Exchange rate puzzle in New Zealand: New evidence*

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Abstract

This paper adopts an event-study approach that utilises a combination of the asset pricing model of the exchange rate due to Engel and West (2010) and a state space model to examine the impact of monetary policy shocks on the change of the New Zealand exchange rate. We find evidence to support the "exchange rate puzzle" (ERP) originally coined by Grilli and Roubini (1995). The ERP in the New Zealand context was also found in Wilkinson *et al.* (2001). Using newer data, the present study is able to account for the role of the recent global financial crisis (GFC) in influencing the nexus between the exchange rate and interest rate. It is found that the GFC had a mediating effect on the ERP, showing the exchange rate responded asymmetrically to monetary policy shocks.

Keywords: Monetary Policy Shocks, ERP, OCR, Event Study, GFC

JEL Classification: E43, E52

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1 Introduction

New Zealand is a small open economy with a significant tradable sector. Consequently, fluctuations in the exchange rate, calculated as foreign currency against one New Zealand dollar, can have large macroeconomic impacts. There is constant pressure from manufacturers in the country to have the exchange rate increased via some domestic monetary measure. Since March 1999 the Reserve Bank of New Zealand (RBNZ) has adopted Official Cash Rate (OCR) as the monetary policy instrument. It is often suggested that the Reserve Bank should ease monetary policy (lower the OCR) in an attempt to raise the exchange rate. It is against this background that the present paper seeks to shed light on the relationship between the OCR and the exchange rate in the New Zealand context.

Grilli and Roubini (1995) find that while positive innovations in U.S. interest rates lead to an impact appreciation of the U.S. dollar (USD), positive innovations in the interest rates of the other G-7 countries are associated with an impact depreciation of their currency. The authors coin this finding an "exchange rate puzzle" (ERP). They offer two explanations for such a puzzle; one is that the U.S. is the "leader" country in the setting of monetary policy for the G-7 area, while the other countries are "followers". The other explanation suggests endogenous policy reaction to underlying inflationary shocks that are a cause of exchange rate depreciation. Wilkinson *et al.* (2001), using data on the New Zealand (NZ) exchange rates from 1985 to 1998, found that contractionary monetary policy may lead to a depreciation of the New Zealand Dollar (NZD) rather than an appreciation, hence the existence of ERP. Zettelmeyer (2004), using a more up-to-date data set ending in August 1999, found that the NZ-US exchange rate reacted to short-term interest rate changes triggered by monetary policy shocks in the direction showing the absence of the ERP. The contrast of the findings from the two studies may be attributable to the difference in their approaches; the former uses a Vector Autoregressive (VAR) model while the latter an event study analysis, which necessarily implies a different reconstruction of monetary policy shocks.

To avoid the criticisms on VAR which will be elaborated in the next section, this paper adopts a combination of the event-study approach and an asset pricing model of the exchange rate (Engel and West, 2010) to examine the impact of monetary policy shocks on the change of the exchange rate. The exchange rate is defined as the value of the USD in terms of the NZD (a rise in the exchange rate is a depreciation of the NZD). The present research uses changes in market OCR expectations as the measure of monetary policy shock. With the asset pricing model, we are able to extend Zettelmeyer's work to account for the effects on the exchange rate of US asset returns, risk-free returns and currency risk premium. Vithessonthi (2014) finds that the Thai baht and the Japanese yen exchange rate returns reacted asymmetrically to monetary policy surprises during the recent Global Financial Crisis[1] (GFC) period in relation to the non-financial crisis period. Our sample is collected for the period October 2003 – January 2014, which enables us to test if there is any GFC effect on the NZD-USD exchange rate behaviour.

The plan of the paper is as follows. Section 2 presents a brief literature review on two approaches with which the relationship between monetary policy shocks and exchange rates are investigated. It presents empirical evidence for and against the ERP. Section 3 elaborates the modelling framework and estimation procedures. Section 4 describes the data and discusses the empirical results, with some concluding remarks contained in Section 5.

2 Literature review

2.1 Identification of monetary policy shocks: VAR vs Event study

Two approaches are used to measure the impact of monetary policy shocks on exchange rates. One dwells on the VAR framework which includes the Structural Vector Autoregression (SVAR) model and the Vector Error Correction Model (VECM). This approach is commonly used to examine the long run dynamic effects of monetary policy shocks on exchange rates. The other is the event-study method, which is typically

[1] For the present study, the GFC period refers to the period from the 3rd quarter 2007 through the 2nd quarter 2011 when the US QE2 stopped. We are of the opinion that the US QE policy would affect the NZ-US relative returns.

used to examine the short run effects or the same day effects of monetary policy changes on exchange rates. The fundamental difference between the two approaches is in the way that monetary policy shocks are constructed. In the VAR (SVAR) model, the monetary policy shock is measured by the disturbance term (the structural disturbance) pertaining to the monetary variable equation, for example, the short-term interest rate equation, subject to imposition of identifying restrictions. While with the event study approach, the monetary policy shock is measured as the unexpected change in the monetary policy variable within an event window.

Despite the fact that the VAR model is commonly used to examine the relationship between monetary policy and the exchange rate, many have expressed dissatisfaction with it. Rudebusch (1998)'s criticisms on the VAR approach point out that the monetary policy equation or monetary reaction equation in the VAR system would use final and revised data to model policy reactions, while in the real world policy makers had to react to initial releases of data. This point is also shared by Brunner (2000). Moreover, the significance of lagged variables in the VARs suggested that the central bank would react to old information systematically, which is unlikely in reality. A number of studies (for example, Engel and Frankel, 1984; Hardouvelis, 1984; Hakkio and Pearce, 1985; and Ito and Roley, 1987) noted that in comparison with the VAR approach, an event study has better outcomes on isolating the economic news' effects from the effects of monetary policy shocks on the exchange rate.

Zettelmeyer (2004) used changes in short-term interest rates to measure monetary policy shock after controlling for potential endogeneity of monetary policy actions (OCR announcements) and other shocks that might have also affected the interest rates. Specifically, Zettelmeyer (2004) argues that three month interest rates are used as a policy measure because they are sufficiently short to reflect the policy targets that the authorities set for the immediate future, but at the same time sufficiently long to react only to the extent that changes in the policy rate were unanticipated. Zettelmeyer's approach is to instrument the 90-day interest rate to obtain the monetary policy shock to the exchange market. The instrumental variable is the direction of underlying central bank policy, which takes values, -1, 0 and 1 as formed in Bonato et al. (1999), for a regression similar to equation (8). Since this particular instrumental variable primarily shows the *intention* of the policy announcement, and such an intention is subject to interpretation by the market, Zettelmeyer noted that the actual impact of the announcement may have been different.

The asset pricing model for the exchange rate given in Engel and West (2010) and further elaborated in Munro (2014) implies that use of short-term interest rates as a measure of risk free return ruled out the possibility that the risk adjustment component in interest rate may cancel that of the exchange rate and, as a result, ignored the risk premium components of the interest rate.

2.2 Monetary policy variables

Monetary policy variables are the channels through which monetary shocks are transmitted to the market. Rudebusch (1998) suggested utilising rates from the federal funds futures contracts, rather than short term interest rates, as such a channel. This avoided the problem that the interest rate residuals from the VAR were assumed uncorrelated with financial market shocks. In financial markets, shocks in futures markets may differ from the VAR interest rate residuals. This conjecture was supported by the lack of fit of the shocks estimated from the VAR to the ones based on the federal funds futures contracts. Short-term interest rates are used in Zettelmeyer (2004) and Dungey and Fry (2009) for a New Zealand study. Other measures of monetary policy shocks include changes in base money (M1) in Cushman and Zha (1997) and Wilkinson *et al.* (2001), changes in non-borrowed reserves in Koray and McMillin (1999), Kim (2001), and Faust and Rogers (2003).

Bernanke and Blinder (1992) indicate that changes in short term interest rates are dominated by monetary policy shocks but are not as sensitive to other influences. Therefore, short term interest rates are more informative in indicating monetary policy shocks compared to other indicators. The market interest rate is the monetary authority's interest rate plus a risk premium. In addition, for an event study whereby the event window is 24 hours long or shorter, such as the present study, unexpected changes in the relative short-term interest rate would be the most appropriate measure of relevant monetary shocks. This gives rise to the central bank's base interest gazette (the OCR in New Zealand).

2.3 Empirical evidence for or against ERP

Dornbusch's (1976) well known exchange rate overshooting hypothesis states that an interest rate increase leads to an immediate appreciation in the nominal exchange rate, in line with uncovered interest parity. The so-called ERP occurs when the overshooting hypothesis is inconsistent with data, or when a contractionary monetary policy shock is followed by a depreciation of the domestic currency. Sims (1992) noted that *increases* in the money supply were associated with *appreciation* of the exchange rate in France and in Germany (but not in Japan, the United Kingdom or the United States). Grilli and Roubini (1995) find that while positive innovations in U.S. interest rates lead to an impact appreciation of the U.S. dollar, positive innovations in the interest rates of the other G-7 countries are associated with an impact depreciation of their currency. They offer two explanations for such a puzzle; one is that the U.S. is the "leader" country in the setting of monetary policy for the G-7 area, while the other countries are "followers". The other explanation suggests endogenous policy reaction to underlying inflationary shocks that are a cause of exchange rate depreciation. Eichenbaum and Evans (1995), Lewis (1995), Cushman and Zha (1997), Hardouvelis (1988), Bonser-Neal, Roley, and Gordon (1998), and Kim and Roubini (2000), to name just a few more, have all examined the relationship between monetary policy shocks and exchange rates movements in different countries and found conflicting results.

For New Zealand, Wilkinson *et al.* (2001) found that a contraction in monetary policy may lead to a depreciation of the NZD, hence the existence of the ERP. Zettelmeyer (2004) used the event study approach and found no evidence for the ERP. Kearns and Manners (2006), using the event study approach with intraday data, found no evidence for the ERP for Australia, New Zealand, Canada, and United Kingdom.

3 Modelling framework

3.1 The exchange rate model

In this paper, we attempt to explain the impact of monetary policy shock on the exchange rate of NZ/US currency using the asset pricing model (APM) due to Engel and West (2010). The authors found that exchange rate and future fundamentals are highly correlated and this relationship is consistent with an asset pricing model for the exchange rate. Under the APM, the relationship between exchange rate and interest rate is empirically closer to theory than under other models. This finding is backed up by Monro (2014). Following the authors, we use lower case letters to denote logarithms to specify the unconditional mean of the real exchange rate as,

$$q_t = -R_t - \Lambda_t + \bar{q} \tag{1}$$

The R_t is the relative return defined as $\sum_{j=0}^{\infty} E_t \left(r_{t+j}^{NZ} - r_{t+j}^{US}\right)$, and the Λ_t is the risk premium for holding the US dollar and is defined as $\sum_{j=0}^{\infty} E_t \, \lambda_{t+j}$. The r_t^K is the real interest rate for country K, $K \in \{NZ, US\}$, which equals the nominal interest rate divided by the expected inflation rate, namely, $r_t^K \equiv i_t^K - E_t \pi_{t+1}^K$. The λ_t, defined as $r_t^{US} - r_t^{NZ} + E_t q_{t+1} - q_t$, is the excess return on US interest-bearing assets computed as the real interest rate differential between the US and NZ taking into account the expected real exchange rate change over the next period. The $\bar{q}$ is the long-run equilibrium exchange rate. Munro (2014) found that large changes in Λ_t occurred during financial turmoil periods, such as the Asia Financial Crisis, the 911 terrorist attack, and the GFC.

Considering that the relative returns may also be subject to shocks to the risk premium, Munro (2014) suggests to model the real exchange rate and the relative return simultaneously, namely,

$$q_t = -\alpha R_t - E_t \Lambda_t + \bar{q} \tag{2}$$

$$R_t = R_t^f - \gamma E_t \Lambda_t \tag{3}$$

where α is an unknown constant to accommodate the possible scenarios that the relative return is not fully priced into the level of the real exchange rate ($|\alpha| < 1$); and similarly, the free parameter, γ, allows for the possibility of a differential effect of the risk premium on the relative return and the real exchange rate. The risk-free component of the relative return, R_t^f, is equal to the relative expected value of the inverse of the sum of all future consumption discount factors (page 5, Munro 2014).

Engel and West (2005) find that relative economic fundamentals, such as, inflation differentials, interest rate differentials, follow a random walk process, namely, $X_t = X_{t-1} + \eta_t^X,\ X \in (R^f, \Lambda)$. Therefore, R_t and Λ_t in equations (2) and (3) can be viewed as being made up of past shocks, which implies that the percentage change in the level of the exchange rate is driven by shocks to relative returns of the NZ and US currencies, and shocks to the risk premium of holding the US currency. Since the interest is in modelling changes in the exchange rate, equations (2) and (3) are written in first difference forms,

$$\Delta q_t = -\alpha \Delta R_t - \eta_t^{\Lambda} \tag{4}$$
$$\Delta R_t = \eta_t^{R^f} - \gamma \eta_t^{\Lambda} \tag{5}$$

where $\eta_t^{R^f}$ and η_t^{Λ} are the shocks to the relative risk-free return and the risk premium, respectively. Because the relative risk-free return is assumed to follow a random walk process, $\eta_t^{R^f}$ can be estimated by ΔR_t^f, and as a result, η_t^{Λ} can be estimated upon obtaining an estimate of γ from equation (5)[2].

The first difference forms of the model as given by equations (4) and (5) fit well the event study approach that the present research adopts whereby an event is an OCR announcement by the RBNZ; and the first differences of the variables straddle the event window. The event window for the present study is the 24-hour period to 11:00 am on the OCR announcement day, thus $\Delta X_t = X_t - X_{t-1}$, $X \in \{i^{f\_NZ}, i^{f\_US}, \eta^{Rf\_NZ}, \eta^{Rf\_US}, \eta^{\Lambda\_NZ}, \eta^{\Lambda\_US}\}$; *t* and *t-1* are 11:00am on the announcement day and the same time the previous day. The timeframe of the event window corresponds to the 24-hour period to 5pm in the previous day in

[2] Munro (2014) estimated the model coefficients using a Bayesian methodology.

the US (or 6pm or 7pm, depending on whether day-light saving is on in either country, more detailed information is in Appendix).

The η_t^{Rf} encapsulates three categories of random factors that affect monetary policy, namely, first, those that make monetary policy deviate from the set path; second, unexpected change in monetary policy; and third, expectations about future monetary policy that are not reflected in the short-term interest rate. Over the sample period 23 October 2003 – 30 January 2014, there are three US Federal Open Market Committee meetings (FOMC) (The details are in the Appendix) that overlap the 24-hour window. To rule out possible simultaneous effects of both US and NZ policy announcements for the three dates (events), these three particular observations will be excluded in the regression analysis below. Thus, we can expect that for the remaining events, the η_t^{Rf} should only contain shocks originated from NZ monetary policy surprises.

Equations (4) and (5) provide a framework for simultaneously modelling return and exchange rate, and show that the dynamic processes of the two variables are purely driven by shocks to relative risk-free return and currency premium. The α in (4) measures the impact of a shock to risk-free return on the change in the exchange rate provided the correlation between η_t^{Rf} and η_t^{Λ} is zero. Munro (2014) finds that such a correlation was insignificantly different from zero for eight currency pairs including the NZ-US pair for the period December 1989-July 2013. However, such an estimate of α will capture the compound effects of the three forces as mentioned above which is not exactly what is needed for the purpose of the present study which aims for evaluating the contribution of a monetary policy shock to exchange rate changes.

3.2 Measure of monetary policy shock

Since this study uses the event-study approach, identification of monetary policy shocks does not involve sifting through regression residuals like the VAR approach but focuses on the exogeneity and unexpectedness of each policy action under study. Unlike Zettelmeyer, the instrument used in the present paper is a market based measure of OCR surprises and therefore should be more capable of capturing market reactions than the direction variable. More specifically, the study uses the difference between the actual OCR level and the market OCR expectation for the OCR announcement day (Monetary Policy Statements and OCR Reviews).

In New Zealand, the overnight indexed swap rates (OIS) securities are an "over-the-counter" derivative on the OCR, where an agreement is made to exchange the compounded return of the realised OCR on a notional initial principle over a future period against the return based on a specified OIS rate. The market OCR expectations, $\overline{OCR}$, are formed one day before the OCR announcement day. Since the $\overline{OCR}$ are not subject to the endogeneity (reverse causality) problem as discussed in Zettelmeyer (2004), changes in the short-term interest rate that are only attributable to changes in $\overline{OCR}$ are deemed the size of the impact of monetary policy shock perceived by the market. As the instrument for the short-term interest rate, changes in $\overline{OCR}$ not only capture the directions of the shock but also the magnitude of it and hence is more informative than the underlying direction variable in Zettelmeyer (2004).

Apart from using as the instrumental variable a market based measure of policy, the present paper also differs from Zettelmeyer's in terms of the channel through which monetary shocks are transmitted to the market. In Zettelmeyer, the 90-day interest rate is used as the channel to transmit policy shocks, while the present paper uses shocks to the unobservable risk free return. As Munro (2014) demonstrated, in the exchange market, only risk-free returns matter and interest rates account for a minor share of exchange rate variances. Thus, we chose to use risk-free return shocks to be instrumented OCR surprises and to explain the exchange rate movements.

Since a monetary policy shock directly affects risk-free return, evaluation of the effect of OCR surprises on exchange rate calls for a correlation analysis relating the aforementioned surprises to the resulting changes in the exchange rate, with the risk-free return as the transmitting media. Given that ΔR_t is the relative real asset return of NZ to US, equation (5) implies that the η_t^{Rf} component of the relative return in general should be made up of the shock to NZ risk free return, $\eta_t^{Rf\text{-}NZ}$, and that to US risk free return, $\eta_t^{Rf\text{-}US}$. Because, during either of the window periods, only in New Zealand is there a policy change or policy expectation; and Δi_t^{US} can be considered equal to 0 since the federal funds rate stayed unchanged, $\eta_t^{Rf\_US}$ can be ignored from η_t^{Rf}. Therefore, the task becomes to extract the component of $\eta_t^{Rf\_NZ}$, $\dot{\eta}_t^{Rf\_NZ}$, that is attributable to monetary policy shock originated from New Zealand. The $\dot{\eta}_t^{Rf\_NZ}$ is deemed zero if the level of the announced OCR is in accordance with the market expectation over the window period. Before extracting $\dot{\eta}_t^{Rf\_NZ}$ from $\eta_t^{Rf\_NZ}$, it is necessary to estimate the latter first.

Given the statistical evidence reported in Engel and West (2005) and the argument presented in Munro (2014), the level of New Zealand risk free return can be written as a random walk process and the level of New Zealand real asset return can be written as the level of risk free return plus a currency risk premium, namely,

$$R_t^{f\_NZ} = R_{t-1}^{f\_NZ} + \eta_t^{Rf\_NZ} \tag{6}$$

$$R_t^{NZ} = R_t^{f\_NZ} + \mathrm{v}_t^{NZ} \tag{7}$$

Equations (6) and (7) comprise a state space model with the level of risk free return, $R_t^{f\_NZ}$, as the state variable and real asset return, R_t^{NZ}, as the observed variable. The disturbance term, v_t^{NZ}, as suggested by equation (2), is predominantly currency risk premium. The empirical evidence presented in Munro (2014, Table 4) shows that the correlation between $\eta_t^{Rf\_NZ}$ and $\eta_t^{\Lambda\_NZ}$ is not significantly different from zero. Because Λ_t^{NZ} follows a near random walk process (Engel and West, 2005), Λ_t^{NZ} can be viewed as being made up by the present and all the past η^{Λ_NZ}, and the near zero correlation between $\eta_t^{Rf\_NZ}$ and $\eta_t^{\Lambda\_NZ}$ should imply a near zero correlation between $\eta_t^{Rf\_NZ}$ and Λ_t^{NZ}. Therefore, the $\eta_t^{Rf\_NZ}$ can then be backed out by applying Kalman filter to the system.

To extract $\dot{\eta}_t^{Rf\_NZ}$ econometrically amounts to projecting $\eta_t^{Rf\_NZ}$ into the space spanned by the differences between actual OCRs and market OCR expectations; which are used as the measure of monetary policy shock. Denote the Kalman filter estimate of $\eta_t^{Rf\_NZ}$ by $\hat{\eta}_t^{Rf\_NZ}$ and market surprises by $\Delta\overline{OCR}(=\overline{OCR} - OCR)$, then the fitted value from the regression in equation (8) is taken to be the estimate of $\dot{\eta}_t^{Rf\_NZ}$, the impact on the risk free return of the monetary policy shock.

$$\hat{\eta}_t^{Rf\_NZ} = \gamma_1 + \gamma_2 \Delta\overline{OCR}_t + \epsilon_t \quad (8)$$

Thus, we instrument shocks to risk free return by OCR surprises since OCR surprises are absorbed by the exchange market via the channel of expected relative return which, in turn, is determined by risk free return. In essence, the least squares estimation of equation (8) addresses the possibility that the risk free return may be affected by factors that also affect the changes in the OCR.

To arrive at an econometric model suitable for the present study, a general functional form for combining equations (4) and (5) may be written as $\Delta q_t = f(\eta_t^{Rf\_NZ}, \eta_t^{Rf\_US}, \eta_t^{\Lambda})$. Ignoring the shocks to US risk free returns (the reasons were discussed above), substituting $\dot{\eta}_t^{Rf\_NZ}$ by its estimate, $\hat{\dot{\eta}}_t^{Rf\_NZ}$, from equation (8) and assuming a linear functional form gives the two-variable model

$$\Delta q_t = \alpha + \beta_\eta \hat{\dot{\eta}}_t^{Rf\_NZ} + \xi_t \quad (9)$$

where the error term ξ consists of the currency premium, η_t^{Λ}, and non-monetary policy shocks ($\eta_t^{Rf\_NZ} - \dot{\eta}_t^{Rf\_NZ}$). Equation (9) is similar to Zettelmeyer's model that the expected change in the exchange rate within the window is only attributable to shocks generated by unexpected monetary policy changes. The shocks that enter the model are the shocks to the risk free return specified in equation (6), which, in turn, is a reflection of monetary policy shock generated by the OCR announcement.

Zettelmeyer (2004) found that adding controls to the two-variable model did not change the modelling outcomes. Since our sample period covers the GFC which Zettelmeyer's did not, our second model specification includes a control variable to account for possible GFC impact on the relationship between the exchange rate and shocks to NZ's risk free return. This model is given as equation (10) below.

$$\Delta q_t = \alpha + \alpha_{GFC} D_{GFC} + \beta_\eta \hat{\dot{\eta}}_t^{Rf\_NZ} + \beta_{GFC} \hat{\dot{\eta}}_t^{Rf\_NZ} D_{GFC} + \xi_t \quad (10)$$

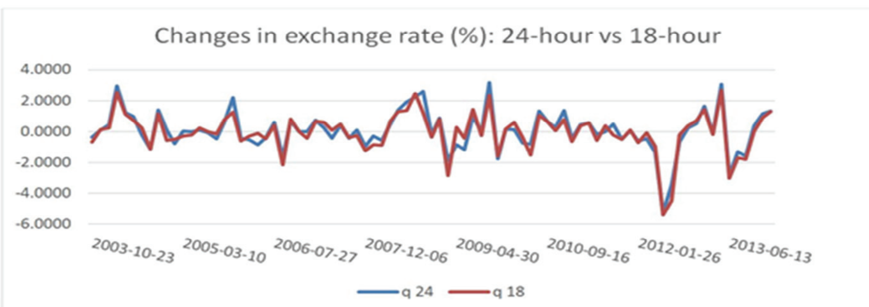
The model given in equation (10) allows hypothesis-testing about whether there is asymmetrical response of the exchange rate to monetary policy shocks between the GFC and non-GFC periods. There are two sets of estimates for both equations (9) and (10), corresponding to the two types of swap rates used to measure the relative return in equation (7).

4 Data and empirical results

4.1 Data

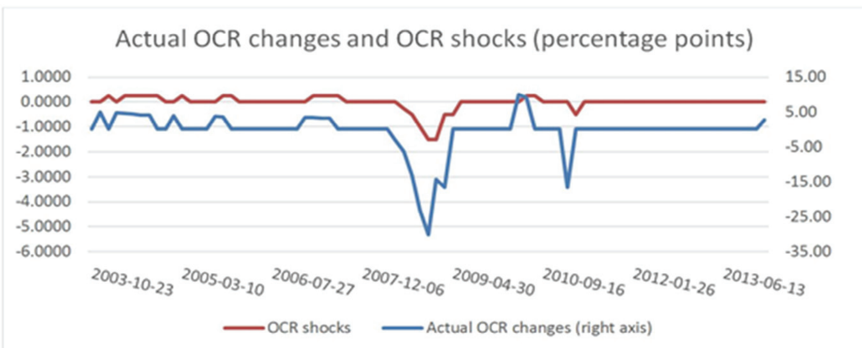
RBNZ collects exchange rate data on a daily basis at 11:00am and 5:10pm. Thus, there are two sizes for our event window that straddles the OCR announcement. One is a 24-hour window, that is, the 24-hour period to 11:00am on the OCR announcement day. The 24-hour window based on the 5:10pm data is disregarded simply because the amount of time elapsed from the announcement to the end of the window is too large for any change in the interest rates to be only subject to the announcement. The other one is the 18-hour window, namely, from 5:10pm on the day before the announcement through 11am on the announcement day. Figures 1 shows the changes in the exchange rates for both the 24-hour and 18-hour windows. The window size did not seem to matter since the two series almost trace over each other.

Figure 1.



The entire sample period starts from 23 October 2003 to 30 January 2014, for which the OCR expectation data are available. But the 5:10pm data only begin in September 2006, which means a loss of about a quarter of the total observations if the 18-hour window sample is used instead of the 24-hour one. Nevertheless, the shortened window width should increase the likelihood that the differences in the exchange rate between 11:00am on the OCR announcement days and 5:10pm the day before were only driven by events occurring shortly after the announcement time. Therefore, the smaller sample will be utilised to provide a "second opinion" for estimates based on the full sample. The sample period also includes the global financial crisis, which allows statistical testing of the significance of the GFC in altering the effects of monetary policy shocks on the exchange rate. Since March 1999, the OCR has been the instrument for the RBNZ to implement its monetary policy. In general, the RBNZ reviews the OCR eight times in each year, and makes adjustments deemed necessary. The dates for possible changes are announced in advance, so that the financial markets can anticipate the direction and level of any change with whatever public knowledge is available at the time. This includes the possibility of an announcement that there will be no change. The $\overline{OCR}$ are constructed using the OIS due to Krippner (2009); the actual OCR changes and OCR shocks, both in percentage points, are presented in Figure 2.

Figure 2.



For the real relative return between NZ and US, two measures are constructed. One is based on the 10-year zero coupon swaps rate (Bloomberg codes: I04910y Index and I05210Y Index, respectively, for NZ and US data); the other is based on the 10-year plain vanilla swaps rate (Bloomberg codes: NDSW10 Curncy and USSW10 Curncy, respectively, for NZ and US data). Due to lack of daily inflation data in either country, the relative return is deflated using quarterly CPIs because the highest frequency of NZ CPI is quarterly (Bloomberg codes: NZCPCCPI Index and CPURNSA Index, respectively, for NZ and US, rebased on the June quarter 2006). Figure 3 shows the changes in the NZ-US relative real returns based on the 10-year zero coupon swap rate and the 10-year plain vanilla swap rate, on the OCR announcement dates.

The expected relative real return between NZ and US had to be constructed. Following Munro (2014), relative nominal returns over the next 10 years are summed and deflated by the expected future relative inflation rate. Two measures of relative nominal returns are considered, namely, the 10-year zero coupon swaps rate and the 10-year plain vanilla swap rate. The expected future relative inflation rate is calculated as a forward sum of forecast values based on an AR(1) process. In Munro (2014), the coefficient was estimated to be 0.88 for the NZ-US exchange rate for period December 1994 – July 2013. Considering that our sample largely overlaps with Munro's, we also use 0.88 for constructing this particular variable; however, two variations are included as well, which are 0.91 and 0.85 to check sensitivity of estimation results to the value of the coefficient. The plots of both types of swap rates constructed using 0.88 are presented in Figure 3.

Figure 3.

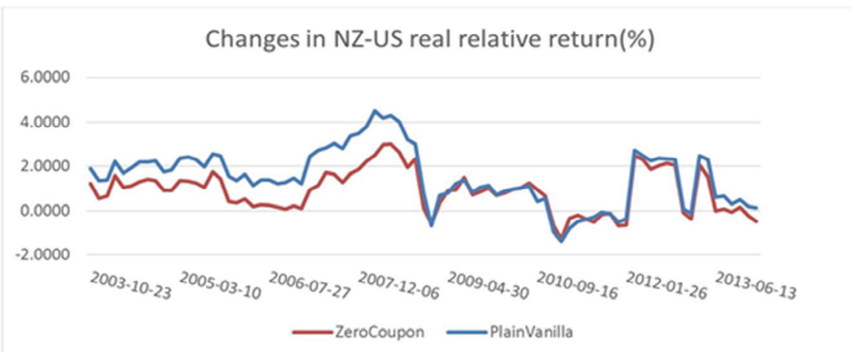


Table 1 provides a comparison of the present study with two recent studies using the event-study approach to examining the relation between monetary policy shocks and the NZ exchange rate. The comparison reveals that the present study not only uses a larger sample, but employs an asset pricing model to address differentials in returns between the two countries and currency risks. The instrumental variable in Zettelmeyer's study is a discrete variable with three values, namely, -1, 0, and 1; such trichotomy certainly limits the correlation between the instrumental variable and the interest rate which is a continuous variable. The instrument in the present study is a continuous variable and has a high correlation with the continuous real relative return variable. The expansion of the sample also allows for testing of the statistical significance of GFC in altering the relations between monetary policy shocks and the exchange rate.

Table 1. A comparison of the present study to other event studies

	Zettelmeyer (2004)	Kearns and Manners (2006)	This Research
Model/Estimation Method	Two-stage least squares	Ordinary least squares	Asset pricing model/Kalman filter and least squares
Event window	24 hours	70 minutes for exchange rate, 24 hours for interest rate	24 and 18 hours
Instrument Variable	Future direction of monetary policy condition.	N/A	Market based OCR shocks
Variables	90-day interest rate Directions of monetary policy Nominal exchange rate	30-day interest rate 90-day interest rate Nominal exchange rate	Real domestic and foreign relative returns Nominal exchange rate GFC indicator
Sample period	08/01/1990 ~ 01/19/2000	17/03/1999 ~ 10/06/2004	23/10/2003 ~ 30/01/2014
Observations	35	42	83

4.2 Empirical results

Table 2. Estimation results
(10YZC: 10 year zero coupon swap rate; 10YVS: 10 year vanilla swap rate)

Section A		
	Eq. (8)	
	10YZC	10YVS
γ_1	0.0092	0.0224
γ_2	0.4859**	0.7328***
F stats	9.362***	20.140***

Section B								
	24-hour				18-hour			
	Eq. (9)		Eq. (10)		Eq. (9)		Eq. (10)	
	10YZC	10YVS	10YZC	10YVS	10YZC	10YVS	10YZC	10YVS
α	0.0006	0.0007	-0.0035	-0.0038	-0.0014	-0.0014	-0.0066	-0.0071
β_η	-0.0061	-0.0040	0.0649**	0.0431**	-0.0055	-0.0083	0.0853**	0.0566**
α_{GFC}			0.0055	0.0060			0.0073	0.0079
β_{GFC}			-0.0737**	-0.0489**			-0.0918**	-0.0609**
N	82	82	82	82	59	59	59	59
R^2	0.006	0.006	0.06	0.07	0.008	0.008	0.05	0.05

The estimation results of equations (8), (9) and (10) are presented in Table 2 for both the window sizes and the two measures of real relative returns. Panel A of the table shows that OCR shocks are highly significant in explaining the shocks to the risk free returns that are part of the relative real returns. Therefore, there is strong evidence that the shocks to the risk free returns can be attributed to the OCR shocks. This supports instrumenting the shocks to risk free return by the OCR shocks to address mismeasurement due to non-policy economic shocks that happened to coincide with a policy announcement.

Panel B presents the estimates of the magnitude and direction of changes in the exchange rate as a result of OCR shocks which are channelled through the risk free component of the expected relative real returns. The small R^2 values are consistent with both Zettelmeyer (2004) and Kearns and Manners (2006). The baseline model of equation (9) has shown the insignificance of OCR shocks in explaining the movements in the exchange rate. However, controlling for the GFC effects has improved the model specification in terms of significance of model coefficients and

R^2. For both the window sizes, the significances of the coefficients are determined using the corrected standard error estimates according to the Newey-West heteroscedasticity and autocorrelation consistent estimator to address possible serial correlations in the regression residuals. The contrast between the two model specifications of equations (9) and (10) may highlight the importance of the GFC in mediating the relationship. In that sense, estimation based on equation (9) would suffer from an omitted variable bias.

Interpretations of the responses in terms of OCR shocks need refer to the first stage regression results in panel A of Table 2 which indicates that if the OCR shock increases by 100 basis points, the shock to the risk free return will increase by 0.4859 percentage points for zero coupon based relative real return, and 0.7382 percentage points for the vanilla based relative real return. The estimated responses of the exchange rate to monetary policy shocks are found to be 6.5 (0.0649 × 100) and 4.3 (0.0431 × 100) percentage points, respectively, for the zero coupon based and vanilla based relative real returns, for the 24-hour window period; these responses increased to 8.5 (=0.0853 × 100) and 5.7 (=0.0566 × 100) percentage points for the 18-hour window. Thus, a positive OCR shock of 100 basis points would cause the exchange rate to depreciate by about 3.2 percentage points (=6.5 × 0.4859 and 4.3 × 0.7382) for both the measures of relative real returns for the 24-hour window, and about 4.1 percentage points (= 8.5 × 0.489 and 5.3 × 0.7382) for the 18-hour window. Hence, there is evidence for ERP. However, during the GFC period, a positive OCR shock of 100 basis points would appreciate the NZ currency by 0.43 [3] or 0.32 [4] percentage points, depending on the measure of the relative real return and window size; the ERP was absent.

The response of the exchange rate to the monetary shock behaved differently during the GFC and non-GFC periods. In particular, for a contractionary monetary policy shock the exchange rate depreciated before and after the GFC period and appreciated slightly during the GFC period; and there is a stark difference in magnitude of the response of the exchange rate to monetary shock between the two periods. Such a contrast pattern is also found in Vithessonthi (2014) in the case of Thailand

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[3] (0.0649 – 0.0737) × 100 × 0.4859 ≈ -0.43 and (0.0431 – 0.0489) × 100 × 0.7328 ≈ -0.43

[4] (0.0853 – 0.0918) × 100 × 0.4859 ≈ -0.32 and (0.0566 – 0.0609) × 100 × 0.7328 ≈ -0.32

for the Thai baht and the Japanese Yen exchange rate. An explanation offered in Vithessonthi (2014) regarding the difference in magnitude is that during the GFC period capital flight from the US resulted in large capital inflows to safer countries which may moderate the response of the spot exchange rate to monetary policy surprises.

5 Conclusions

In recent years, a high exchange rate has created difficulties for New Zealand's export sectors. Some commentators have put pressure on the Reserve Bank of New Zealand to lower the highly appreciated New Zealand dollar by relaxing monetary policy. Although there have been previous studies examining the relationship between monetary policy shocks and exchange rate movements, there has not been enough research focusing on how monetary policy shocks influence the exchange rate since the RBNZ adopted the Official Cash Rate as its monetary policy instrument in March 1999. The research reported in this paper was carried out to examine the relationship between monetary policy shocks and New Zealand exchange rate movements since that date, taking into account possible influence from the global financial crisis.

Coupling an event study approach with an asset pricing model, this research employed data for the period October 2003-January 2014 and found evidence for the ERP in New Zealand for the pre- and post-GFC periods. The GFC has significantly altered how the exchange rate responded to monetary policy shocks in that the ERP was absent for the period. This finding shows that exchange rate return reacted asymmetrically to monetary policy surprises during the GFC period. Additionally, the effect of a monetary policy surprise on the exchange rate change was stronger during the financial crisis period. It is, however, necessary to point out that the low R^2s in the regressions showed a limited role that monetary policy shock had in determining exchange rate movements. This result is consistent with some previous studies. Eichenbaum and Evans (1995), for example, noted that monetary policy was important to maintain stable economic development, but the movements of exchange rate are not exclusively determined by monetary policy shocks. In addition, Dalziel (2002) and Karim, Lee and Gan (2007) also argued that monetary policy shocks only explain relatively small changes of exchange rate movements.

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Appendix

24-hour period in the US corresponding to the 24 hours to 11am in Auckland

	US Daylight saving	US Non-Daylight saving
NZ Daylight saving	6pm-6pm (previous day)	5pm-5pm (previous day)
NZ Non-Daylight saving	7pm-7pm (previous day)	Nonexistent

18-hour period in the US corresponding to the 18 hours to 11am in Auckland

	US Daylight saving	US Non-Daylight saving
NZ Daylight saving	12am-6pm (previous day)	11pm-5pm (previous day)
NZ Non-Daylight saving	1am-7pm (previous day)	Nonexistent

Dates when $\eta_t^{Rf\_US}$ may not be ignorable and hence are excluded in the estimation

NZ OCR Announcement Dates	USA FOMC Meeting Dates
31/01/2013	29-30/01/2013
31/10/2013	29-30/10/2013
30/01/2014	28-29/01/2014

Estimation results of equations (9) and (10): ρ_π =0.91 and ρ_π =0.85

ρ_π =0.91

Section A

	Eq. (8) 10YZC	Eq. (8) 10YVS
γ_1	0.0027	0.01600
γ_2	0.6929**	0.93987***

Section B

	24-hour				18-hour			
	Eq. (9)		Eq. (10)		Eq. (9)		Eq. (10)	
	10YZC	10YVS	10YZC	10YVS	10YZC	10YVS	10YZC	10YVS
α	0.0006	0.0006	-0.0030	-0.0033	-0.0015	-0.0015	-0.0059	-0.0065
β_η	-0.0043	-0.0031	0.0455**	0.0336**	-0.0058	-0.0043	0.0600**	0.0441**
α_{GFC}			0.0050	0.0055			0.0067	0.0073
β_{GFC}			-0.0517**	-0.0381**			-0.0644**	-0.0475**
N	82	82	82	82	59	59	59	59
R^2	0.006	0.006	0.06	0.07	0.008	0.008	0.05	0.05

***: significant at 1%; **: significant at 5%; *: significant at 10%

ρ_π =0.85

Section A

	Eq. (8) 10YZC	Eq. (8) 10YVS
γ_1	0.0130	0.0263
γ_2	0.3625**	0.6095***

Section B

	24-hour				18-hour			
	Eq. (9)		Eq. (10)		Eq. (9)		Eq. (10)	
	10YZC	10YVS	10YZC	10YVS	10YZC	10YVS	10YZC	10YVS
α	0.0008	0.0007	-0.0040	-0.0042	-0.0014	-0.0014	-0.0066	-0.0076
β_η	-0.0081	-0.0048	0.0870**	0.0518**	-0.0111	-0.0066	0.0853**	0.0680**
α_{GFC}			0.0062	0.0064			0.0073	0.0084
β_{GFC}			-0.0987**	-0.0587**			-0.0918**	-0.0732**
N	82	82	82	82	59	59	59	59
R^2	0.006	0.006	0.06	0.07	0.008	0.008	0.05	0.05