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Does the Kiwi fly when the Kangaroo jumps? The effect of Australian macroeconomic news on the New Zealand dollar*

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Abstract

We conduct an event study that examines how the New Zealand - US (NZ/US) and the Australia - US (AU/US) exchange rates responds to the release of Australian macroeconomic news including the CPI, GDP, trade balance, and monetary policy decisions. We use two different measures of the unanticipated component of the news announcements. First, we use the difference between the actual value of the data and a survey of market participants' expectations of that data announcement. Second, we use the immediate response of the AU/US exchange rate to the news announcement. Our study has three main conclusions: 1) We show that the effects of the macro news in one country can also transmit to another country via the non-bilateral exchange rate (probably in anticipation of future spill-over effects). 2) Combined with results that show that the AU/US exchange rate responds by very little to New Zealand news, the results suggest that the low variation in the New Zealand - Australia cross rate is because both currencies respond in a similar fashion to Australian (but not New Zealand) macroeconomic data.

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3) We highlight the problems associated with the events studies in which the surprises are calculated from a market price and propose a new estimator that overcomes this problem.

1 Introduction

"No man is an island, entire of itself"
John Donne (1572-1631)

On June 6, 2001, the quarter on quarter growth rate of the Australian GDP came out 0.6 percent stronger than the median market expectation. In the following 15 minutes of this announcement, the Australia - US (AU/US) exchange rate appreciated by 0.78 percent. The New Zealand - US (NZ/US) exchange rate in the same 15 minute window, appreciated by 0.34 percent.

On November 5, 2003, the Reserve Bank of Australia surprised the markets by increasing the official interest rate by 25 basis points to 5 percent. This outcome was a surprise to the markets who had priced in a 50 percent probability to this outcome (the one month bank bill yield, which can be used as a proxy for the surprise component of the decision, increased by 16 basis points following the interest rate announcement). The AU/US exchange rate appreciated by 0.7 percent in the following 15 minutes, while the NZ/US exchange rate rose by 0.31 percent in the same window. A similar surprise of 9 basis points by the July 2, 2003 decision of the Reserve Bank of Australia (a no change in policy) led to a 0.43 percent increase in the AU/US exchange rate, and to a 0.2 percent appreciation of the NZ/US exchange rate.

On April 24, 2007, the headline CPI data in Australia came out 0.5 per cent lower than median market expectation (quarter on quarter term). Following this announcement the AU/US exchange rate depreciated by 0.85 percent, while the NZ/US exchange rate depreciated by 0.4 per cent.

On March 3, 2006, the trade balance data for the Australian economy recorded a negative surprise of $1380 million (Australian dollars) compared with the market's expectations. The AU/US exchange rate depreciated by 0.32 percent following the announcement, and the NZ/US exchange rate depreciated by 0.18 per cent.

These selected examples outline the main theme of this paper: Australian specific monetary and non-monetary news (more precisely surprises) affect the AU/US and the NZ/US exchange rates in the same direction. In other words, the NZ/US (and by implication all the other New Zealand dollar cross exchange rates such as NZ/Yen, NZ/Euro) do respond to the Australian specific macroeconomic surprises in the same direction as the Australian dollar exchange rates responses, leaving the New Zealand - Australia cross

exchange rate very stable (probably one of the most stable freely floating exchange rates).

In fact a similar pattern can also be observed by a simple examination of the daily time series which reveals that the New Zealand and Australian currencies are highly correlated over short time periods. Between 1999 and 2008 for example, the correlation between the daily changes in the New Zealand trade-weighted index (TWI) and the Australian trade-weighted index was 0.66. The estimated regression between the daily change in the New Zealand TWI and the Australian TWI is $\Delta ln(S_{NZ}) = 0.60 \Delta ln(S_{AU}) + \varepsilon$, $R^2 = 0.44$.[1] Even at 15 minute intervals the correlation between the NZ/US and the AU/US exchange rates is 0.48.

This very low long term volatility of the New Zealand - Australia (NZ/AU) exchange rate can be seen by a casual eye-ball examination of the data. NZ/AU exchange rate is much less volatile than the exchange rates of either country with other currencies. For example, the NZ/AU exchange rate varied over a 21.8 percent range between January 1991 and May 2009, while the New Zealand - US (NZ/US) exchange rate varied over a 69.9 percent range and the Australia - US (AU/US) exchange rate varied over a 65.4 percent range.[2]

This kind of transmission of foreign shocks, via the non-bilateral exchange rate has, to our knowledge, never been investigated.[3] In this paper we use a high-frequency events analysis to test this kind of spill-overs by estimating the effects of Australian macroeconomic surprises on the NZ/US exchange rate. We do this by examining the response of the NZ/US dollar to the surprise component of Australian macroeconomic data announcements in a short interval immediately following the data announcement. As well as using a measure of the surprise derived directly from survey data, we develop an estimator that uses the changes in the AU/US exchange rate following the data announcement as the measure of surprise. To examine the symmetry of the trans-Tasman relationship, we also estimate whether New Zealand macroeconomic shocks affect the AU/US exchange rate.

[1] The Australian TWI is calculated at 4 pm Sydney time by the Reserve Bank of Australia, while the New Zealand TWI is calculated by the authors using the same 4 pm Australian exchange rate data and the official Reserve Bank of New Zealand formula using 2007 weights. The standard error of the slope coefficient is 0.013.

[2] These figures are calculated from the monthly average numbers that are available on the Reserve Bank of New Zealand website. The range is calculated as a fraction of the maximum value.

[3] A similar question could be asked for the Canadian dollar: Does a US specific surprise lead the Canada-Euro exchange rate to follow the US-Euro response for example?

Our results suggest that the NZ/US exchange rate responds strongly and significantly to Australian GDP and trade balance surprises, the two real Australian macroeconomic surprises we considered. However, it responds less to the nominal Australian shocks we considered, with no response to CPI shock and only a small response to monetary policy announcements. A comparison of the relative responses of the NZ/US and AU/US exchange rates to the same Australian surprises shows the NZ/US exchange rate responds half as much to a real shock as the AU/US exchange rate, and by less to a nominal shock. Thus while the New Zealand dollar appreciates against most currencies in response to positive news about the Australian dollar, it depreciates against the Australian dollar.

Our results also show the AU/US exchange rate responds to New Zealand GDP and monetary policy surprises although it does not respond at all to the CPI surprises. The AU/US exchange rate responds much less to a New Zealand announcement surprise than the NZ/US exchange rate does, so the analysis indicates that the New Zealand dollar is much more responsive to Australian news than the Australian dollar is to New Zealand news. This is not surprising given the relative sizes of the economies. Nonetheless, this means that the value of the New Zealand dollar is much more influenced by the state of the Australian economy than the Australian dollar is influenced by the state of the New Zealand economy.

The economic rationale for this kind of spill-over is very simple and intuitive. A strong Australian economy, whose share in New Zealand's trade and foreign direct investment is very large, means a stronger New Zealand economy in the near future, hence a rise in the NZ/US dollar. This boost to the New Zealand economy, could come from the traditional trade channel: A stronger Australian economy would require more of New Zealand's exports. The boost can also come from FDI, where the Australian firms may invest more in the New Zealand economy.

The remainder of the paper is structured as follows. Section 2 summarises the related literature. Section 3 outlines the econometric strategy we will be following. Section 4 describes the data. Section 5 presents the results from the estimation and section 6 concludes.

2 Related Literature

In recent years, a large literature has examined how exchange rates and interest rates respond to macroeconomic news (Andersen et al (2003) for example examine the news effects on the exchange rate, while the Gürkaynak et al 2005 examines the effects of news on the interest rates). This literature has typically shown that interest rates increase and exchange rates appreciate in response to unexpected monetary policy tightenings, stronger-than-expected news about the real economy, or positive inflation surprises.

The effects of the monetary and non-monetary surprises on exchange rate has been widely investigated. Zettelmeyer (2003) examines the response of exchange rates to interest rates using daily data. Kearns and Manners (2006) uses intra-day data for Australia, New Zealand and the UK and shows a strong influence of monetary policy on the exchange rate. They also show that the impact of monetary policy on the exchange rate depends on how the surprise affects expectations of future monetary policy.

A number of papers have examined the effects of "surprises" on domestic interest rates and other asset prices, such as the equity prices and the exchange rate. This "events analysis" literature goes back to the seminal piece by Kuttner (2001). Kuttner (2001) uses the changes in the Federal Funds Futures rate (adjusted for the number of the days left in the month) on the days of FOMC announcements. The basic idea behind this kind of measuring of the surprise or the unexpected component of the news is that in an efficient market, the market prices prior to the announcement would incorporate all the available information. Therefore, the change in the rates following the announcement must be the due to the surprise only.

Bernanke and Kuttner (2005) examined effects of the monetary policy surprises on the equity prices. By using daily data, Bernanke and Kuttner (2005) consider how the impact of the monetary policy surprises depend on the changes to the profile of future anticipated monetary policy. A related literature has attempted to consider the longer-run impact of interest rates on the exchange rate.

In addition to Kearns and Manners (2006), the response of the New Zealand dollar has also been investigated by Karagedikli and Siklos (2008), and Coleman and Karagedikli (2008) in high-frequency events analysis. Coleman and Karagedikli (2008), in particular, building on the approach in Faust et al (2007), looks at the joint (simultaneous) effects of the news on the yield curve and the spot exchange rate, hence the whole exchange rate schedule.

To examine the "surprise spill-overs", we use an events study approach. There are two advantages of this simple approach: First, it does not rely on shocks/surprises that are estimated from a model (a structrural VAR for example). In addition, the surprise measures used in events studies are the surprises to the 'market'. As Engel (2007) argues "[u]*ndoubtedly the market uses much more information in constructing forecasts than is included in [estimated models]. The "event study" approach gives us a very crisp measure of the surprise - the difference between the actual announced [data], and the expectation of that announcement."*

Our paper is closely linked to that of Craine and Martin (2008), who analysed the effects of the monetary policy spill-overs across the US and Australia on responses of security prices. They find that the US monetary policy surprises do affect the Australian interest rates and equity returns, while the Australian monetary policy surprises do not spill over to the US. Ehrmann et al (2005) find similar cross country/region spill-overs between the US and the euro area.

3 Econometric strategy

The primary purpose of this paper is to measure how the surprise component of an information announcement I_t^A released at time t in country A (say Australia) affects the exchange rate of country B (say New Zealand). Two different estimation techniques are used. The first uses a direct measure of the information surprise, typically the difference between the announced value of a macroeconomic variable such as GDP and the market expectation of this variable. While this is our favoured estimate, it may suffer from measurement error problems, as the measure of the surprise available to the econometrician may not properly capture the extent to which market participants were surprised at time t. The second estimate attempts to circumvent this problem by using the immediate response of the exchange rate in country A to the news announcement as an indirect measure of the surprise. While this indirect measure is also contaminated by measurement error, it is a different type of measurement error and an estimation strategy is developed to make adjustments for its effects.

3.1 Estimating the effects of news using direct survey measures

Denote the logarithms of the exchange rates between countries A and B and a third country (the United States) at time t as s_t^A and s_t^B respectively, and assume the response between t and $t+T$ to a news release I_t^A can be modelled as

$$\Delta_T s_t^A = \alpha_{T0}^A + \beta^A I_t^A + u_{Tt}^A \quad (1)$$
$$\Delta_T s_t^B = \alpha_{T0}^B + \beta^B I_t^A + u_{Tt}^B \quad (2)$$

The covariance matrix is

$$\Sigma_T^{AB} = \begin{pmatrix} \sigma_{AT}^2 & \sigma_{ABT} \\ \sigma_{ABT} & \sigma_{BT}^2 \end{pmatrix} \quad (3)$$

with

$$\Sigma_T^{AB} = T \begin{pmatrix} \sigma_A^2 & \sigma_{AB} \\ \sigma_{AB} & \sigma_B^2 \end{pmatrix} \quad (4)$$

if the exchange rates follow random walks.

If the size of surprise I_t^A is known, it is straightforward to estimate the effect of news on the exchange rate of either country by estimating equation 1 or equation 2 directly using ordinary least squares. If I_t^A is not accurately measured, these estimates will be biased towards zero because of attenuation bias. In practice, this is likely to be the case. For most of the macroeconomic variables under consideration, the measure of the surprise is the difference between the headline figure announced at time t and the surveyed expectations of this figure.

There are two problems with this measure of surprises. First, the expectations survey may not be accurate, possibly because the survey is not completely up to date. Secondly, the headline figure will not capture all of the information about the macroeconomic aggregate that is released at time t. For instance, a CPI announcement may contain information about the extent to which the CPI change was due to temporary rather than permanent factors, information that is not reflected in the headline figure.

3.2 Estimating the effects of news using indirect exchange rate measures

If a direct measure of I_t^A is not available, or one is concerned about measurement error, an indirect measure of I_t^A can be used: the change in country A's exchange rate with a third country in a short interval immediately following the announcement. In this case we ascertain how much country B's exchange rate responds to a news surprise that causes a 1 percent change in country's A exchange rate rather than ascertaining how much country B's exchange rate responds to the actual news, say a 1 percent GDP surprise. The coefficient of interest is therefore the relative response of the exchange rates of countries A and B to different types of news.

Consider the following ordinary least squares regression, with N_1 observations corresponding to the N_1 news announcements:

$$\Delta_T s_t^B = \gamma_{T0} + \beta_T \Delta_T s_t^A + \upsilon_{Tt} \tag{5}$$

The estimate $\hat{\beta}_T$ is

$$\hat{\beta}_T = \frac{\Sigma_t(\beta^B I_t^A + u_{Tt}^B)(\beta^A I_t^A + u_{Tt}^A)}{\Sigma_t(\beta^A I_t^A + u_{Tt}^A)^2} \tag{6}$$

which has a probability limit

$$\beta_T^p = plim(\hat{\beta}_T) = \frac{\beta^B \beta^A \sigma_I^2 + \sigma_{ABT}}{(\beta^A)^2 \sigma_I^2 + \sigma_{AT}^2} \tag{7}$$

where σ_I^2 is the variance of the news announcements. The parameter of interest is the ratio β^B/β^A.

Unfortunately, this cannot be identified from the ordinary least squares estimate of β_T because of the "background" correlation between the exchange rate innovations to equations 1 and 2. This background noise may reflect the common movement of s_t^A and s_t^B during the interval T because both exchange rates respond to news in the third country, or it may reflect a common response to other local news that affects both currencies during the interval. As the length of the interval increases, the size of this background correlation becomes large relative to the size of the response of the exchange rate to the news signal, and the simple OLS estimate of β_T increasingly reflects the background correlation rather the effect of the news. While the probability

limit of β_T approaches β^B/β^A as σ^2_{AT} and σ_{ABT} approach zero, when σ^2_{AT} and σ_{ABT} are non zero this ratio cannot be identified from β_T, even if σ^2_{AT} and σ_{ABT} are known with certainty.

A consistent estimator for the ratio β^B/β^A can be obtained by using observations for equation 5 at two different intervals of length T_1 and T_2, combined with independent estimates of the parameters σ^2_{AT} and σ_{ABT}. The latter can be easily obtained by regressing $\Delta_T s^A_t$ against $\Delta_T s^B_t$ over T_1 and T_2 minute intervals using all the available data from non-announcement dates and times.[4] Rearranging equation 6 and applying to both periods T_1 and T_2, we have

$$((\beta^A)^2\sigma^2_I + \sigma^2_{AT1})\beta^p_{T1} = (\beta^B\beta^A\sigma^2_I + \sigma_{ABT1}) \quad (8)$$
$$((\beta^A)^2\sigma^2_I + \sigma^2_{AT2})\beta^p_{T2} = (\beta^B\beta^A\sigma^2_I + \sigma_{ABT2}) \quad (9)$$

and consequently

$$\begin{aligned} \frac{\beta^B}{\beta^A} &= \frac{\beta^p_{T1}\beta^p_{T2}(\sigma^2_{AT2} - \sigma^2_{AT1}) + (\beta^p_{T2}\sigma_{ABT1} - \beta^p_{T1}\sigma_{ABT2})}{(\beta^p_{T2}\sigma^2_{AT2} - \beta^p_{T1}\sigma^2_{AT1}) + (\sigma^2_{AT1} - \sigma^2_{AT2})} \\ &= g(\beta^p_{T1}, \beta^p_{T2}, \sigma^2_{AT1}, \sigma^2_{AT2}, \sigma_{ABT1}, \sigma_{ABT2}) \end{aligned} \quad (10)$$

If the exchange rate follows a random walk, equation 10 can be expressed as

$$\begin{aligned} \frac{\beta^B}{\beta^A} &= \frac{\beta^p_{T1}\beta^p_{T2}(T_2/T_1 - 1) + (\beta^p_{T2} - T_2/T_1\beta^p_{T1})\rho_{AB1}}{(T_2/T_1\beta^p_{T2} - \beta^p_{T1}) + (1 - T_2/T_1)\rho_{AB1}} \\ &= h(\beta^p_{T1}, \beta^p_{T2}, \rho_{AB1}) \end{aligned} \quad (11)$$

where $\rho_{AB1} = \sigma_{ABT1}/\sigma^2_{AT1}$.

The functions g(.) or h(.) can be used to estimate the ratio β^B/β^A from estimates $(\hat\beta^p_{T1}, \hat\beta^p_{T2}, \hat\sigma^2_{AT1}, \hat\sigma^2_{AT2}, \hat\sigma_{ABT1}, \hat\sigma_{ABT2})$ or $(\hat\beta^p_{T1}, \hat\beta^p_{T2}, \hat\rho_{AB1})$. The asymptotic distribution of the ratio β^B/β^A can be calculated using standard non-linear theory (see Appendix 1). However, because we have relatively small samples, we also bootstrap the estimates to provide an estimate of the confidence intervals. The bootstrap was calculated by estimating the parameters $(\beta^p_{T1}, \beta^p_{T2}, \rho_{AB1})$ in the function $h(.)$ or the parameters $(\beta^p_{T1}, \beta^p_{T2}, \sigma^2_{AT1}, \sigma^2_{AT2}, \sigma_{ABT1}, \sigma_{ABT2})$ in the function $g(.)$ using repetitive samples of the N_1 values

[4] We use daily observations at 10 am and 11 am between 2001 and 2006, giving $N_2 = 2881$ observations.

of the announcement date data and the N_2 values of the background "noise" data. The confidence intervals are larger than suggested by the asymptotic distribution of the estimator, and have an extended upper tail. For small samples the standard errors are considerably bigger than the standard errors of the direct estimates. We chose the estimator based on the function $h(.)$ rather than $g(.)$ because the bootstrap estimates of the variance of $g(.)$ evaluated at the sample estimates tend to be very large, seemingly because the denominator has a term involving the difference between two small random numbers $\hat{\sigma}^2_{AT1}$ and $\hat{\sigma}^2_{AT2}$ that is often very close to zero.

The estimator we developed in this section is, at least in spirit, similar to the identification through heteroscedasticity of Rigobon (2003), Rigobon and Sack (2003), Rigobon and Sack (2004) and Rigobon and Sack (2007), as we use the information that the variances of the exchange rates are different on the days of news and non-news. An alternative way of estimating the equation 5 in a way that is closer to the '*identification through heteroscedasticity*' approach would be the following: Let Σ_A and Σ_{NA} denote the variance-covariance matrices of $(\Delta s^A_t, \Delta s^B_t)$' in windows $T1$, the 15 minute window on announcement and no-announcement days respectively. Then:

$$\Sigma_A = \begin{bmatrix} \sigma^2_I \beta^{A2} + \sigma^2_A & \sigma^2_I \beta^A \beta^B + \sigma_{AB} \\ . & \sigma^2_I \beta^{B2} + \sigma^2_B \end{bmatrix} \tag{12}$$

and

$$\Sigma_{NA} = \begin{bmatrix} \sigma^2_A & \sigma_{AB} \\ . & \sigma^2_B \end{bmatrix} \tag{13}$$

Given estimates of Σ_A and Σ_{NA}, there are six estimates that can be used to solve for six unknowns: β^A, β^B, σ^2_A, σ^2_B, σ_{AB} and σ_I. This is a just identified GMM, which can be estimated with delta method.[5]

The results of the estimates made using the direct survey measure of the news for both Australian and New Zealand macroeconomic announcements are presented in section 4.1. We favour these estimates in this paper because the standard errors are relatively small. The indirect measure is only used to measure the effect of Australian surprises and is presented in section 4.2.

[5] In fact, if we just want to identify this ratio, we do not need all 6 equations. For example, we can write $\frac{\beta^B}{\beta^A} = \frac{[\Sigma]_{22} - \sigma^2_B}{[\Sigma]_{12} - \sigma^2_{AB}}$, which is a function of four unknowns.

4 Data

The surprise measures we use are summarised in Tables 1 and 2. For the direct measures of surprises we use the difference between the actual announcement outcome and the survey measure that is collected by agencies such as Reuters or Bloomberg. For example, GDP surprise is the actual outcome of the GDP less the median market expectation of that GDP announcement. The data for Australian macro announcements were supplied to us by the Reserve Bank of Australia.[6] For Australian monetary policy surprises we use the daily change in the 30-day bank bill yield from the Reserve Bank of Australia website, recorded for the 11.00 am read. Similar data for New Zealand macroeconomic surprises were used in earlier work by Karagedikli and Siklos (2008), and Coleman and Karagedikli (2008). For New Zealand monetary policy surprises we use the 15 minute change in the 30-day bank bill yield to be consistent.[7] Table 2 provides details of the sample periods we use.

The direct survey measure of the announcement surprises may contain measurement error from one of several sources. It may arise due to the timing of the survey. If the survey was not conducted 'just' before the announcement this would induce some error. It may also arise due to the small number of market participants surveyed. Perhaps more importantly, it may also arise due to the fact that the economists surveyed are not the traders/dealers who participate in the actual market. Moreover, what the econometrician observes as the surprise, which is the headline number, may be different than what the market participants might have observe. Despite these possibilities, Andersen et al (2003) find these survey measures to be a very accurate read of the markets' expectations.

The indirect measures of surprises are the 15 minute changes or the 40 minute changes in the AU/US dollar exchange rate immediately following an Australian macroeconomic announcement. The 15 minute window starts 5 minutes before the announcement and ends 10 minutes after the announcements, while the 40 minute window starts 10 minutes before the announcement and ends 30 minutes after the announcement. The exchange rate data were obtained from the the Reserve Bank of New Zealand's market-watch database, which has 5 minute data available since April 2001.

[6] For details see Clifton and Plumb (2008), 'Economic Data Releases and the Australian Dollar', Reserve Bank of Australia Bulletin Bulletin, April.

[7] We also used the 90-day bank bill yields as a measure of monetary policy surprises and obtained very similar results.

Table 1
Descriptions of Surprise Measures

Measure	Description	For Variables
Direct measure	Actual less Bloomberg survey of market participants	GDP, CPI, TB, CA*,
Direct measure	15 minute change in 30 day Bank Bill yield	New Zealand Monetary Policy
Direct measure	One day change in 30 day Bank Bill yield	Australian Monetary Policy
Indirect Measure	15 or 40 minute change in AU-US exchange rate around the event	All

Notes: Current Account (CA) surprises are only available for New Zealand.

Table 2
Descriptions of Data

Variable	Frequency	First	Last	No of Obs
		Australia		
GDP	Q	June 2001	June 2007	25
CPI	Q	April 2001	June 2007	25
Trade Balance	M	May 2001	November 2006	68
Monetary Policy	M	April 2001	December 2006	63
		New Zealand		
GDP	Q	June 2001	December 2006	23
CPI	Q	April 2001	October 2006	23
Trade Balance	M	April 2001	November 2006	65
Monetary Policy	8 a year	April 2001	December 2006	47
Current Account	Q	June 2001	December 2006	22

5 Empirical Results

In this section we present the results using the direct and indirect measures of surprises.

5.1 Results of the direct estimation

In this section we report the results of the "direct" estimation, that is responses of the exchange rates to the "survey" measure of surprises. Equations (1) - (2) are estimated by OLS.

We report the results separately for five types of shocks in Tables 3 - 7. The top panel in each table shows the responses of the three exchange rates (AU/US, NZ/US and NZ/AU) to the Australian macroeconomic surprises. The bottom panel shows the responses of the exchange rates to the New Zealand macroeconomic surprises. For both of these surprises (the Australian and New Zealand surprises) we report the results from a 15 minute window and a 40 minute window. In addition to the estimated coefficients and their standard errors, we also report the ratio of the Australian and New Zealand coefficients.

We start with the responses to the GDP surprises in Table 3. A 1 percent positive Australian GDP surprise (i.e. actual GDP outcome being higher than the survey) causes a 0.53 percent increase in the AU/US exchange rate and a 0.27 percent increase in the NZ/US exchange rate in the 15 minute interval. These responses go up slightly in the 40 minute interval.[8] The ratios of the NZ/US exchange rate response to the AU/US exchange rate response, β^{NZ}/β^{AU}, are 0.51 and 0.50 in the respective windows. This implies that the NZ/US exchange rate responds by half as much as the AU/US exchange rate to an Australian GDP surprise. These two results mean the NZ/AU exchange rate depreciates by 0.26 percent in response to a 1 percent Australian GDP surprise. Nonetheless the small Australian weight in the Trade Weighted Index (TWI) means the New Zealand TWI appreciates in response to positive Australian GDP news.

[8] The standard errors got slightly larger in the 40 minute interval. This has been a standard finding of the high-frequency events analysis that the benefit of having short windows is the increased precision of the estimates.

Table 3
Responses to GDP Surprises

	15 Min			40 Min		
AU GDP	AU/US	NZ/US	NZ/AU	AU/US	NZ/US	NZ/AU
β	0.0053	0.0027	-0.0026	0.0058	0.0029	-0.0029
se	(0.0012**)	(0.0010**)	(0.0009**)	(0.0015**)	(0.0013)	(0.0009**)
β^{NZ}/β^{AU}	0.51			0.50		
R-sq	0.44	0.23	0.26	0.39	0.18	0.32
	15 Min			40 Min		
NZ GDP	AU/US	NZ/US	NZ/AU	AU/US	NZ/US	NZ/AU
β	0.0015	0.0052	0.0036	0.0022	0.0070	0.0048
se	(0.0006*)	(0.0015**)	(0.0015**)	(0.0007**)	(0.0020**)	(0.0017**)
β^{AU}/β^{NZ}	0.30			0.31		
R-sq	0.23	0.33	0.23	0.29	0.34	0.28

Notes: ** or * indicates statistical significance at the 1% or 5% levels.

Table 4
Responses to Trade Balance Surprises

	15 Min			40 Min		
AU TB	AU-US	NZ-US	NZ-AU	AU-US	NZ-US	NZ-AU
β	1.9645	0.9121	-1.0524	1.7052	0.9155	-0.7897
se	(0.3905**)	(0.3215**)	(0.2151**)	(0.3527**)	(0.2863**)	(0.2532**)
β^{NZ}/β^{AU}	0.46			0.54		
R-sq	0.27	0.11	0.27	0.26	0.13	0.13
	15 Min			40 Min		
NZ TB	AU-US	NZ-US	NZ-AU	AU-US	NZ-US	NZ-AU
β	0.4938	1.8589	1.9333	0.2891	2.3288	2.0397
se	(0.2160*)	(0.4407**)	(0.5600**)	(0.2916)	(0.4761**)	(0.6259**)
β^{AU}/β^{NZ}	0.27			0.12		
R-sq	0.07	0.21	0.16	0.01	0.27	0.25

Notes: ** or * indicates statistical significance at the 1% or 5% levels.

Table 5
Responses to Current Account Surprises

	15 Min			40 Min		
NZ CA	AU-US	NZ-US	NZ-AU	AU-US	NZ-US	NZ-AU
β	0.0007	0.0039	0.0031	0.0001	0.0038	0.0037
se	(0.0003*)	(0.0008**)	(0.0008**)	(0.0010)	(0.0010**)	(0.0011**)
β^{AU}/β^{NZ}	0.19			0.04		
R-sq	0.17	0.46	0.41	0.00	0.39	0.37

Notes: ** or * indicates statistical significance at the 1% or 5% levels.

The response of the AU/US exchange rate to the New Zealand GDP surprises are also significant. A 1 percent New Zealand GDP surprise causes a 0.15 percent appreciation of the AU/US exchange rate in the 15 minute window. However, the ratio, β^{AU}/β^{NZ} is only 0.30, significantly lower than the ratio β^{NZ}/β^{AU} for Australian GDP surprises. This means the NZ/AU cross-rate appreciates more to positive New Zealand GDP surprises than it depreciates to positive Australian GDP surprises.

There are two explanations for these findings about the effects of the GDP surprises on each countries' exchange rates. First, there may be a significant transmission of the shocks between the two countries, albeit more from Australia to New Zealand. For example, a stronger than expected Australian economy may be expected to lead to greater imports from New Zealand, justifying a higher exchange rate with the rest of the world. Secondly, the size of the GDP growth in one country may be a signal for the size of the GDP growth in the other country, so when a positive GDP surprise is observed in one economy the exchange rate of that country appreciates because expectations about the strength of the local economy are revised upwards. The effects of the signalling is likely to be stronger if the two economies are believed to face similar shocks and to be similarly affected.

Table 4 shows the responses to the trade balance surprises. The trade balance surprises are measured in millions of dollars in the respective currencies. A 100 million dollar positive surprise in the Australian trade balance causes the AU/US exchange rate to increase by 0.19 percent in the 15 minute window. The NZ/US exchange rate responds by almost half of the AU/US exchange rate response, 0.091 percent. Both these results are significant at 1 percent level. The results are similar in the 40 minute intervals, and the ratios β^{NZ}/β^{AU} are 0.46 and 0. 54 respectively in the 15 minute and the 40 minute windows. These ratios are very similar to the ratios for the Australian GDP

shocks. Thus the story that emerges from the trade balance responses is similar to the GDP story.

The responses of these currencies to New Zealand trade balance surprises reveal a different story. The AU/US exchange rate responses to the New Zealand trade balance surprises are much lower, with β^{AU}/β^{NZ} ratios of 0.27 and 0.12 in the 15 and 40 minute windows. However, the AU/US exchange rate response is only significant in the 15 minute window and becomes insignificant in 40 minute window. These numbers probably have reflect the relatively small importance of the bilateral trade to Australia.

The estimates of the response to current account news (which we only have for New Zealand) are similar. These results are reported in table 5. The quarterly current account surprises are measured in terms of billions of New Zealand dollars. A better than expected quarterly current account figure of one billion New Zealand dollars causes the NZ/US exchange rate to appreciate by 0.39 percent. The AU/US exchange rate response is only 19 percent of that and is significant only in the 15 minute window.

Table 6
Responses to CPI Surprises

	15 Min			40 Min		
AU CPI	AU-US	NZ-US	NZ-AU	AU-US	NZ-US	NZ-AU
β	0.0046	0.0002	-0.0044	0.0069	0.0016	-0.0053
se	(0.0012**)	(0.0006)	(0.0012**)	(0.0018**)	(0.0011)	(0.0015**)
β^{NZ}/β^{AU}	0.05			0.23		
R-sq	0.35	0.01	0.38	0.36	0.07	0.34
	15 Min			40 Min		
NZ CPI	AU-US	NZ-US	NZ-AU	AU-US	NZ-US	NZ-AU
β	0.0006	0.0052	0.0045	-0.0005	0.0057	0.0062
se	(0.0007)	(0.0018**)	(0.0020**)	(0.0017)	(0.0021**)	(0.0019**)
β^{AU}/β^{NZ}	0.12			-0.08		
R-sq	0.03	0.26	0.20	0.00	0.24	0.34

Notes: ** or * indicates statistical significance at the 1% or 5% levels.

Table 6 reports the responses to the CPI surprises. There is no cross country response in the exchange rates: the NZ/US exchange rate does not respond to Australian CPI surprises, and the AU/US exchange rate does not respond to New Zealand CPI surprises. However, each currency responds to its own

country surprises in almost identical ways. The estimated responses indicate the exchange rates change by 0.5 percent to a 1 percent domestic CPI surprise.

Finally, table 7 reports the responses to the monetary policy surprises. These surprises are measured by the change in the 30 day bank bill yield in both countries, in basis points. The idea is that in efficient markets the participants must have priced in all the interest rate changes they expect from the central bank. Therefore any movement in a short term interest rate like the 30-day bill rate following the interest rate announcement must reflect the surprise element of the decision (Kuttner (2001), Bernanke and Kuttner (2005), Gürkaynak et al (2005)). For New Zealand shocks we use the change in this yield over a 15 minute window. In the case of Australia we use the daily changes in the 30-day bank bill yield, due to the unavailability of intra-day short-term interest rate data. The use of the daily data may be inducing some classical "errors in variables" attenuation bias into the estimates. Therefore we think the NZ/US exchange rate responses to these Australian monetary policy surprises is biased towards zero.[9]

A 100 basis points surprise in the monetary policy stance in Australia causes the AU/US exchange rate to appreciate by 2.3 per cent and the NZ/US exchange rate to appreciate by 0.75 percent. The responses of the NZ/US exchange rate is statistically significant at the 1 percent significance level. Given the potential presence of measurement error in our measure of the Australian monetary policy surprises, we believe the AU/US exchange rate and the NZ/US exchange rate responses to the Australian monetary policy surprises may well be higher than we estimated (although the ratio may remain the same) A 100 basis points monetary policy surprise in New Zealand causes the NZ/US dollar exchange rate to appreciate by 2.5 percent and the AU/US exchange rate to appreciate by 0.3 percent, although the AU/US exchange rate response is only significant in 40 minute regressions. The β^{AU}/β^{NZ} ratio is at 0.12 as opposed to the 0.33 for β^{NZ}/β^{AU}. It appears, therefore that the New Zealand dollar appreciates modestly when monetary policy is tightened in Australia, although by only a third as much as the Australian dollar appreciates, while there is little effect in the opposite direction.

[9] If one believes the relative variances of the intra-day and daily exchange rates can be a proxy for the intra-day and daily interest rates, the attenuation bias may be corrected easily. Alternatively if one believes the relative variances of the intra-day interest rates in New Zealand and Australia and the relative variances of the daily interest rates in Australia and New Zealand are similar, again this attenuation bias may be corrected.

Table 7
Responses to Monetary Policy Surprises

	15 Min			40 Min		
AU Mon	AU-US	NZ-US	NZ-AU	AU-US	NZ-US	NZ-AU
β	0.0230	0.0075	-0.0155	0.0241	0.0114	-0.0127
se	(0.0041**)	(0.0021**)	(0.0032**)	(0.0051**)	(0.0033**)	(0.0043**)
β^{NZ}/β^{AU}	0.33			0.47		
R-sq	0.34	0.17	0.28	0.27	0.16	0.12
	15 Min			40 Min		
NZ Mon	AU-US	NZ-US	NZ-AU	AU-US	NZ-US	NZ-AU
β	0.0030	0.0253	0.0223	0.0058	0.0355	0.0298
se	(0.0020)	(0.0073**)	(0.0074**)	(0.0026*)	(0.0010**)	(0.0098**)
β^{NZ}/β^{AU}	0.12			0.16		
R-sq	0.05	0.20	0.17	0.09	0.21	0.17

Notes: ** or * indicates statistical significance at the 1% or 5% levels.

Overall, this section established a strong and robust response of the NZ/US exchange rate to the Australian macroeconomic data surprises and a smaller and not as robust response of the AU/US dollar exchange rate to the New Zealand macroeconomic surprises.

5.2 Results of the indirect estimation

Tables 8 - 11 present the results of the regressions that estimate the response of the New Zealand dollar to the indirect measure of the Australian shocks. These regressions estimate how much an Australian shock that causes a 1 percent change in the AU/US dollar will affect the NZ/US exchange rate. Consequently, the estimated coefficient measures the relative response of the New Zealand and Australian exchange rates to an Australian shock.

Each table presents the results for a single shock, and each has four sections. The first section shows the correlation between the change in the NZ/US and the AU/NZ exchange rate in the 15 minute interval that starts 5 minutes prior to a news announcement, and ends 10 minutes afterwards. As discussed in section 2.2, this is a biased estimate of the extent to which the New Zealand exchange rate responds to Australian news because it includes the effect of the ordinary "background" correlation between the New Zealand and Australian dollars, as well as the response to the news announcement.

The effect of this background correlation is minimised by having a small interval, but it is still there. The second section is similar, except it shows the correlation between the change in the New Zealand/U.S. and the Australia/US rate in the 40 minute interval that starts 10 minutes prior to a news announcement, and ends 30 minutes afterwards. The third section shows the correlation between the change in the NZ/US and the AU/NZ rate in 15 minute intervals that do not include an announcement. This is the "background" correlation of the series and is estimated using two 15 minute intervals in each day in the sample (2881 observations.) The same sample is used for each announcement. The estimated coefficient is 0.48, meaning that on average in any 15 minute interval half of the change in the AU/NZ exchange rate will be reflected in the NZ/US exchange rate. The fourth section uses the three estimated coefficients to calculate the estimated function $h(.)$ that corrects for the background correlation. The bootstrapped 90 and 95 percent confidence intervals for this estimate are shown, as well as the asymptotic standard error. The first three sections also show the sample standard deviation of the 15 or 40 minute changes of both the NZ/US and the AU/NZ exchange rate changes. For both currencies, the standard deviation of the background 15 minute period changes is approximately 0.07 percent. The standard deviation of the changes on the announcement occasions is normally larger, suggesting that there is an additional response to the news on these occasions.

Table 8 shows the results for the GDP announcement. The coefficients between the NZ/US exchange rate and the AU/U.S exchange rate are 0.54 and 0.63 for the 15 minute and 40 minute intervals, and both are statistically significant. The implied ratio $\beta^{NZ}/\beta^{AU} = 0.53$, with a 95 percent confidence interval of (0.44, 0.78). These results suggest that the New Zealand dollar responds by approximately half as much to Australian GDP news as the Australian dollar does, appreciating in response to news that the Australian economy is stronger than expected, and depreciating when the Australian dollar is weaker than expected. This result is line with the direct estimates.

Table 9 has the results for the Australian trade shocks. Consistent with the direct estimation results, the estimated ratio $\beta^{NZ}/\beta^{AU} = 0.42$, with a 95 percent confidence interval of (0.32, 0.73), meaning that the New Zealand dollar appreciates to news about the Australian trade position coefficients by about half as much as the Australian dollar. The coefficients between the NZ/US exchange rate and the AU/NZ exchange rate are 0.32 and 0.57 for the 15 minute and 40 minute intervals, and both are statistically significant.

The results for the CPI shocks are in Table 10. The estimate of the ratio

$\beta^{NZ}/\beta^{AU} = -0.37$ with a 95 percent confidence interval of (-2.26,2.72): that is, the coefficient is very imprecisely estimated, and is not significantly different from zero. This result is in accordance with the results of the direct estimates, that Australian CPI news has little effect on the New Zealand dollar. The very large bootstrapped confidence interval suggests that the small sample properties of the estimator are problematic when the true value of the estimator is near zero.

Table 11 shows the results for the effect of Australian monetary surprises on the New Zealand dollar. While statistically significant, the coefficients between the NZ/US exchange rate and the AU/US exchange rate for the 15 and 40 minute intervals are relatively small, 0.33 and 0.39 respectively, and the implied ratio $\beta^{NZ}/\beta^{AU} = 0.25$. These point estimates are close to the direct estimates. However, as in the case for CPI surprises, the 95 percent confidence interval for β^{NZ}/β^{AU} is very wide and it cannot be concluded that the ratio is significantly different from zero.

These indirect estimates provide broad support for the direct estimation approach. In both cases there is strong evidence that the New Zealand and Australian currencies respond to news about the real side of the Australian economy, appreciating in response to news that the Australian economy is stronger than expected, or that the trade balance is more positive. The NZ/US exchange rate responds by about half as much as the AU/US exchange rate to these real shocks, implying that good news about Australian exports or Australian economic activity causes the New Zealand dollar to appreciate against the rest of the world. Similarly, in both cases the results suggest that the New Zealand dollar responds by much less than the Australian dollar to Australian monetary news, be it about the CPI or the stance of monetary policy. In this case, however, the indirect estimator has very large small sample standard errors, and thus is of relatively limited use.

Table 8
NZ/US dollar response to Australian GDP surprises

Announcement regression: 15 minute intervals						N.obs	R^2
$\Delta ln(s_t^{NZ/US})$	=	-0.00017	+ 0.54	$\Delta ln(s_t^{AU/US})$	+ e_t	25	0.60
		(0.00023)	(0.093**)				
$std(\Delta ln(s_t^{NZ/US}))$ = 0.0018			$std(\Delta ln(s_t^{AU/US}))$ =0.0025				
Announcement regression: 40 minute intervals						N.obs	R^2
$\Delta s_t^{NZ/US}$	=	-0.00046	+ 0.63	$\Delta s_t^{AU/US}$	+ e_t	25	0.70
		(0.00024)	(0.085**)				
$std(\Delta ln(s_t^{NZ/US}))$ = 0.0022			$std(\Delta ln(s_t^{AU/US}))$ =0.0029				
Background correlation 15 minute intervals						N.obs	R^2
$\Delta ln(s_t^{NZ/US})$	=	-0.00002	+ 0.480	$\Delta ln(s_t^{AU/US})$	+ e_t	2881	0.24
		(0.00001*)	(0.016**)				
$std(\Delta ln(s_t^{NZ/US}))$ = 0.00072			$std(\Delta ln(s_t^{AU/US}))$ =0.00073				
Ratio $\beta^{NZ}/\beta^{AU} = h(\beta^p_{15}, \beta^p_{40}, \rho_{AB1})$							
β^{NZ}/β^{AU} = 0.53*				Asymptotic std = 0.073			
90 % confidence interval = (0.44, 0.72)				95 % confidence interval = (0.42, 0.78)			

Notes: ** or * indicates statistical significance at the 1% or 5% levels.

Table 9
NZ/US dollar response to Australian trade data surprises

Announcement regression: 15 minute intervals						N.obs	R^2
$\Delta ln(s_t^{NZ/US})$	=	-0.00003	+ 0.32	$\Delta ln(s_t^{AU/US})$	$+ e_t$	67	0.32
		(0.00006)	(0.057**)				
$std(\Delta ln(s_t^{NZ/US}))$ = 0.0006			$std(\Delta ln(s_t^{AU/US}))$ =0.0011				
Announcement regression: 40 minute intervals						N.obs	R^2
$\Delta s_t^{NZ/US}$	=	-0.00007	+ 0.57	$\Delta s_t^{AU/US}$	$+ e_t$	67	0.57
		(0.0001)	(0.062**)				
$std(\Delta ln(s_t^{NZ/US}))$ = 0.0011			$std(\Delta ln(s_t^{AU/US}))$ =0.0016				
Background correlation 15 minute intervals						N.obs	R^2
$\Delta ln(s_t^{NZ/US})$	=	-0.00002	+ 0.480	$\Delta ln(s_t^{AU/US})$	$+ e_t$	2881	0.24
		(0.00001*)	(0.016**)				
$std(\Delta ln(s_t^{NZ/US}))$ = 0.00072			$std(\Delta ln(s_t^{AU/US}))$ =0.00073				
Ratio $\beta^{NZ}/\beta^{AU} = h(\beta_{15}^p, \beta_{40}^p, \rho_{AB1})$							
β^{NZ}/β^{AU} = 0.42*				Asymptotic std = 0.02			
90 % confidence interval = (0.35, 0.61)				95 % confidence interval = (0.32, 0.73)			

Notes: ** or * indicates statistical significance at the 1% or 5% levels.

Table 10
NZ/US dollar response to Australian CPI surprises

Announcement regression: 15 minute intervals						N.obs	R^2
$\Delta ln(s_t^{NZ/US})$	=	-0.0005	+ 0.16	$\Delta ln(s_t^{AU/US})$	$+ e_t$	25	0.16
		(0.00015**)	(0.073*)				
$std(\Delta ln(s_t^{NZ/US})) = 0.0008$			$std(\Delta ln(s_t^{AU/US})) = 0.0020$				
Announcement regression: 40 minute intervals						N.obs	R^2
$\Delta s_t^{NZ/US}$	=	-0.00043	+ 0.32	$\Delta s_t^{AU/US}$	$+ e_t$	25	0.39
		(0.00015)	(0.084**)				
$std(\Delta ln(s_t^{NZ/US})) = 0.0015$			$std(\Delta ln(s_t^{AU/US})) = 0.0030$				
Background correlation 15 minute intervals						N.obs	R^2
$\Delta ln(s_t^{NZ/US})$	=	-0.00002	+ 0.480	$\Delta ln(s_t^{AU/US})$	$+ e_t$	2881	0.24
		(0.00001*)	(0.016**)				
$std(\Delta ln(s_t^{NZ/US})) = 0.00072$			$std(\Delta ln(s_t^{AU/US})) = 0.00073$				
Ratio $\beta^{NZ}/\beta^{AU} = h(\beta_{15}^p, \beta_{40}^p, \rho_{AB1})$							
β^{NZ}/β^{AU} = -0.37				Asymptotic std = 1.23			
90 % confidence interval = (-1.06, 1.45)				95 % confidence interval = (-2.26, 2.72)			

Notes: ** or * indicates statistical significance at the 1% or 5% levels.

Table 11
NZ/US dollar response to Australian monetary policy surprises

Announcement regression: 15 minute intervals						N.obs	R^2
$\Delta ln(s_t^{NZ/US})$	=	-0.00005	+ 0.33	$\Delta ln(s_t^{AU/US})$	$+ e_t$	63	0.52
		(0.00008)	(0.041**)				
$std(\Delta ln(s_t^{NZ/US})) = 0.0009$			$std(\Delta ln(s_t^{AU/US}))$ =0.0019				
Announcement regression: 40 minute intervals						N.obs	R^2
$\Delta s_t^{NZ/US}$	=	-0.00025	+ 0.39	$\Delta s_t^{AU/US}$	$+ e_t$	67	0.40
		(0.00014)	(0.061**)				
$std(\Delta ln(s_t^{NZ/US})) = 0.0014$			$std(\Delta ln(s_t^{AU/US}))$ =0.0022				
Background correlation 15 minute intervals						N.obs	R^2
$\Delta ln(s_t^{NZ/US})$	=	-0.00002	+ 0.480	$\Delta ln(s_t^{AU/US})$	$+ e_t$	2881	0.24
		(0.00001*)	(0.016**)				
$std(\Delta ln(s_t^{NZ/US})) = 0.00072$			$std(\Delta ln(s_t^{AU/US}))$ =0.00073				
Ratio $\beta^{NZ}/\beta^{AU} = h(\beta_{15}^p, \beta_{40}^p, \rho_{AB1})$							
$\beta^{NZ}/\beta^{AU} = 0.25$			Asymptotic std = 0.23				
90 % confidence interval = (-0.11, 0.80)			95 % confidence interval = (-0.59, 1.29)				

Notes: ** or * indicates statistical significance at the 1% or 5% levels.

6 Conclusions

In the last two decades, the New Zealand - Australia exchange rate has been remarkably stable, varying within a ±11 percent band around a central rate of \$NZ1 = \$AU 0.86 cents. During this period, high frequency changes in the exchange rate have also been very highly correlated. One hypothesis to explain this correlation is that that New Zealand's exchange rates with other countries are directly affected by the state of the Australian economy. This paper has offered a test of this hypothesis, by using a high frequency event analysis to examine the effects of Australian macroeconomic data announcements on the NZ/US exchange rate.

The results of the paper suggest that the NZ/US and AU/US exchange rates respond in a similar way to announcements about the real state of the Australian economy. In particular, the NZ/US exchange rate appreciates to news

that the Australian economy is stronger than previously anticipated, and depreciates to news that the Australian economy is weaker than anticipated. The NZ/US response is half as strong as the AU/US response, so that the New Zealand dollar also depreciates against the Australian dollar in response to better than expected news about the Australian economy. Nonetheless, the strength of the relationship is suggestive that the direct response of the New Zealand dollar to Australian macroeconomic news is likely to be a major reason why the two currencies move so closely together in the short term. The NZ/US and AU/US exchange rate also responds in a similar way to Australian monetary policy announcements, although the relative size of the New Zealand response is not as large as the response to real shocks. In contrast, the NZ/US exchange rate was unaffected by Australian CPI data, even though the AU/US exchange rate appreciates in response to stronger than expected CPI announcements.

The paper also shows that the AU/US and NZ/US exchange rates are affected in a similar way by announcements about the state of the New Zealand economy. The effect is much smaller, however, possibly reflecting the greater importance of the Australian economy to New Zealand than the New Zealand economy to Australia. New Zealand GDP announcements have the largest effect on the AU/US exchange rate, but even in this case the AU/US exchange rate only responds by 30 percent as much as the NZ/US exchange rate in response to a New Zealand data surprise.

To the extent that the Australian and New Zealand macroeconomic cycles are in tandem with each other, the asymmetry of this relationship may explain why the New Zealand exchange rate is more cyclical than the Australian exchange rate. An unanticipated one percent increase in GDP in both countries will lead to an appreciation of both currencies, but the New Zealand dollar will appreciate by more than Australian dollar, for while they both respond to their respective domestic news announcements by the same amount, the New Zealand dollar appreciates by more to the Australian GDP data than the Australian dollar responds to the New Zealand GDP data. A similar effect occurs in response to announcements about the trade balance and the stance of monetary policy. To the extent that Australian and New Zealand macroeconomic cycles are out of tandem, as occurred in the 1998 and 2008 when New Zealand experienced much steeper downturns than Australia, the effect of the state of the Australian economy on the New Zealand dollar may prevent the New Zealand dollar from adjusting in a manner New Zealand monetary authorities find desirable. The failure of the New Zealand dollar to adjust to the value desired by the Reserve Bank of New Zealand in 2007, which resulting in Reserve Bank intervention in the currency markets, may

be a direct consequence of the way the market value of the New Zealand dollar is determined by the state of the Australian economy as well as the state of the New Zealand economy.

In addition to the substantive economic results, the paper also developed a new method of estimating how announcements in one country affect the exchange rate in another country that does not depend on the use of survey data to measure the surprise component of announcements. This methodology may be useful if survey measures are not available, or if there is reason to doubt that that headline announcement figure accurately captures all the market sensitive information released. The approach is to use the change in the exchange rate in one country immediately following an announcement in that country as a measure of the surprise component of the announcement. This approach is in many ways similar to the way that changes in market interest rates are used to measure monetary policy surprises. Nonetheless, there are some differences, as one needs to make an adjustment for the ordinary correlation that occurs between the two exchange rates during short intervals. The estimation procedure produced estimates remarkably similar to those produced using direct survey measures of the surprise component of the announcement for the Australian GDP and trade balance shocks, but was not particularly useful for the monetary policy of CPI shocks because in these cases the estimator had very large standard errors. The very large "background" correlation between the NZ/US and the AU/US exchange rates may in fact be disadvantageous to the successful use of the estimator, for it made extracting the response of the NZ/US exchange rate during announcement intervals more difficult. In future, it may prove useful to use longer samples and to use different bilateral currency partners (eg regressing the NZ/US exchange rate against the AU/Euro rate) to obtain the best results.

We present evidence that supports the third hypothesis but we cannot say whether this is the dominant factor or the other two hypothesis are just as important. On a related matter, the explained variation (R-squared) in this paper is significantly larger compared with many international literature (Andersen et al (2003) and Faust et al (2007)). However, they are still below 0.50 in most instances. In other words, even in short 15 minute interval, where there is a dominant piece of news, R-squared are relatively low. Therefore we are still a long way away from explaining the rest of the volatility and presumably the rest of the co-movement between the two currencies.

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Appendix

To derive the asymptotic distribution of the estimator of the ratio β^B/β^A, we stack the following three equations estimated with N_1, N_1, and N_2 observations into a a single equation.

$$\begin{aligned} \Delta_{T1} s_t^B &= \gamma_1 + \beta_1 \Delta_{T1} s_t^A + v_{1t} \\ \Delta_{T2} s_t^B &= \gamma_2 + \beta_2 \Delta_{T2} s_t^A + v_{2t} \\ \Delta_{T1} s_t^B &= \gamma_3 + \rho_{AB1} \Delta_{T1} s_t^A + v_{3t} \end{aligned}$$

or

$$\begin{bmatrix} \Delta_{T1} s_t^B \\ \Delta_{T2} s_t^B \\ \Delta_{T1} s_t^B \end{bmatrix} = \begin{bmatrix} \left[\Delta_{T1} s_t^A\right] & 0 & 0 \\ 0 & \left[\Delta_{T2} s_t^B\right] & 0 \\ 0 & 0 & \left[\Delta_{T1} s_t^A\right] \end{bmatrix} \begin{bmatrix} \beta_1 \\ \beta_2 \\ \rho_{AB1} \end{bmatrix} + \begin{bmatrix} v_{1t} \\ v_{2t} \\ v_{3t} \end{bmatrix} \quad (14)$$

or

$$Y = X\delta + v, \ var(v) = \Psi = \begin{bmatrix} \sigma_1^2 I_{N_1} & \sigma_{12} I_{N_1} & 0 \\ \sigma_{12} I_{N_1} & \sigma_2^2 I_{N_1} & 0 \\ 0 & 0 & \sigma_3^2 I_{N_2} \end{bmatrix}$$

The first two equations are estimated using the N_1 time intervals on the announcement dates, while the third is estimated using the N_2 intervals on all the available dates to obtain a correction for the background correlation

between the series. The parameter of interest, β^B/β^A, is given by equation *

$$\frac{\beta^B}{\beta^A} = h(\beta_1, \beta_2, \rho_{AB1}) = \frac{\beta_1\beta_2(T_2/T_1 - 1) + (\beta_2 - T_2/T_1\beta_1)\rho_{AB1}}{(T_2/T_1\beta_2 - \beta_1) + (1 - T_2/T_1)\rho_{AB1}} \tag{15}$$

If $\sqrt{N}\hat{\delta} \rightarrow N(\delta, [X'\Psi^{-1}X]^{-1})$, then $\sqrt{N}h(\hat{\delta}) \rightarrow N(h(\delta), \frac{\partial h}{\partial \delta'}[X'\Psi^{-1}X]^{-1}\frac{\partial h'}{\partial \delta})$. The latter expression is straightforward to calculate from the function $h(.)$, and the whole expression is evaluated at the sample values $\hat{\delta}$.