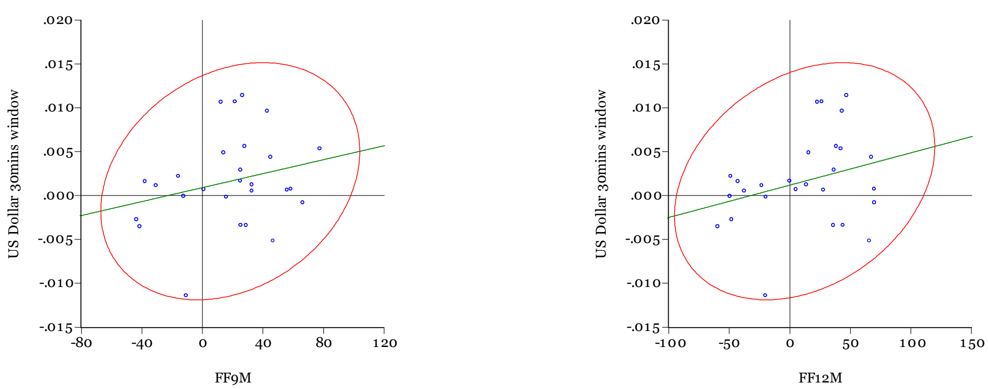
Note: The surprises correspond, from top to bottom figure, to s1, s2, and s3 in the Tables and text.

Figure 3a
Market Versus RBNZ Forward Interest Rate Track Differential*



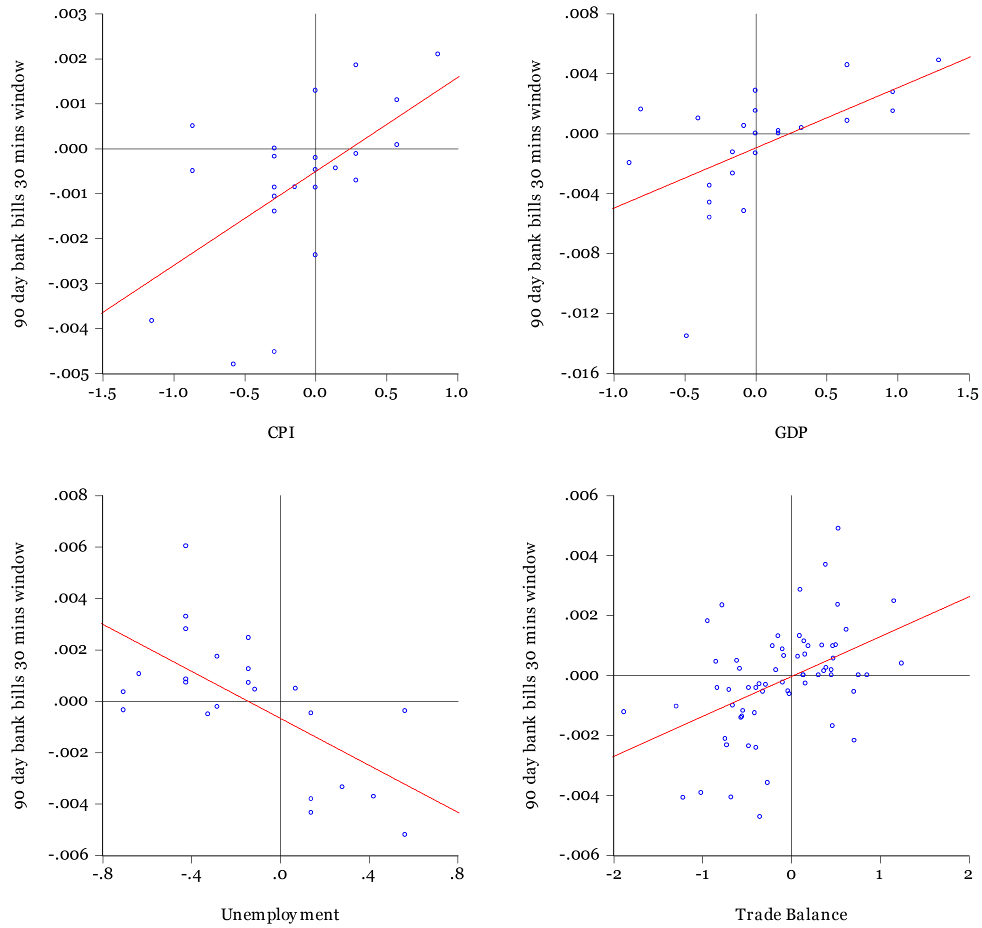
*Note: FF9M and FF12M defined in the text.
Day/Month/Year shown on the bottom axis refers to dates
when MPS statements and interest rate forward tracks were released.
Source: RBNZ and authors calculations.

Figure 3b
Market Versus the RBNZ Forward Interest Rate Track and the NZD-USD Exchange Rate*



*Note: FF9M and FF12M are defined in the text. Source: RBNZ and authors' calculations.

Figure 4 Macro Announcement Surprises and Interest Rate Changes*



*Note: Surprises defined int the text. Source: RBNZ and authors' calculations.

Table 1 Policy Events and Measures of Monetary Policy Surprises

Basis of Surprise Measure	1st available Observation	No. of Observations*	Monetary Policy Surprise Label
Change in the 1st contract on 90 day bank bills futures (MP_t^1)	16 August 2000	55	MP_t^1
Weighted market expectations from Reuters (MP_t^2)	14 November 2001	48	MP_t^2
Change in Overnight Index Swaps (OIS); (MP_t^3)	20 March 2002	43	MP_t^3

* In all case the last observation is the MPS release of January 27, 2007.

Table 2 Summary Statistics for Monetary Policy Surprise Proxies

	Proxy		
Summary Statistics	MP_t^1	MP_t^2	MP_t^3
Mean	-0.005	0.003	-0.001
Maximum	0.23	0.20	0.19
Minimum	-0.21	-0.17	-0.19
Std. Deviation	0.073	0.08	0.072
Correlation Matrix	MP_t^1	MP_t^2	MP_t^3
MP_t^1	1		
MP_t^2	0.72	1	
MP_t^3	0.87	0.78	1
Observations	55	45	43

Table 3a Exchange Rate Responses to Monetary Policy Surprises: Benchmark Specification

	AUD-NZD			USD-NZD		
Coefficient	MP_t^1	MP_t^2	MP_t^3	MP_t^1	MP_t^2	MP_t^3
Window	30 minutes			30 minutes		
β	0.033*** (0.006)	0.013 (0.008)	0.032*** (0.009)	0.041*** (0.008)	0.021** (0.010)	0.039*** (0.010)
Obs.	55	45	43	55	45	43
R^2	0.37	0.06	0.25	0.42	0.13	0.30
	60 minutes			60 minutes		
β	0.036*** (0.008)	0.012 (0.009)	0.032*** (0.010)	0.044*** (0.010)	0.020* (0.011)	0.041*** (0.013)
Obs.	55	45	43	55	45	43
R^2	0.35	0.04	0.20	0.36	0.08	0.24
	1 day			1 day		
β	0.035*** (0.010)	0.013 (0.010)	0.035*** (0.013)	0.044*** (0.012)	0.021* (0.012)	0.043*** (0.015)
Obs.	55	45	43	55	45	43
R^2	0.23	0.04	0.17	0.19	0.07	0.19

Note: Estimates of β based on equation (4), using least squares with White corrected standard errors. *** signifies statistically significant at the 1% level, ** at the 5% level, *at the 10% level of significance. See Table 1 for the definition of monetary policy surprises.

Table 3b Exchange Rate Responses to Monetary Policy Surprises: Asymmetric Specification

	AUD-NZD			USD-NZD		
Coefficient	MP_t^1	MP_t^2	MP_t^3	MP_t^1	MP_t^2	MP_t^3
Window	30 minutes			30 minutes		
$\beta+$	0.018**	0.002	0.00	0.024**	0.002	0.003
	(0.01)	(0.012)	(0.014)	(0.012)	(0.015)	(0.018)
$\beta-$	0.047***	0.027**	0.063***	0.056***	0.041	0.076***
	(0.047)	(0.014)	(0.013)	(0.010)	(0.019)**	(0.012)
Obs.	55	45	43	55	45	43
$\bar{R}^2$	0.41	0.08	0.47	0.43	0.14	0.49
	60 minutes			60 minutes		
$\beta+$	0.015***	0.003	-0.001	0.021*	-0.003	-0.004
	(0.011)	(0.011)	(0.012)	(0.001)	(0.014)	(0.015)
$\beta-$	0.058***	0.027	0.073***	0.066	0.046	0.089
	(0.011)	(0.017)	(0.015)	(0.013)***	(0.023)**	(0.016)*
Obs.	55	45	43	55	45	43
$\bar{R}^2$	0.40	0.06	0.47	0.39	0.12	0.48
	1 day			1 day		
$\beta+$	0.008	-0.002	-0.003	0.017	0.009	-0.001
	(0.013)	(0.015)	(0.017)	(0.017)	(0.017)	(0.015)
$\beta-$	0.060***	0.029	0.077***	0.056***	0.036	0.081***
	(0.015)	(0.021)	(0.115)	(0.019)	(0.027)	(0.022)
Obs.	55	45	43	55	45	43
$\bar{R}^2$	0.20	0.05	0.38	0.21	0.08	0.32

Note: See notes to Table 3a. $\beta+$ is the coefficient for the response of a positive MP surprise (i.e., an unexpected interest rate increase); $\beta-$ is the coefficient for the response of a negative MP surprise (i.e., an unexpected interest rate decrease).

Table 4 The Level or Permanent Effect of Monetary Policy Surprises on USD-NZD Exchange Rates

Monetary Policy Surprise	Constant	Level	$\overline{R}^2$	Obs.	WALD
MP_t^1	-0.002 (0.006)	0.828*** (0.085)	0.68	55	-0.17 (.08)
MP_t^3	-0.006 (0.004)	0.755*** (0.063)	0.80	43	-0.25 (.06)

Note: *** signifies statistically significant at the 1% level. Newey-West standard errors in parenthesis. Equation (6) estimated via least squares. Results are for the USD-NZD exchange rate. See Table 1 for the definition of monetary policy surprises. 30 minutes widow used.

Table 5 Permanent and Transitory Effects of Monetary Policy Surprises on Exchange rates

	AUD-NZD		USD-NZD	
Variable	MP_t^1	MP_t^3	MP_t^1	MP_t^3
Window:	30 minutes window			
Level	0.036*** (0.016)	0.035*** (0.029)	0.044*** (0.009)	0.043*** (0.011)
Timing	0.009 (0.007)	-0.029 (0.009)	0.014 (0.019)	-0.037 (0.031)
Obs.	55	55	43	43
$\overline{R}^2$	0.44	0.45	0.47	0.52
F-Stat	21.81	22.67	17.21	18.22
Window:	60 minutes			
Level	0.040*** (0.016)	0.038*** (0.008)	0.049*** (0.010)	0.047*** (0.013)
Timing	0.008 (0.008)	-0.041 (0.010)	0.009 (0.019)	-0.048 (0.030)
Obs.	55	55	43	43
$\overline{R}^2$	0.42	0.43	0.42	0.46
F-Stat	20.92	21.11	14.18	14.93
Window:	1 Day			
Level	0.045*** (0.011)	0.043*** (0.012)	0.047*** (0.012)	0.049*** (0.014)
Timing	-0.007 (0.011)	-0.056 (0.012)	0.009 (0.023)	-0.048 (0.041)
Obs.	55	55	43	43
$\overline{R}^2$	0.33	0.43	0.27	0.37
F-Stat	9.99	12.58	7.54	9.74

Note: *** indicates statistically significant at the 1% level. Equation (7) estimated via least squares. Standard errors in parenthesis. Controls for FOMC announcements included but coefficient estimates not shown. Standard errors are bootstrapped as described in Gürkaynak (2005), based on a 1000 replications. Results are for the USD-NZD exchange rate. See Table 1 for the definition of monetary policy surprises. White standard errors used (conclusions are unaffected when Newey-West standard errors are used).

Table 6a The Impact of the Forward Interest Rate Track on the AUD-NZD Exchange Rate

Variables	MP_t^1			MP_t^2			MP_t^3		
Window	30 minutes								
MP_t^u	0.034*** (0.010)	0.033*** (0.010)	0.032*** (0.010)	0.014 (0.013)	0.012 (0.012)	0.011 (0.012)	0.028* (0.018)	0.026* (0.015)	).027** (0.013)
fs9m		0.003 (0.002)			0.004** (0.002)			0.003 (0.002)	
fs12m			0.003 (0.002)			0.004** (0.002)			0.004** (0.002)
R^2 /Obs+	0.31/28	0.34/27	0.35/27	0.06/28	0.13/27	0.15/27	0.14/28	0.21/27	0.26/27
Window	60 minutes								
MP_t^u	0.040*** (0.009)	0.040*** (0.010)	0.039*** (0.013)	0.013 (0.013)	0.013 (0.012)	0.012 (0.012)	0.030* (0.017)	0.027** (0.013)	0.029*** (0.012)
fs9m		0.003 (0.002)			0.005 (0.002)			0.004 (0.002)	
fs12m			0.003 (0.002)			0.004 (0.002)			0.004 (0.002)
R^2	0.34	0.38	0.40	0.04	0.12	0.15	0.13	0.20	0.25
Window	1 day								
MP_t^u	0.025* (0.015)	0.031** (0.015)	0.029* (0.015)	0.009 (0.015)	0.014 (0.013)	0.014 (0.013)	0.023 (0.020)	0.021 (0.017)	0.022 (0.015)
fs9m		0.003 (0.003)						0.003 (0.003)	
fs12m			0.003 (0.0030		0.004 (0.003)	0.004 (0.003)			0.004 (0.003)
R^2	0.11	0.17	0.20	0.02	0.08	0.11	0.06	0.10	0.14

Note: MP is defined in Table 1. The estimates of the constant term are not shown to conserve space. The dependent variable is the rate of change in the nominal exchange rate. See Table 5 for explanation of symbols for significance levels. + number of observations the same for all window lengths.

Table 6b The Impact of the Forward Interest Rate Track on the USD-NZD Exchange Rate

Variables	MP_t^1			MP_t^2			MP_t^3		
Window	30 minutes								
MP_t^u	0.037*** (0.013)	0.036*** (0.015)	0.035*** (0.015)	0.014 (0.017)	0.012 (0.017)	0.011 (0.016)	0.028 (0.024)	0.026 (0.022)	0.027* (0.020)
fs9m		0.003 (0.003)			0.004** (0.002)			0.003 (0.003)	
fs12m			0.003* (0.002)			0.004** (0.002)			0.004** (0.002)
R^2	0.28	0.28	0.29	0.05	0.09	0.11	0.10	0.15	0.19
Window	60 minutes								
MP_t^u	0.045*** (0.014)	0.045*** (0.014)	0.044*** (0.015)	0.016 (0.018)	0.016 (0.017)	0.014 (0.016)	0.035* (0.025)	0.032* (0.020)	0.034** (0.019)
fs9m		0.005* (0.003)			0.006* (0.003)			0.005 (0.003)	
fs12m			0.004** (0.002)			0.005* (0.003)			0.005* (0.003)
R^2	0.27	0.33	0.33	0.04	0.13	0.14	0.12	0.19	0.22
Window	1 day								
MP_t^u	0.048*** (0.018)	0.051*** (0.020)	0.050** (0.020)	0.032** (0.019)	0.035* (0.021)	0.034* (0.020)	0.058** (0.026)	0.057** (0.026)	0.057*** (0.023)
fs9m		0.001 (0.004)			0.003 (0.004)			0.001 (0.004)	
fs12m			0.001 (0.003)			0.003 (0.003)			0.003 (0.003)
R^2	0.23	0.23	0.23	0.12	0.12	0.14	0.23	0.24	0.26

See note to Table 6a.

Table 7 Macro Announcement Surprises and the Exchange Rate

	30 minutes	R^2	60 minutes	R^2	1 day	R^2
Announcement	AUD-NZD					
CPI	0.0024*** (0.0007)	0.34	0.0029*** (0.0008)	0.42	0.0025*** (0.0011)	0.18
GDP	0.0027** (0.0010)	0.27	0.0036*** (0.0012)	0.34	0.0039*** (0.0016)	0.26
CA	0.0071*** (0.0015)	0.53	0.0074*** (0.0018)	0.54	0.0083*** (0.0028)	0.37
RS	0.0014*** (0.0003)	0.31	0.0016*** (0.0003)	0.31	0.0011** (0.0006)	0.09
TB	0.0012*** (0.0003)	0.20	0.0015*** (0.0004)	0.22	0.0014** (0.0006)	0.10
U	-0.0048*** (0.0010)	0.57	-0.0054*** 0.0011)	0.52	-0.0054 (0.0019)	0.30
	USD-NZD					
CPI	0.0021*** (0.0007)	0.32	0.0032*** (0.0009)	0.40	0.0039*** (0.0011)	0.27
GDP	0.0040*** (0.0013)	0.31	0.0052*** (0.0016)	0.35	0.0047 (0.0030)	0.17
CA	0.0080*** (0.0013)	0.58	0.0090*** (0.0015)	0.61	0.0078*** (0.0024)	0.22
RS	0.0015*** (0.0004)	0.27	0.0017*** (0.0004)	0.29	0.0014* (0.0007)	0.07
TB	0.0013*** (0.0003)	0.21	0.0016*** (0.0004)	0.18	0.0011 (0.0007)	0.04
U	-0.0046*** (0.0013)	.42	-0.0044** (0.0016)	0.29	-0.0055** (0.0025)	0.21

Notes: Equation (8) estimated via least squares. To conserve space coefficient estimates for MP_t^u not shown. The independent variables include a constant and MP_t^1 (see Table 1 for the definition) not shown to conserve space. CPI (Consumer Price Index), GDP (Gross Domestic Product), CA (Current Account), RS (Retail Sales), TB (Trade Balance), and U (unemployment rate) are surprise measures evaluated as defined in equation (1). All announcements are for New Zealand data. The timing of the announcements is explained in the paper. See Table 5 for explanation of symbols for significance levels.

APPENDIX – A. Measurement error in survey based forecasts

For the surprise measures s1 and s3, one can safely assume that the variance of the measurement error is much smaller than the variance of the surprise itself, hence can carry with the least squares estimation. As long as the markets are large and liquid enough, the error component can be assumed to be small.
However, with the surprise measure s2 the measurement error is a problem. This is a survey based measure, where the number of respondents is around 15. So, this survey nature of the measure on its own warrants taking the measurement error issue seriously. Moreover, the measurement error may have some other structure due to the nature of the survey in New Zealand. Surveys are not conducted just before" each policy announcements. Sometimes, the surprises are conducted many days or weeks before an announcement. For financial markets, even a survey conducted a few days before can be problematic, as the markets may change its view dramatically in that period.

$$\Delta E_t = \alpha + \beta S^*_{2,t} + \varepsilon_t$$

$$S_{2,t} = S^*_{2,t} + \eta_t$$

The η is the classical measurement errors. However, we have additional information that we can use when treating this error. We can safely assume that some part of this error would be related to the number of days between the survey is conducted and the policy is announced. For example, the greater the number of days, the bigger the error. We can characterize the η as follows:

$$\eta_t = \delta D_t \zeta_t + \varphi_t$$

where D is the number of days between survey and announcement, ζ is a variable that creates the random error according to the days and the coefficient δ and φ is the additional iid error. We further assume $cov(\varepsilon_t, \varphi_t) = 0$, $cov(D_t, \varepsilon_t) = 0$, $cov(D_t, \varphi_t) = 0$, $cov(\zeta_t, \varepsilon_t) = 0$, $cov(\zeta_t, \varphi_t) = 0$, $\varepsilon_t\, N(0, \sigma^2_\varepsilon)$, $\varphi_t\, N(0, \sigma^2_\varphi)$ and $\zeta_t)\, N(0, \sigma^2_\zeta)$ The σ^2_φ can be large as well. For example, the only market participants that are surveyed are the ones that are based in New Zealand and a few that are based in Australia. So, not including the US and the UK based market participants in the survey may be adding extra error. There, perceptions of New Zealand monetary policy could be different than the domestic markets.
The equation we estimate becomes:

$$\Delta E_t = \alpha + \beta S_{2,t} + (\varepsilon - \beta\varphi_t - \beta\delta D_t\zeta_t)$$

or

$$\Delta E_t = \alpha + \beta S_{2,t} + v_t$$

where $v_t = \varepsilon - \beta\varphi_t - \beta\delta D_t\zeta_t$

We can show that the covariance between the new error term v_t and the right hand side variable S_t is not zero, which is a crucial violation of the least squares estimates:

$$cov(v_t, S_t) = -\beta\delta^2\sigma_D^2\sigma_\zeta^2 - \beta\sigma_\varphi^2$$

Under this error, the variance of the estimated $\hat{\beta}$ coefficient would have a downward bias. The probability limit of the coefficient β would be the following:

$$plim\beta = \beta(1 - \frac{\beta\delta^2\sigma_D^2\sigma_\zeta^2 + \beta\sigma_\varphi^2}{\sigma_S^2})$$

Table A summarises the variances, covariances, and the probability limits of the $\hat{\beta}$ coefficient under the OLS with no measurement error, with classical measurement error and the kind of measurement error we discussed above. The variance of the estimates gets larger in our case compared with the conventional classical measurement error. The covariance between the error and the independent variable is also larger. The inconsistency of the estimated coefficient is also much larger, implying a larger bias.

Table A Summary

		OLS	Classical ME	Our ME
$var(\hat{\beta})$	=	$\frac{\sigma_\varepsilon^2}{\sum S_t^2}$	$\frac{\sigma_\varepsilon^2+\sigma_\eta^2}{\sum S_t^2}$	$\frac{\sigma_v^2+\sigma_\eta^2}{\sum S_t^2}$
$cov(S_t, error)$	=	0	$-\beta\sigma_v^2$	$-\beta\delta^2\sigma_D^2\sigma_\zeta^2 - \beta\sigma_\varphi^2$
$plim\hat{\beta}$	=	β	$\beta[1 - \frac{\sigma_\varepsilon^2}{\sigma_S^2}]$	$\beta[1 - \frac{\beta\delta^2\sigma_D^2\sigma_\zeta^2+\beta\sigma_\varphi^2}{\sigma_S^2}]$

TABLE A1 – OCR Dates

Date (Links are to news releases)	Change in OCR	OCR rate	OBS #
26 April 2007	+0.25	7.75	55
8 March 2007	+0.25	7.50	54
25 January 2007	No change	7.25	53
7 December 2006	No change	7.25	52
26 October 2006	No change	7.25	51
14 September 2006	No change	7.25	50
27 July 2006	No change	7.25	49
8 June 2006	No change	7.25	48
27 April 2006	No change	7.25	47
9 March 2006	No change	7.25	46
26 January 2006	No change	7.25	45
8 December 2005	+0.25	7.25	44
27 October 2005	+0.25	7.00	43
15 September 2005	No change	6.75	42
28 July 2005	No change	6.75	41
9 June 2005	No change	6.75	40

28 April 2005	No change	6.75	39
10 March 2005	+0.25	6.75	38
27 January 2005	No change	6.50	37
9 December 2004	No change	6.50	36
28 October 2004	+0.25	6.50	35
9 September 2004	+0.25	6.25	34
29 July 2004	+0.25	6.00	33
10 June 2004	+0.25	5.75	32
29 April 2004	+0.25	5.50	31
11 March 2004	No change	5.25	30
29 January 2004	+0.25	5.25	29
4 December 2003	No change	5.00	28
23 October 2003	No change	5.00	27
4 September 2003	No change	5.00	26
24 July 2003	-0.25	5.00	25
5 June 2003	-0.25	5.25	24
24 April 2003	-0.25	5.50	23
6 March 2003	No change	5.75	22

23 January 2003	No change	5.75	21
20 November 2002	No change	5.75	20
2 October 2002	No change	5.75	19
14 August 2002	No change	5.75	18
3 July 2002	+0.25	5.75	17
15 May 2002	+0.25	5.50	16
17 April 2002	+0.25	5.25	15
20 March 2002 **s3 sample starts**	+0.25	5.00	14
23 January 2002	No change	4.75	13
14 November 2001 **s2 sample starts**	-0.50	4.75	12
3 October 2001	No change	5.25	11
19 September 2001	-0.50	5.25	10
15 August 2001	No change	5.75	9
4 July 2001	No change	5.75	8
16 May 2001	-0.25	5.75	7
19 April 2001	-0.25	6.00	6
14 March 2001	-0.25	6.25	5

24 January 2001	No change	6.50	4
6 December 2000	No change	6.50	3
4 October 2000	No change	6.50	2
16 August 2000	No change	6.50	1

FIGURE A1 - Monetary Policy Surprises in New Zealand

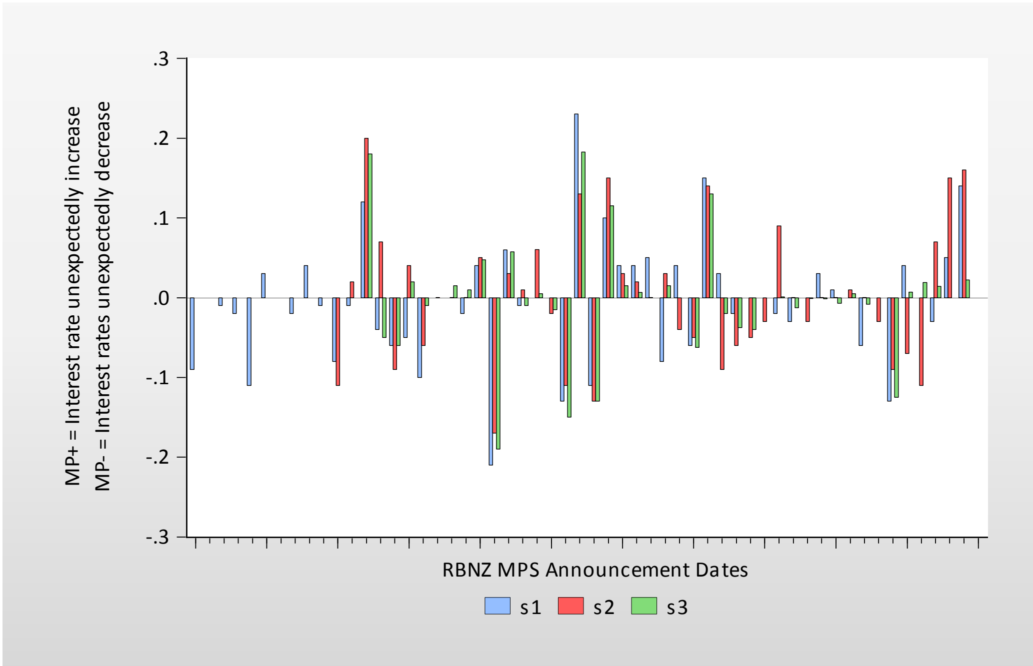


Table 6a_i The Impact of the Forward Interest Rate Track on the AUD-NZD Exchange Rate: Asymmetric Responses

Variables	MP_t^1			MP_t^2			MP_t^3		
Window	30 minutes								
MP_t^u +	0.002 (0.001)	0.026 (0.023)	0.027 (0.021)	-0.004 (0.019)	0.003 (0.025)	0.007 (0.027)	-0.008 (0.025)	-0.005 (0.026)	-0.004 (0.029)
MP_t^u -	0.047*** (0.017)	0.039** (0.016)	0.036** (0.016)	0.039* (0.022)	0.022 (0.022)	0.002 (0.025)	0.082*** (0.017)	0.076*** (0.023)	0.074*** (0.025)
fs9m		0.003 (0.016)			0.005 (0.003)			0.001 (0.003)	
fs12m			0.003 (0.002)			0.004 (0.013)			0.001 (0.002)
$\bar{R}^2$	0.32	0.26	0.35	0.11	0.17	0.06	0.42	0.31	0.32
Window	60 minutes								
MP_t^u +	0.002 (0.019)	0.029 (0.020)	0.031* (0.018)	-0.008 (0.018)	-0.001 (0.002)	0.004 (0.024)	-0.011 (0.023)	-0.009 (0.025)	-0.008 (0.028)
MP_t^u -	0.058*** (0.016)	0.050*** (0.015)	0.046*** (0.013)	0.045* (0.024)	0.031 (0.025)	0.021 (0.789)	-0.088** (0.018)	0.083*** (0.024)	0.083*** (0.028)
fs9m		0.003 (0.002)			0.004 (0.003)			0.001 (0.003)	
fs12m			0.003 (0.002)			0.005 (0.003)			0.0008 (0.003)
$\bar{R}^2$	0.37	0.39	0.39	0.12	0.17	0.20	0.42	0.41	0.41
Window	1 day								
MP_t^u +	0.009 (0.029)	0.029 (0.031)	0.032 (0.002)	-0.012 (0.024)	-0.004 (0.034)	0.012 (0.030)	-0.007 (0.002)	-0.009 (0.036)	-0.005 (0.036)
MP_t^u -	0.042 (0.027)	0.032 (0.029)	0.026 (0.028)	0.042 (0.028)	0.033 (0.034)	0.016 (0.031)	0.069*** (0.020)	-0.074** (0.030)	0.068** (0.031)
fs9m		0.003 (0.003)						-0.0005 (0.004)	
fs12m			0.003 (0.003)		0.002 (0.003)	0.005 (0.003)			0.001 (0.004)
$\bar{R}^2$	0.05	0.07	0.20	0.02	0.07	0.01	0.12	0.22	0.22

Table 6a_ii The Impact of the Forward Interest Rate Track on the USD-NZD Exchange Rate: Asymmetric Responses

Variables	MP_t^1			MP_t^2			MP_t^3		
Window	30 minutes								
MP_t^u +	0.026 (0.025)	0.028 (0.030)	0.030 (0.028)	-0.013 (0.023)	-0.013 (0.034)	-0.010 (0.035)	-0.007 (0.031)	--0.017 (0.034)	-0.016 (0.038)
MP_t^u -	0.049** (0.021)	0.043** (0.021)	0.039* (0.021)	0.085*** (0.026)	0.044 (0.034)	0.039 (0.036)	0.089*** (0.028)	0.088** (0.033)	0.086** (0.035)
fs9m		0.003 (0.002)			0.003 (0.003)			-0.001 (0.004)	
fs12m			0.002 (0.002)			0.003 (0.003)			0.0002 (0.004)
$\overline{R}^2$	0.29	0.28	0.29	0.29	0.17	0.18	0.30	0.36	0.36
Window	60 minutes								
MP_t^u +	0.025 (0.002)	0.035 (0.025)	0.036 (0.023)	-0.023 (0.020)	-0.022 (0.030)	-0.019 (0.031)	-0.024 (0.026)	-0.023 (0.031)	-0.024 (0.035)
MP_t^u -	0.066** (0.026)	0.054** (0.024)	0.050** (0.024)	0.111*** (0.029)	0.064 (0.038)	0.057 (0.040)	-0.110* (0.032)	0.108** (0.040)	0.109** (0.043)
fs9m		0.004*** (0.002)			0.003 (0.004)			0.0004 (0.004)	
fs12m			0.004 (0.002)			0.057 (0.040)			0.0001 (0.004)
$\overline{R}^2$	0.30	0.33	0.33	0.37	0.22	0.23	0.41	0.40	0.40
Window	1 day								
MP_t^u +	0.045** (0.022)	0.055** (0.026)	0.058** (0.023)	0.011 (0.024)	0.014 (0.037)	0.020 (0.004)	0.014 (0.027)	0.006 (0.036)	0.008 (0.040)
MP_t^u -	0.051 (0.041)	0.047 (0.041)	0.042 (0.041)	0.064 (0.048)	0.059 (0.052)	0.050 (0.055)	0.107** (0.044)	0.118*** (0.059)	0.014** (0.055)
fs9m		0.001 (0.004)						-0.0003 (0.005)	
fs12m			0.002 (0.002)		0.002 (0.005)	0.002 (0.004)			-0.002 (0.005)
$\overline{R}^2$	0.23	0.23	0.23	0.16	0.15	0.16	0.32	0.32	0.32