RESERVE BANK
OF NEW ZEALAND

DP2008/02

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January 2008

JEL classification: E43, E44, E52

www.rbnz.govt.nz/research/discusspapers/

Discussion Paper Series

ISSN 1177-7567

DP2008/02

Explaining Movements in the NZ Dollar: Central Bank Communication and the Surprise Element in Monetary Policy?*

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Abstract

We conduct a high frequency event analysis to estimate the effects of monetary policy surprises, data surprises, and central bank verbal statements on the New Zealand-US dollar and the New Zealand-Australian dollar exchange rates. We find data surprises and monetary policy surprises have significant and large effects on exchange rate movements. More importantly, RBNZ interest rate decisions have a largely permanent impact on the exchange rate. Significantly, the impact of the published interest rate track seems to explain some 10 per cent additional variation in the exchange rate.

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* The views expressed in this paper are those of the author(s) and do not necessarily reflect the views of the Reserve Bank of New Zealand. We would like to thank David Drage, Aaron Drew, Andrew Coleman, Anne Mahon, Clinton Watkins, Katrin Ullrich, Petra Geraats, the participants at the Optimal Monetary Policy and Central Bank Communications conference in May 2007, and the Reserve Bank of New Zealand.

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ISSN 1177-7567

1 Introduction

On July 26th, 2007 the Reserve Bank of New Zealand (RBNZ) increased the official cash rate (OCR), the principal instrument of monetary policy, by 25 basis points, a move that was believed to have been broadly anticipated by financial markets. Nevertheless, the New Zealand dollar depreciated by the end of the day by just under half a per cent against the Australian and US dollars. Assuming there was a surprise element in the move, what was newsworthy in the RBNZ's announcement is not entirely clear. However, the following sentence found at the end of the RBNZ's statement explaining its decision may well have been a possible source of the movement in the exchange rate: " *... 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 wording of the RBNZ's statement may well have influenced market expectations beyond the information contained in the OCR announcement. A number of interesting questions with direct policy relevance are inspired by such events. For example, do interest rate actions by a central bank speak louder than other types of statements or communication activities? (e.g., see the survey by Blinder et. al., 2007) What are the effects of central bank surprises on exchange rate movements, and does the manner in which the surprise is transmitted to markets matter for the exchange rate?

This paper seeks to provide some answers to these questions. For the purposes of this study, we have constructed a dataset with several unique characteristics. The New Zealand experience holds particular interest since, among other institutional features dealing with the delivery of monetary policy, it is one of only a few central banks in the world to provide quantitative forward guidance about the future interest rate track. Moreover, given the unique role of the RBNZ's Monetary Policy Statements (hereafter MPS), which represent the focal point of the RBNZ's communication policy and where it publishes its views concerning the current and anticipated future stance of monetary policy, we are able to quantify not only the impact of surprises in monetary policy, but also whether, over time, as the RBNZ revises its stance, as a result of new information published in successive MPSs, this generates a separate source of monetary policy surprises.

The exchange rate, of course, plays a crucial role in small open economies, perhaps even more so in flexible inflation targeting (IT) regimes. Having eschewed foreign exchange intervention for well over 15 years, exchange rate developments in New Zealand first led the RBNZ to announce in 2006 that foreign exchange intervention might be used to supplement the OCR, the principal instrument of monetary policy. On June 11, 2007 the RBNZ finally did intervene to put downward pressure on a rapidly depreciating NZ dollar. Recently, Clarida and Waldman (2007)[1] report evidence to the effect that 'bad news for inflation' is 'good news' for nominal exchange rate. The reason is that this type of news convinces markets to expect the central bank to lean against an inflation surprise.They report that a 1 per cent inflation surprise in New Zealand increases the New Zealand-US dollar exchange rate by 0.7 per cent in a 10 minute window around data announcements (5 minutes before and 5 minutes after an announcement).[2] Our estimates are not only considerably larger but we also find that what, and how, the RBNZ communicates to markets moves the NZ dollar. Equally important is our finding that the release of a forward interest rate track does not add to the surprise component of monetary policy. Fears expressed by some (see Blinder et.al. 2007 for a discussion) that this type of move is an example of central banking that is too transparent are overblown.

The results of this paper can also be linked to the emerging literature on central bank communication and transparency. Nevertheless, our paper departs from the extant literature in several respects. First, as noted above, we explicitly consider the impact of the publication of the so-called interest rate forward track by the RBNZ. Second, we consider several other sources of news of both the domestic and foreign varieties. Not surprisingly, since New Zealand is a small open economy, shocks from the U.S. and Australia must also be controlled for. Third, we not only consider the NZD-USD exchange rate behavior but we also examine the impact of various surprises on the NZD-AUD exchange rate since Australia is NZ's closest and largest trade and investment partner.

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 reviews the main mechanisms used by the RBNZ to communicate monetary policy to the public and introduces the monetary policy surprises used in the paper. Section 4 outlines the empirical findings of our paper. Section 5 concludes.

[1] We became aware of their paper after the present study was prepared.

[2] A rise in the exchange rate is interpreted here as an appreciation of the currency.

2 Literature review

There is 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 focuses primarily on the effects of news releases, typically originating from the financial press, on stock returns and, at first, to a lesser extent on interest rates and exchange rates.

Recently, there has been a change in emphasis with considerably greater interest shown in exploring how asset prices also react to announcements and other forms of communication by the monetary authorities. What explains this development? Siklos and Bohl (2007) argue that there are at least three explanations. First, many central banks now rely on an overnight interest rate, or a similar instrument, to guide the general level of interest rates.[4] 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 events of 9/11), central banks do not deviate from them. Naturally, this prompts financial market participants to form their expectations at known intervals of time. Second, central banks in several countries are now more formally independent, transparent, and accountable 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). There are many benefits from a policy of clear and effective central bank communication, including the ability to help align the markets' expectations about the likely future course of monetary policy decisions with the central bank's own views of the future. 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. Central banks have dramatically increased the amount of guidance they provide to financial markets. In other words, central banks have become more 'talkative'. As a result, there is a recognition that the monetary authority can influence markets on a daily basis.

What makes the role of the central bank in influencing asset prices interesting, and

[3] Andersen, Bollerslev, Diebold, and Vega (2005), and Faust, Rogers, Wang and Wright (2007), also provide a comprehensive bibliography of the relevant literature.

[4] Almost simultaneously most central banks in the industrial world that target inflation have eschewed foreign exchange intervention.

[5] There is an extensive literature on the sources and state of transparency in central banks around the world. Siklos (2002; also see references therein) is one survey, while a more recent survey, together with new empirical evidence, can be found in van der Cruijsen and Eijffinger (2008).

relevant for policy making, is that financial market participants especially seek out information about expected future economic developments. Since financial market participants are also forward-looking, any monetary policy surprise can potentially have an 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] While there are limits to how transparent a central bank can be, and there may well be pitfalls in being too transparent (Mishkin 2004, Cukierman 2008), it is far from clear that most central banks have reached that point. Indeed, in an attempt to provide even more guidance about the current and future stance of monetary policy some central banks, such as the RBNZ, began to publish forward tracks for short-term interest rates (see section 3 below).[7] Additionally, the RBNZ publishes interest rate projections based on different scenarios about inflation pressure, and is the first central bank to have done so.[8] In the case of US or the euro area, where there is arguably less central bank transparency, at least according to some metric (e.g., Geraats and Eijffinger 2007), recent studies use interest rate futures, or forward exchange rates, to proxy forward looking sentiment in financial markets (Connoly and Kohler 2004, Rigobon and Sack 2004, Brand, Buncic, and Turunen 2006).

Having identified the stimulus behind this literature, it is worthwhile considering the questions that preoccupy present day researchers, when attempting to identify the impact on asset prices stemming from central bank actions. They are: the measurement of news effects from various sources, the estimation methodology, and the choice of sampling frequency.

A frequently used objective measure of news, or surprise, is the following:

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

where $s_{i,t}$ is the surprise component of an announcement type i, at time t, and is defined the difference between the announced value of the economic indicator in question, A, and its median expected value based on forecast or survey data

[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] The Norges Bank and the Bank of England have also followed suit.

[8] There is an ongoing debate about the benefits and risks of this kind of transparency. See, for example, Woodford (2005), Goodhart (2001, 2005), and Blinder et. al. (2007).

(E) divided by the sample standard deviation, σ_i. This standardizes the surprise thereby permitting a comparison of regression coefficients across different kinds of announcements. The resulting surprise variable can then be used to estimate a regression of the form

$$\Delta r_t = \alpha + \beta s_{i,t} + \varepsilon_t$$

where $\Delta \mathrm{r}_t$ is the return on a particular asset, $s_{i,t}$ is defined by equation (1), and ε_t is a residual that captures the unanticipated portion of monetary policy (e.g., see Kuttner 2001, Bernanke and Kuttner 2005, and references therein).

Governments and private institutions release a considerable amount of data at regular intervals. The number of data announcements can be large as in the US, where there are at least 83 data related announcements. However, there appears to be no systematic way of selecting one type of news announcement over another.[9] For example, Ramchader, Simpson, and Chaudhry (2005) use 23 separate releases in US macroeconomic indicators, while Connolly and Kohler (2004) rely on only 12 such announcements. Nevertheless, the extant literature, at least for the US, has clearly identified a few announcements (e.g., non-farm payrolls in the U.S.; e.g., see Faust et.al. 2007) as consistently having a significant impact on asset prices. In the case of New Zealand, there are relatively few data releases. Additionally, for some key indicators, such as capacity utilization, there are no available data for market expectations. An important complication for a small open economy such as New Zealand, is that the potential effects of both domestic and foreign surprises (viz., from the U.S. and Australia) are also likely be relevant influences on domestic asset prices.

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 (Szebestyen 2005, Andersson 2007). Nevertheless, there have been promising efforts so far, with most studies suggesting that ‘verbal interventions’ do move markets (e.g., Ehrmann and Fratzscher 2003). However, a difficulty with interpretations of verbal announcements is that statements by central

[9] There exist, of course, techniques that effectively reduce the number of announcements, such as principal components analysis. See, for example, Siklos and Bohl (2007).

bankers may obscure the monetary authority's likely course of action, or mask the inherent uncertainty about the future course of monetary policy.[10] Yet, there is also widespread acceptance of the notion that what the central bank communicates, and how, affects financial markets. This is especially true of inflation targeting central banks whose credibility depends on meeting statutory inflation objectives. Moreover, since most such central banks conduct policy in small open economies, there is added emphasis on communicating anticipated economic outcomes that are partly dependent on the current stance of policy.

Often, the literature relies on univariate time series regressions. Following Engle (1982), a related literature has also developed which argues that unexpected events can also influence the conditional volatility of asset prices, not just their levels. In this context, researchers have relied on conditional volatility models such as GARCH(1,1) or EGARCH(1,1) specifications, except at very high frequencies where the conditional volatility approach is not suitable and measures of realized volatility work better (Andersson 2007, Andersen, Bollerslev, Christoffersen, and Diebold 2005). Other studies also recognize the problem of endogeneity. Asset markets for different asset prices are linked, and returns are possibly jointly determined. More recently, event type studies have proved popular (Gürkaynak 2005) because they lead to a natural focus on known, and fixed, future announcement dates of central bank actions, a feature that is part and parcel of how many central banks now implement monetary policy.

As noted above, one of the biggest challenges is identifying asset price reactions to market news versus central bank announcements. Rigobon and Sack (2003) use the heteroskedasticity found in interest rates and stock market returns to identify the reaction of monetary policy to the stock market. They posit that the responsiveness of monetary policy will become a stronger determinant of the covariance between interest rates and stock market returns during periods when equity market shocks are more volatile. Gürkaynak, Sack, and Swanson (2005a) investigate the issue from a different angle. For example, in the FOMC announcement on 28 January 2004, there was no change in the Fed policy rate. Treating the monetary policy action as a 0 basis points change, and not a surprise, omits the potential impact the Fed can have on expectations of future policy actions following the release of the Fed's explanation for its most recent decision. They investigate

[10] This is the principle of 'constructive ambiguity' associated with Alan Greenspan's strategy of communicating the conduct of U.S. monetary policy in public.

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", a hypothesis that is eventually 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 Piazessi (2002), Rigobon and Sack (2003), Ellingsen and Söderstrom (2003), and Bernanke and Kuttner (2005), to name just a few. Gürkaynak et al (2005a, 2005b) argue that central bank communication can account for more than three-fourths of the variation in movements of five and ten year Treasury yields around FOMC meetings. Accordingly, they are unable reject the hypothesis that a second factor exists, namely the response to what the Fed says it might do in future. Brand, Buncic, and Turunen (2006) apply the same technique to investigate euro area data, pointing out the necessity of adding a third factor stemming from the delay between the ECB's interest rate announcement and the ECB's President's news conference which begins shortly after the rate announcement is made.

Finally, there is the crucial matter of sampling frequency. Some researchers have reported that news events dissipate within a matter of hours (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. The foregoing considerations also suggest that a natural estimation procedure ought to be the event study approach, since the technique appears to be best suited to identify the phenomenon of interest, namely how asset prices react to a surprise announcement. Recent findings of Gürkaynak et al (2005a, 2005b), who use three different windows of 30 minutes, 1 hour, and daily, support this conclusion.

Ehrmann and Fratzscher (2004a, 2004b) counter that intra-daily data contain over-reactions of the markets, and they defend the use of daily data. Not all market participants necessarily react within a few hours. For example, they may wait for a day or so to determine whether the surprise reflects a permanent or a transitory change in policies. There is also a presumption that markets react to the same news at the same time. The news transmitted to different markets may be met with delays. Central banks communicate not only to financial markets but to the public more generally. Moreover, with intra-daily data, one needs to define a window, and the results may be sensitive to the chosen discrete time interval. Indeed, precisely because there may be both transitory and a permanent impact from central bank interest rate announcements, advocates of intra-daily data have devised new strategies to overcome some of the criticisms levelled at very high frequency data analysis. There are also other known biases in intra-daily data due to non-synchronous trading activities (Andersen, Bollerslev, Diebold, and Labys 2001; MacKinlay 1997). Another apparent explanation for some of the contradictory findings between daily and intra-daily data, not considered in this paper, originates from the omission of potentially crucial information from order flows. Evans and Lyons (2003, 2005), and Andersen and Bollerslev (1998), have argued that trading volume represents an important explanatory variable for asset price movements.[11] In any event, it is clear that both time series and event study approaches have improved our understanding of the impact of central bank communication on asset price movements.

2.1 Monetary Policy Surprises and Asset Prices

The surprise element of monetary policy can be calculated from a few sources. One can simply look at the change in 90 day interest rates around policy announcements, as in Gürkaynak et al (2005, 2005b). A surprise can also be derived from the change in the futures contract's price relative to the day prior to the policy action. Kuttner (2001) proposes the use of the futures markets data to gauge the unanticipated component of monetary policy, and his approach has been frequently adopted. For the US, data for fed funds futures are used and have been found to have good predictive properties for the realized fed funds rate (Krueger and Kuttner 1996, Gürkaynak 2005, and Hamilton 2007). In New Zealand, one can use the futures of 90 day bank bills, or Overnight Indexed Swaps (hereafter OIS; Choy 2003, Gordon and Krippner 2004).[12] Both are used in the empirical evidence presented below. Finally, there is the Reuters survey of market participants on the likely future course of the policy rate.

Recently, the literature has adopted several approaches to extract information contained in monetary policy announcements. For example, Gürkaynak et al (2005), and Brand, Buncic and Turunen (2006), employ a recursive type approach to extract the size of the response to news. Assume that the relevant time window is 10

[11] Additionally, there is the problem that intra-daily data appear not to be a martingale while difference stationarity characterizes data sampled at the daily frequency.

[12] 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 proven useful to the RBNZ as a means of deriving market expectations about the OCR. See Choy (2003).

minutes (Δf_t^{10}), that is, the length of time over which the implied forward rate is calculated, and define the reaction of the market to a central bank interest rate setting decision as taking place over a 30 minute period (Δf_t^{30}). Hence, we can write

$$\Delta f_t^{10} = \lambda_0 + \lambda_1 \Delta f_t^{30} + resid_t \tag{2}$$

Equation (3) indicates 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. The residuals in this regression (*resid*) are assumed then to represent changes in market expectations about the future path of interest rates and is referred to as the 'path' factor.[13] In a second stage, equation (2) 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 the interest rate and, as pointed out by Gürkaynak (2005), the hypothesized restrictions need not be unique.[14] In what follows, we essentially adopt the estimation strategy of Gürkaynak (2005), not only to facilitate comparisons with the existing literature, but because this approach also permits us to use a unique dataset permitting the decomposition of the sources of surprises to the NZ dollar exchange rate.

A separate debate has raged over concerns about whether the impact of central bank communication of the more verbal variety can be quantified and how. For example, a simple quantifiable measure of central bank communication might be errors in central bank inflation forecasts. In New Zealand, there is the added information that can be quantified from the release of the future interest rate track. Alternatively, an extensive literature has created dummy variables representing subjective assessments of various central bank releases (e.g., inflation or monetary policy reports, news releases around overnight rate decisions). Researchers read these releases and interpret them for signs of an expected tightening or softening of monetary policy. In another variant, students might be asked to read the same releases, and base their interpretations on an overall assessment of others' interpretations of what the central bank is trying to communicate regarding the future outlook for the economy. In still another attempt to extract information from central bank statements and publications, documents are scanned for keywords (e.g.,

[13] In the case of the ECB considered by Brand, Buncic and Turunen (2006) there is a third factor, called the timing factor, which arises because there is a gap between the announcement of the ECB policy rate and the press conference held by the President of the ECB.

[14] We are grateful to Ken Kuttner for sharing with us his comments on an earlier version of Gürkaynak *et al* (2005a).

tighter, looser, inflation risk) that might signal the central bank's views about the likely stance of future monetary policy.

Space limitations prevent an extensive discussion of the pros and cons of interpreting such news releases (see, however, Berger, de Haan and Sturm (2006), Ehrmann and Fratzcher (2004b), Blinder et.al. (2007), and references therein). Kohn and Sack (2004) find that central bank talk is most influential when commentary focuses on issues of direct concern to the central bank and, consequently, may have relevant information to convey. Siklos and Bohl (2007) also conclude that central banks deliberately convey more information at certain times about certain aspects of economic activity than at other times (e.g., inflation versus the exchange rate), and that aggregating information about the contents of central bank releases leads to an underestimate of the impact of central bank 'words' on asset prices.

3 Monetary Policy Communication at the RBNZ and Monetary Policy Surprises

The RBNZ communicates its monetary policy function with the public through the following activities:

- Monetary Policy Statements (MPS) and Interim OCR reviews
- Speeches by the Governor and members of the senior management
- Finance and Expenditure Select Committee testimonies
- Press releases

However, the first item has been the most important means of communications for monetary policy decisions at the RBNZ. Other means of communications such as speeches did play a very significant role when the RBNZ conducted "open mouth operations". However, the Monetary Policy Statements and the OCR reviews are the most important ones for the interest rate decisions. For this reason, we only focus on the forms of communications that are associated with interest rate decisions. We briefly describe this form of communication below.

3.1 Monetary Policy Statements and Interim OCR Reviews

There are eight official cash rate (OCR) reviews a year: four of them are accompanied by a Monetary Policy Statement (a detailed discussion on the state of the economy) while the remaining four are accompanied by a short statement, usually one page long. MPSs are published at 9.00 am New Zealand time (3.00*pm* the previous day in the Eastern U.S. time zone). The dates when these statements are released can be found at: `http://www.rbnz.govt.nz/monpol/statements/0090630.html`.

The MPS is, arguably, the most important communication device used by the RBNZ. Each issue is an in depth analysis of the state of the economy, and contains forecasts for a wide variety of economic time series. While considerable attention is devoted to inflation, exchange rate, and economic growth forecasts, there is also considerable interest in the RBNZ's publication of alternative scenarios for 90-day interest rates, conditional of different expectations paths for future inflation, that is, a forward track for interest rate movements. Every OCR decision is accompanied by a one page press release, while MPS releases are also accompanied by the data set used in preparing the MPS. All of these documents and announcements are released at the same time as are the interest rate decisions by the RBNZ.

The RBNZ began using the overnight lending rate as the instrument in March 1999. Prior to that date the RBNZ had a 'settlement cash' which served the role of the policy instrument. Interestingly, when the RBNZ relied on the settlement cash as its instrument, it was only changed twice. Instead, the RBNZ issued statements, since referred to as 'open mouth operations' that were deemed effective (Archer 2005, Guthrie and Wright 2000) but led to considerable volatility in overnight interest rate movements. Table 1 provides some information about the frequency of monetary policy announcement events since 2000. The resulting announcements lead to 55 events that will be the subject of the empirical analysis to follow.

3.2 Monetary Policy Surprises

As previously noted, there are several ways to calculate the surprise component of monetary policy actions. Kuttner (2001), Bernanke and Kuttner (2005), and Gürkaynak et al (2005a, 2005b) use fed funds futures to calculate the surprise components of the monetary policy actions (also see Gürkanak 2005). In New Zealand, one can use 90 day bank bill futures to calculate the surprise components. This instrument is not directly comparable to fed funds futures, since the 90 day bank bill rate is not the actual policy rate (i.e., the OCR). However, it is widely agreed that bank bills represent the instrument which the OCR aims to influence. First, second, third, and fourth contracts for the 90 day bank bill futures can be used to calculate different components of the surprise in a manner described in Gürkaynak (2005). We provide a brief methodological explanation below. Alternatively, Overnight Indexed Swaps (OIS) can also be used to calculate the surprise components of monetary policy. 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 this committee. Since the survey may well impact the Governor's decision we also use the relevant survey data to construct a surprise series.[15]

Table 1 below summarises the surprises measures used in this study, and the number of events considered in the empirical exercise that follows:

[15] The Governor of the RBNZ is statutorily the only individual accountable for OCR decisions. However, a committee exists that gives advice to the Governor. The Bank of Canada, for example, also relies on a similar arrangement while, of course, the committee structure has an explicit legal function at the Bank of England, for example, and also at the U.S. Federal Reserve.

Table 1 Policy Events and Measures of Monetary Policy Surprises

Measure	First observation	No of observations	Label
Change in 1st contract of the 90 day bank bill futures	16 Aug 2000	55	s1
Weighted market expectations by Reuters	14 November 2001	48	s2
Change in Overnight Indexed Swaps	20 March 2002	43	s3

Table 2 below provides descriptive statistics for the three different surprise measures defined above. The summary statistics are comparable. Nevertheless, the correlation coefficients between them, while high, vary from a low of 0.72 to a high of 0.87.

Table 2 Surprise Measures, Descriptive Statistics

	s1	s2	s3
Mean	-0.005	0.003	-0.001
Maximum	0.23	0.20	0.19
Minimum	-0.21	-0.17	-0.19
Std. Dev.	0.073	0.08	0.072
Pairwise	Correlation Matrix		
	s1	s2	s3
s1	1		
s2	0.72	1	
s3	0.87	0.78	1
Obs	55	45	43

Note: s1, s2 and s3 are the types of surprises constructed from bank bills, the Reuters survey, and OIS. The text provides additional details.

Certain features of the calculations reported in Table 2 are worthy of discussion. One arises because of the possibility of a term premium. As in the extant literature (Kuttner 2001, Bernanke and Kuttner 2005, Gürkaynak et al 2005a, 2005b, Gürkaynak 2005), while the term premium can, in principle, exist and 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. Piazessi and Swanson (2008), for example, show that one day changes in the fed fund futures around the FOMC announcements are very small. As a result, defining a relatively narrow window around 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). A second feature of the sample arises from the fact that, during the first two thirds of the period covered in the empirical analysis that follows, there was a worldwide decline in long rates. This too can be problematic since it is unclear 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 kind of trends would be negligible.

4 Empirical Results

4.1 Responses to Monetary Policy Surprises

We begin with the following regression similar to Kuttner (2001), Bernanke and Kuttner (2005), and Gürkaynak et al (2005a,b):

$$\Delta E_t = \alpha + \beta MP_t^u + \varepsilon_t \tag{3}$$

where ΔE_t is the rate of change in the nominal exchange rate defined as the foreign currency price of the New Zealand dollar, collected at various intervals, and MP_t^u represents a vector of monetary policy surprises. Consequently, a negative value ΔE_t represents a depreciation of the NZ currency. It is important to keep in mind that the USD-NZD will also be influenced by announcements abroad, especially from the U.S. and Australia. Most of the major U.S. macroeconomic data are released at 8.30 am Eastern time in the US (viz., the Consumer Price Index, Gross Domestic Product, Housing starts, Jobless claims, Nonfarm payrolls, Producer Price Index, Retail Sales, Trade balance, unemployment rate). Industrial Production is announced at 9.15 am Eastern time. All these data announcements correspond to early morning the following day in New Zealand. Hence, by the time an OCR announcement is made, it is unlikely that this type of news would further impact the exchange rate. The FOMC releases its announcements at 2.15 pm Eastern time and, depending on the time of the year, this corresponds either to 6.15 am, 7.15 am or 8.15 am the next day local New Zealand time. New Zealand markets open at 8.00 am local time, and RBNZ announcements are at 9.00 am local time in New Zealand. Since our window calculations begin at 8.50 am New Zealand time, we can safely assume the markets to react to the US news within 35 to 50 minutes from the release of news (50 minutes for data releases, and between 35 to 50 minutes for FOMC announcements, depending of the time of the year). Therefore, we do control for US monetary policy surprises that take place 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 part of the FOMC decisions.[16]

New Zealand data releases also pose a problem on five occasions when the monthly Trade Balance data 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 10.45 am local time in New Zealand. Hence, they do not coincide with the 30 and 60 minute windows in our regressions. However, the simultaneous release of these data need to be controlled for in the implementation of equation (3) when daily data are used.

A limitation of the data set is that we do not have tick by tick intraday data prior to April 2001. However, hourly data at ten minutes past every hour are available. In order to increase the sample size, we utilise the hourly data as well. For a 30

[16] We are greatful to Ken Kuttner for providing us with the U.S. fed funds surprises. See Bernanke and Kuttner (2005).

minute window, we use the window of between 8.10 am (instead of 8.50 am) and 9.10 am (instead of 9.20 am) local time in New Zealand. For the 60 minute window, we define the window as beginning at 8.10 am (instead of 8.50 am) to 10.10 am (instead of 9.50 am), again local New Zealand time. We report the results with these additional observations. However, excluding the resulting 5 additional observations did not change our results in any significant fashion. Finally, on one occasion (March 2002), Statistics New Zealand published the GDP release on its website well before the normal announcement time of 10.45 am New Zealand time.[17] We also exclude from our data the OCR announcement following the September 11 terrorist attacks on the US, as this was not a scheduled announcement by the RBNZ.

Table 3 below shows the results of the estimation of equation (4) for the three different surprise measures defined earlier for both the US dollar-New Zealand (USD-NZD) and the Australian-New Zealand (AUD-NZD) exchange rates. Estimates of the constant are omitted from the table, as they are insignificant and are economically uninteresting. Slope coefficients are highly significant for bank bills futures and the OIS, that is, surprise measures 1 and 3 respectively, and are all positive, which implies that the NZ currency appreciates in the face of a positive monetary policy shock. If the latter is interpreted as 'bad news' about inflation, this translates into 'good news' for the exchange rate. For example, a 100 basis points of unanticipated monetary policy results in an appreciation of the AUD of 3.3 per cent in a 30 minute window. A similar size surprise has an even larger impact on the USD, at 4.1 per cent for the same window. The differences between the USD and AUD based estimates are not, however, statistically significant. Notably, the surprise measure based on the Reuters survey (s2) is not significant in any of the NZD-AUD regressions and are only significant at either the 5 or 10 per cent levels in some of the NZD-USD regressions. Because Reuters in New Zealand does not survey market participants on a regular basis, the lags between a particular survey and the actual decision can, at times, be up to 2 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 one day.

[17] 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.

The results in Table 3 highlights two important implications. First, that monetary policy surprises have large effects on the exchange rate. Second, more precise estimates of the impact of monetary policy surprises are obtained from intra-day analysis. Notice from Table 3 that the standard errors are roughly 40 percent larger when equation (4) is estimated using daily data and this is, of course, also reflected in the R^2 estimates.

Table 3 Nominal Exchange Rate Response to Monetary Policy Surprises

	AUD			USD		
	s1	s2	s3	s1	s2	s3
		30 Mins			30 Mins	
β	0.033***	0.013	0.032***	0.041***	0.021**	0.039***
	(0.006)	(0.008)	(0.009)	(0.008)	(0.010)	(0.010)
Obs	55	45	43	55	45	43
R^2	0.37	0.06	0.25	0.42	0.13	0.30
		60 Mins			60 Mins	
β	0.036***	0.012	0.032***	0.044***	0.020*	0.041***
	(0.008)	(0.009)	(0.010)	(0.010)	(0.011)	(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***	0.013	0.035***	0.038***	0.021*	0.043***
	(0.010)	(0.010)	(0.013)	(0.012)	(0.012)	(0.015)
Obs	55	45	43	55	45	43
R^2	0.23	0.04	0.17	0.19	0.07	0.19

Notes: Estimates of β in equation (4), using least squares with White corrected standard errors. *** signifies statistically significant at the 1% level, ** at the 5% and * at the 10% levels. s1, s2, and s3 are defined in Table 1.

4.2 Decomposition of surprises into Timing and Level Effects

The results of the previous section assume that monetary policy surprises have a single dimension, namely as a surprise associated with the current setting of policy. This, of course, is the traditional definition of a surprise. In the US literature cited earlier, these surprises are evaluated from the first contract of the fed fund futures, and, in our study, using the first contract for bank bill futures, or the one month OIS. Some authors have resorted to using longer dated securities (e.g., Rigobon and Sack 2003, 2004), or the change in the third contract for fed fund futures (Bernanke and Kuttner 2005), in order to isolate the permanent component of surprises.

Because central banks are known to sometimes act gradually, there is some uncertainty about whether a necessary tightening or loosening of policy will be carried out immediately, at some future meeting, or even gradually through time. If, say, a 50bp rise in the OCR is expected either at the next meeting, or the one after that, the actual surprise element will depend on when the central bank actually moves (and, of course, by how much). If the move is made at the next meeting, there is no surprise left for the second meeting. Hence, the maturity date of a futures contract will influence the extent to which anticipated interest rate changes will translate into a permanent effect on the exchange rate. This is because, if agents attach equal probability to a tightening move over two periods, the expected move is 25 bp for each of the next two meetings. In other words, the uncertain timing of a surprise implies that these may, in fact, incorporate transitory and permanent components.

We refer to the permanent versus transitory distinction as level (or path) and timing effects, respectively. A surprise in the timing of a policy decision is one that leaves expected OCR unchanged after the current decision. In what follows we rely only on bank bill futures and the OIS (s1 and s3)[18].

To fix ideas, suppose that the contract that expires around the time of the next OCR decision yields a surprise labelled MP_t^1. Therefore, if we assume that there are no further expectations of an interest rate change, this effectively means that the surprise has shifted expectations permanently so that

$$MP_t^1 = level_t \tag{4}$$

Consequently, the surprise component of the current OCR decision contains both a temporary component, related to the timing of changes in the OCR over time, and the level shift described in equation (4). We can then write

$$MP_t^u = \alpha_1 level_t + timing_t \tag{5}$$

[18] Based on the earlier evidence we do not consider further the Reuters survey-based surprise measure.

where MP_t^u is defined in equation (3). Since equation (4) identifies the level shift, we have imposed the necessary restrictions to permit identification of the timing effect in equation (5). Therefore, instead of estimating β in equation (3) we can instead estimate

$$\Delta E_t = \alpha + \beta_1 level_t + \beta_2 timing_t \tag{6}$$

and thereby decompose the sources of changes in the exchange rate.[19]

Of course, in all of the foregoing specifications, MP_t^u is replaced by a generated regressor leading possibly to an errors in variables problem to which we return below.

Table 4 below presents the relevant results. We use the second contract for bank bill futures and the 3 month OIS for the level effect, as they both corresponds approximately to three months after the current OCR decision. There would be at least one meeting in that period, therefore there is the possibility that markets expect the interest rate to change.[20] The coefficient on the level component is not statistically different from unity, implying a parallel shift in short term expected interest rates. The level effect explains between 69 and 80 per cent of variation in surprises. Hence, the timing component is a much smaller fraction of New Zealand surprises, unlike what Gürkaynak (2005) reports for the US. This result is noteworthy as the RBNZ has regularly tried to de-emphasize the importance of the surprise element in monetary policy announcements.

Table 4 Generating the timing component of surprises

	Constant	Level	R^2
Bank Bills Futures (s1)	-0.002	0.828***	
	(0.006)	(0.076)	0.69
OIS (s3)	-0.006	0.755***	
	(0.005)	(0.057)	0.80

[19] Gürkanak (2005) also defines a ‘slope’ effect due to the pace of interest rate changes. We examine this possibility for New Zealand separately, as we shall see.

[20] Using the third contract of bank bill futures, or 9 months OIS, yielded very similar results (not shown).

Note: *** signifies statistically significant at the 1% level. Equation (14) estimated via least squares.

One obvious, problem with the foregoing estimation approach is that market prices may incorporate some idiosyncratic noise. In essence this is a kind of errors-in-variables problem, and, if significant, the regression coefficients will be biased. Moreover, even the survey based measures of monetary policy surprises that are collected just before monetary policy announcements would have this errors-in-variables problem (measurement error). Further, assuming the errors are of the 'classical measurement error' variety, they lead to biasing the estimated coefficient to zero known as attenuation bias.[21]

Table 6 below shows the responses of the exchange rate to the level and the timing of surprises. The results clearly show that the level effect dominates surprise exchange rate movements. It seems the New Zealand dollar exchange rate responds to the permanent component of monetary policy surprises. Since timing is not a factor this further suggests that the RBNZ has successfully mitigated transitory effects from monetary policy surprises. This is unlike the US case (see Gürkaynak 2005) where timing effects show up in the behavior of both interest rate futures and stock returns.

[21] This is a rather 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.

Table 5 Permanent (level) and Transitory(timing) Components of Surprises

	AUD		USD	
	Surprise1	Surprise 3	Surprise1	Surprise 3
		30 Mins		
Level	0.036***	0.035***	0.044***	0.043***
	(0.016)	(0.029)	(0.009)	(0.011)
Timing	0.009	-0.029	0.014	-0.037
	(0.007)	(0.009)	(0.019)	(0.031)
Obs	55	55	43	43
R^2	0.46	0.47	0.50	0.52
F stat	21.81	22.67	17.21	18.22
		60 Mins		
Level	0.040***	0.038***	0.049***	0.047***
	(0.016)	(0.008)	(0.010)	(0.013)
Timing	0.008	-0.041	0.009	-0.048
	(0.008)	(0.010)	(0.019)	(0.030)
Obs	55	55	43	43
R^2	0.45	0.45	0.45	0.47
F stat	20.92	21.11	14.18	14.93
		1 Day		
Level	0.045***	0.043***	0.047***	0.049***
	(0.011)	(0.012)	(0.012)	(0.014)
Timing	-0.007	-0.056	0.009	-0.048
	(0.011)	(0.012)	(0.023)	(0.041)
Obs	55	55	43	43
R^2	0.37	0.43	0.31	0.36
F stat	9.99	12.58	7.54	9.74

Note: *** signifies statistically significant at the 1% level. Equation (4) estimated via least squares. Standard errors in parenthesis. Controls for FOMC announcements included in regressions but coefficient estimates not shown. Standard errors are bootstrapped as in Gürkaynak (2005). 1000 replications were used.

4.3 Does Written communication matter?

Having established that the exchange rate responds to monetary policy surprises, we now wish to determine whether exchange rates also respond to verbal announcements from the RBNZ. We focus specifically on two forms of communication First, the language used by the RBNZ in the MPS to communicate its views about the NZ economic environment. Additionally, we also quantify the information content of the published interest rate track separately since this is not only likely to elicit relatively more attention but also because it is a rather unique feature of RBNZ communication, as noted previously.

Quantifying MPS Statements

We quantify the contents of each MPS in our sample along five different dimensions, namely commentary on output, inflation, interest rates, exchange rate developments, as well as prospects for the international economy ($comm^y$, $comm^p$, $comm^i$, $comm^e$ and $comm^{int}$ respectively). For example, when the outlook on each one of these variables is positive, we assign a value of +1, a -1 when the outlook is weaker, and 0 when the tone of the commentary is neutral. However, to conserve space, we only report regressions using $comm^i$.[22] In addition, we also seek to assign a measure of the 'bias' in any statement. The resulting variable captures the extent to which the RBNZ loosens or tightens monetary policy. If there is a tightening bias in the statement the variable takes the value of +1 whereas in the event of a loosening bias the variable takes the value of -1. When the statement is neutral the bias measure is set to zero. Finally, we add a dummy variable to account for reversals in the RBNZ's outlook over time to see whether changes in sentiment at the RBNZ over the current stance of monetary policy from one MPS to the next might also influence exchange rate changes.

The estimated regression is, therefore, written as follows:

$$\Delta E_t = \alpha + \beta MP_t^u + \sigma_0 comm_t^i + \sigma_1 Bias_t + \varepsilon_t \qquad (7)$$

where all variables were previously defined. Table 6 displays the regression results. Monetary policy surprises are statistically significant as before with largely

[22] The regressions with all other communications variables are available upon request. The conclusions reported below are unchanged.

similar coefficient estimates. The interest rate communication variable is statistically insignificant for both exchange rates and for all windows and the same holds for the bias measure. There is, however, some evidence that reversals in the RBNZ's outlook from one MPS to the next do appear to contribute to exchange rate changes although only if surprises are measured using the Reuters or OIS data. It is reasonable to assume, therefore, that, in the presence of clear and precise language about the likely future course of monetary policy, markets are surprised by changes in the outlook, rather than any bias or statement about the current interest rate outlook, or they focus on specific forms of information that are susceptible to moving the interest rate. As a result, we next consider the impact of the RBNZ's interest rate track on exchange rates.

Table 6 Responses to MPS Interest Rate Commentary

	AUD			USD		
	s1	s2	s3	s1	s2	s3
			30 Mins			
MP_t^u	0.034***	0.014	0.035***	0.043***	0.022**	0.045***
	(0.006)	(0.008)	(0.008)	(0.007)	(0.009)	(0.009)
$Comm^i$	-0.001	0.000	0.000	-0.001	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Bias	0.000	0.001	0.000	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Rev	-0.002	-0.003	-0.005*	-0.004	-0.004*	-0.007***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
R^2	0.4	0.09	0.31	0.47	0.18	0.39
			60 Min			
MP_t^u	0.035***	0.037	0.037***	0.045***	0.021**	0.048***
	(0.008)	(0.007)	(0.008)	(0.009)	(0.011)	(0.011)
$Comm^i$	0.000	-0.001	0.001	-0.001	0.000	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Bias	0.000	0.000	-0.001	0.001	0.001	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	0(.001)
Rev	-0.005	-0.003**	-0.006***	-0.003	-0.005**	-0.008***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
R^2	0.31	0.39	0.38	0.41	0.13	0.33
			1 Day			
MP_t^u	0.038***	0.015	0.041***	0.041***	0.023*	0.047***
	(0.009)	(0.010)	(0.009)	(0.012)	(0.013)	(0.015)
$Comm^i$	-0.001	0.000	0.001	0.000	0.000	0.001
	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)
Bias	0.000	0.000	-0.001	-0.001	0.000	-0.001
	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)
Rev	-0.002	-0.005*	-0.007**	-0.001	-0.003	-0.005*
	(0.004)	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)
R^2	0.25	0.07	0.26	0.21	0.08	0.22

Note: Least squares estimates of equation (8).

Forward track

Since 1994, the RBNZ has published interest rate forecasts. The forecasting process has gone through three stages since then (McCaw and Ranchhod 2002, Ranhhod 2003). Until 1997, interest rate forecasts were presented without taking into account the potential impact of changing future interest rates on key macroeconomic aggregates. During the 1997-1999 period, the RBNZ began to forecast future interest rates conditional on the impact of these rates on key variables such as inflation. Hence, these interest rate forecasts came to be called endogenous policy forecast interest rate tracks. The practice continues since the OCR became the instrument of monetary policy beginning in June 1999. Interest rates are forecasts based on several iterations or calibrations of the RBNZ's formal model of the economy, called the FPS (forecasting and policy system; www.rbnz.govt.nz/research/fps/). Perhaps most germane to the objectives of this study, assumptions about the exchange rate, as well as external forecasts of he external economic environment, represent significant inputs in the process (see McCaw and Ranchhod 2002, Figure 2).

In this section, we make use of novel data obtained from the RBNZ's published interest rate forecasts. The RBNZ publish forecasts of key variables, including the endogenous interest rate track, four times a year. Therefore, our data set contains missing values for every second observation. As a result, our sample consists only of forecasts published in successive MPSs since August 2000.[23]

We calculate the implied 90 day interest rates at 9 and 12 month horizons before the release of the MPS and take the difference between them and the RBNZ's published 90 day interest rates at same horizons. We label these variables $fs9m$ and $fs12m$. They are interpreted as the surprises on implied 90 day rates at the 9 and 12 month horizons, respectively.

We report the regression results in Tables 7a and 7b below.[24] The current surprise variable MP_t^u is significant in all regressions as before. The variables $fs9m$ and $fs12m$ are significant at 5 per cent or 1 per cent levels but only for the 30 minute

[23] We could go back to 1997 with the MPS, and the published interest rate forecasts of the RBNZ. However, then we suffer from the lack of intra-day data for the extended sample.

[24] We also generated the same variables for the 3 and 6 months ahead horizons implied 90 day interest rates. The results were statistically and economically insignificant for those variables, but identical for the current surprise variable.

window. This implies that the additional surprise generated from information in the forward track dissipates very quickly but does suggest a further appreciation in the nominal exchange rate over an above the surprise variable MP_t^u. The effect of the forward track is longer lasting in the USD-NZD exchange rate case lasting through to the 60 minute window. It is clear, however, that the information in the forward track provides additional surprises to the markets. Alternatively, it may be difficult to separately identify the information contained in the interest rate track from overall monetary policy surprises. Hence, the concern that such forward tracks represent too much transparency is not borne out by the evidence. Nevertheless, the results do suggest that the form of communication matters.

Table 7a AUD responses to the interest rate track

	Surprise 1			Surprise 2			Surprise 3		
				30 Min					
MP_t^u	0.034***	0.033***	0.032***	0.014	0.012	0.011	0.028*	0.026*	0.027**
	(0.010)	(0.010)	(0.010)	(0.013)	(0.013)	(0.012)	(0.018)	(0.015)	(0.013)
fs9m		0.003			0.004**			0.003	
		(0.002)			(0.00)2			(0.002)	
fs12m			0.003			0.004**			0.004**
			(0.002)			(0.002)			(0.002
R^2	0.31	0.34	0.35	0.06	0.13	0.15	0.14	0.21	0.26
				60 Min					
MP_t^u	0.040***	0.040***	0.039***	0.013	0.013	0.012	0.030*	0.027**	0.029***
	(0.009)	(0.010)	(0.010)	(0.013)	(0.012)	(0.012)	(0.017)	(0.013)	(0.012)
fs9m		0.003			0.005			0.004	
		(0.002)			(0.002)			(0.002)	
fs12m			0.003			0.004			0.004
			(0.002)			(0.002)			(0.002)
R^2	0.34	0.38	0.40	0.04	0.12	0.15	0.13	0.20	0.25
				1 Day					
MP_t^u	0.025*	0.031**	0.029*	0.009	0.015	0.014	0.023	0.021	0.022
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.013)	(0.020)	(0.017)	(0.015)
fs9m		0.003			0.004			0.003	
		(0.003)			(0.003)			(0.003)	
fs12m			0.003			0.004			0.004
			(0.003)			(0.003)			(0.003)
R^2	0.11	0.17	0.20	0.02	0.08	0.11	0.06	0.10	0.14

Note: Least squares estimates of equation (7) for only MPS events (28 observations).

Table 7b USD responses to the interest rate track

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

Note: See note to Table 7a.

4.4 Macro Data Announcements

We collect six major data announcements: Consumer Price Index (CPI), Current Account(CA), Gross Domestic Product(GDP), Retail Sales (RS), Trade Balance (TB) and Unemployment Rate (U). Of course the data the markets react to would not be limited to these variables only. However, these are the main variables for which the Reuters or Bloomberg have been surveying market participants to obtain an estimate of median market expectations. We should note that the number of participants surveyed vary between 9 and 15, with a mean of around 13. Table 8 below gives more information about the release time of the data, their frequency, and date of the first available observation in our data set.

Table 8 Macro Data Announcements

Variable	Frequency	Time of the day (New Zealand time)	First observation
CPI	Quarterly	10.45 am	18 April 2001
CA	Quarterly	10.45 am	26 June 2001
GDP	Quarterly	10.45 am	29 June 2001
Retail Sales (RS)	Monthly	10.45 am	6 April 2001
Trade Balance (TB)	Monthly	10.45 am	10 April 2001
Unemployment Rate (U)	Quarterly	10.45 am	10 May 2001

Next, we estimate the following regression:

$$\Delta E_t = \alpha_0 + \alpha_1 surprise_t + \alpha_2 MP_t^u + \varepsilon_t \quad (8)$$

Table 9 shows the regression results where, in addition to the monetary policy surprise (MP$_t^u$ results not shown), each data surprise is also included in regressions.

The explanatory power of the regressions are quite high by the standards of intradaily data which suggests that macro data announcements have a very big impact on exchange rate changes in a small open economy such as New Zealand. In the case of Current Account (CA) surprises, they are between 50 and 60 per cent. The results here are also consistent with the theoretical framework put forward by Clarida and Waldman (2007), for the case of CPI surprises. They argue that one can get an idea about the credibility of monetary policy by looking at a non-monetary policy shock (inflation surprises for example), and how that surprise affects the nominal exchange rate. In the case of a CPI surprise, one would expect the nominal exchange rate to depreciate, as a shock to inflation is a permanent shock to the price level. However, they find that bad news for inflation is good news for the nominal exchange rate, a reflection of the credibility of an inflation targeting central banks. This result is confirmed by the estimates shown in Table

9.

Table 9 Exchange rate Responses to Macro Data Announcements

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

Note: Least Squares estimates of equation (7) augmented with surprises based on macro data announcements as defined in the text.

5 Conclusions

This paper considers how certain data and monetary policy surprises have influenced the New Zealand dollar since 2000. As part of the investigation of the impact of monetary policy surprises, we rely on a variable that is not published (or even internally produced) by most central banks, namely the Reserve Bank of New Zealand's forward interest rate track. In addition, we consider whether difference sources of announcements that have a bearing on the exchange rate, both of the verbal and quantitative varieties. We conclude that news does affect the exchange rate. In particular, we find that 'bad' inflation news, that is, an expectation of a rise in future inflation, is 'good' news for the exchange rate, a finding that mirrors the one reported by Clarida and Waldman (2007). More importantly perhaps, we do not conclude that the publication of an interest rate track represents central bank transparency gone too far insofar as the surprise element of such data dissipates rather quickly. Other news events, especially macro data announcements such as developments in the current account, potentially have a much larger impact on the exchange rate. We also find that the RBNZ has done a good job of minimizing the impact of surprises but that monetary policy announcements tend to have a permanent effect on the exchange rate. We take this as evidence that the RBNZ is credible. The evidence in this paper relies on an event study approach. It is conceivable that a time series approach might yield additional insights into the high frequency determinants of the exchange rate. We leave this extension to future research.

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Appendix: Measurement error

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.

$$\Delta E_t = \alpha + \beta S^{*}_{2,t} + \varepsilon_t \tag{9}$$

$$S_{2,t} = S^{*}_{2,t} + \eta_t \tag{10}$$

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. The greater the number of days, bigger the error for example. We can characterise the η as follows:

$$\eta_t = \delta D_t \zeta_t + \varphi_t \tag{11}$$

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 $cov(\varepsilon_t, \varphi_t) = 0$, $cov(D_t, \varepsilon_t) = 0$, $cov(D_t, \varphi_t) = 0$, $cov(\zeta_t, \varepsilon_t) = 0$, $cov(\zeta_t, \varphi_t) = 0$, ε_t $N(0, \sigma^2_\varepsilon)$, φ_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:

$$\Delta E_t = \alpha + \beta S_{2,t} + (\varepsilon - \beta \varphi_t - \beta \delta D_t \zeta_t) \tag{12}$$

or

$$\Delta E_t = \alpha + \beta S_{2,t} + \nu_t \tag{13}$$

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

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

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

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:

$$plim\beta = \beta(1 - \frac{\beta\delta^2\sigma_D^2\sigma_\zeta^2 + \beta\sigma_\varphi^2}{\sigma_S^2}) \quad (14)$$

Table A summarises the 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 the kind of measurement error we discussed above. The variance of the estimates get 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
$var(\hat{\beta})$	=	$\frac{\sigma_\varepsilon^2}{\Sigma S_t^2}$	$\frac{\sigma_\varepsilon^2+\sigma_\eta^2}{\Sigma S_t^2}$	$\frac{\sigma_\nu^2+\sigma_\eta^2}{\Sigma S_t^2}$
$cov(S_t, error)$	=	0	$-\beta\sigma_\nu^2$	$-\beta\delta^2\sigma_D^2\sigma_\zeta^2 - \beta\sigma_\varphi^2$
$plim\hat{\beta}$	=	β	$\beta[1 - \frac{\sigma_\varepsilon^2}{\sigma_S^2}]$	$\beta[1 - \frac{\beta\delta^2\sigma_D^2\sigma_\zeta^2+\beta\sigma_\varphi^2}{\sigma_S^2}]$