**DRAFT for COMMENTS**

# The New Zealand experience of short- and medium-term real exchange rate volatility: drivers and policy implications


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This version: 25 March 2013


**Abstract**

We look at realised real exchange rate volatility in New Zealand over the short term (periods up to one year) and the medium term (periods longer than one year) against the background of New Zealand's macroeconomic experience over several decades. Realised short-term volatility has been higher than that in many other developed countries. Medium-term / cyclical exchange rate volatility has also tended to be quite substantial, with relatively large and long-lasting cycles compared to most other countries. We discuss policy implications associated with this volatility. Medium-term volatility is likely to have the greater impact on macroeconomic performance. Empirical analysis suggests that much of the exchange rate's medium-term volatility can be attributed to the changing macroeconomic fundamentals of real aggregate supply and demand. Measures to improve the flexibility and efficiency of the economy and financial system may help to moderate the reactivity of the exchange rate to changing fundamentals. Monetary policy has some scope within the flexible inflation targeting framework to trade off volatility in the exchange rate against that in inflation to a limited extent, but this scope is subject to inflation expectations remaining anchored. FX intervention might be able to reduce short-term exchange rate volatility in some circumstances, but this is subject to a number of limitations in practice, including successful identification of departures of the exchange rate from levels justified by the fundamentals.



[1] We thank our colleagues at the Reserve Bank and the Treasury for helpful comments on earlier drafts. This paper has been prepared for a joint Reserve Bank-Treasury Forum on the Exchange Rate, Wellington, 26 March 2013. The views expressed in this paper are those of the authors and should not be represented as the views of the Treasury or the Reserve Bank.

## 1 INTRODUCTION

The New Zealand dollar exchange rate is widely perceived to be among the more volatile in its advanced-country peer group.[2] Exchange rate volatility is also often viewed as potentially harmful to macroeconomic performance, through adverse effects on trade or investment, or by encouraging protectionism.[3]

Yet the concept of volatility is ill-defined. A country's measured volatility relative to others can depend on the particular measures used, the horizon or frequency over which movements are measured, and the approaches taken (if any) to de-trend the data. Moreover, policy implications of volatility also depend on the frequency of interest. For example, short-term or high-frequency (e.g. quarterly) volatility may be of little policy interest if firms are able to access hedging markets in desired scale, and at a non-deterrent cost, to cover exchange rate risks over this horizon (see discussions in Mabin, 2011 and Sanderson, 2009). Medium-term or business-cycle frequency volatility may be of greater interest to the extent that hedging markets thin out, or risk management more generally becomes more expensive, with a horizon lengthening into the business-cycle-frequency range. Volatility at this frequency is also likely to be more relevant to firms' longer-term decisions about investment, employment and market strategy.

This paper looks in detail at the New Zealand experience of exchange rate volatility at different frequencies and discusses some policy implications. Different types of policy interventions affect volatility at different frequencies. Some interventions are in the nature of structural policy changes intended to improve durably the cyclical and long-run behaviour of the economy, while others are instead geared towards shorter-run stabilisation of the economy when shocks hit or when foreign exchange markets become disconnected from fundamentals.

We focus on exchange rate volatility at the cyclical frequency (periods one or more years long) and on that at the short-term frequency (one year or shorter). We distinguish between these frequencies because of the different roles of the relevant shocks, transmission mechanisms and market frictions in the economic effects of volatility; and in the impacts of policy interventions. These differences affect the assessment of the costs and benefits of potential policy interventions to address excessive exchange rate volatility.

The rest of the paper proceeds as follows. Section 2 presents summary statistics on the realised short- and medium-term volatility of the exchange rate in New Zealand and other countries over a period of several decades, covering a variety of exchange rate and monetary regimes. Sections 3 and 4 discuss volatility at the medium-term and short-term frequencies respectively, drawing on the New Zealand

[2] See e.g. Mabin (2010) and Schmidt-Hebbel (2006).
[3] See the general discussion in, for example, Darby *et al.* (1999) and Obstfeld and Rogoff (1995). Cassino and Oxley (2013) consider the implications of the literature for the New Zealand case.

macroeconomic experience to shed light on the drivers of this volatility. Section 5 explores some potential policy interventions to address excessive or damaging exchange rate volatility. Section 6 concludes.

## 2 THE DATA AND OUR METHODS FOR MEASURING REALISED VOLATILITY

Conceptually, concern about volatility is probably most relevantly expressed in terms of the extent to which changes in exchange rates surprise market participants, such that their plans predicated on a particular future exchange rate are rendered *ex post* suboptimal in light of the actual exchange rate that eventuates. In the literature, measuring this concept of the predictability of the exchange rate can involve deducing exchange rate expectations from forward markets (e.g. implied volatility), using empirical models to predict exchange rate movements, or relating the volatility in the exchange rate to the volatility of the determinants of the exchange rate. Such models can be based on economic theory of the fundamental determinants of the exchange rate, and may include dependence of exchange rate volatility on its own history and on the volatility in other macroeconomic variables.

Such approaches require careful modelling and are the subject of a vast technical literature. In this paper, we do not attempt such an approach. We instead present simple “unconditional” measures of volatility in the observed exchange rate, that is, we do not attempt to measure exchange rate surprises. We call our measures experienced or “realised” volatility. We illustrate some basic facts about the New Zealand unconditional volatility experience over several decades compared to other countries and explore the kinds of factors that are likely to have been relevant. We leave the analysis of conditional exchange rate volatility for future research.

Experienced or realised volatility is often measured as the typical size of exchange rate movements over a defined horizon, or as the dispersion of the exchange rate around its average or trend over a defined window of time (e.g. the standard deviation of percentage changes or the coefficient of variation).

To measure medium-term or “cyclical” volatility in the level of the exchange rate, we apply the Bry and Boschan (1971; BB) algorithm adapted for use on quarterly data. The BB algorithm requires the researcher to set a number of parameters that affect the duration of the cycles identified. We follow Harding and Pagan’s (2002) restrictions on peak-to-trough (PT) and trough-to-peak (TP) durations of identified cycles to be 2 quarters or longer and full cycles (PTP or TPT) to be 5 quarters or longer. This allows comparability with Schmidt-Hebbel’s (2006) study of cycles in New Zealand macroeconomic variables, which also used a quarterly cycle dating algorithm based on the BB procedure (and which we assume used the same

parameters for minimum phase and cycle durations).[4] We then test the sensitivity of the relative volatility results to changes in these parameters.[5]

These choices of parameters exclude very short cycles but not very long ones. For all countries in our sample there is sufficient medium-run variability in the real exchange rate for a handful of exchange rate cycles to be picked up.[6]

Our cyclical exchange rate volatility measures are calculated using the BIS's real exchange rates based on a "narrow" sample of 27 countries.[7] This sample of countries includes both fixed and floating regime currencies and real exchange rates of countries within currency unions (the euro area). We use a sample period that starts in January 1964 and ends in September 2012, which encompasses for many countries (including New Zealand) at least three different exchange rate arrangements – an internationally-governed system of pegged exchange rates (Bretton Woods), nationally determined fixed exchange rate regimes (e.g. New Zealand and Australia), and floating. Sullivan (2013) provides a history of New Zealand's exchange rate regimes.

We measure short-term volatility (sometimes called "noise") based on central tendencies of the monthly, quarterly and annual movements in the (log) levels of relevant variables. Looking at the change in exchange rates over different frequencies is a similar approach to Mabin's (2010) and, relative to the BB algorithm, (quite substantially) down-weights lower-frequency volatility (for example, removing a single unit root if present). We add to her analysis by supplementing the monthly volatility analysis with quarterly and annual volatility for the calculations of short-term volatility measures, and by calculating standard deviations as a measure of short-term volatility in addition to the average absolute change measure she uses.

[4] The large international literature on business cycles contains a substantial subset that imposes an upper limit of 32 quarters on the cycle duration, and a lower limit of 6 quarters corresponding to that imposed in Burns and Mitchell's (1946) seminal study of US business cycles. The upper limit reflects that Burns and Mitchell did not find business cycles longer than 32 quarters (Baxter and King, 1999). The same limits were subsequently and widely used in applied work and in cycle extraction techniques (e.g. Baxter and King, 1999). Cycle results from the BB algorithm applied here could be viewed as comparable with those using explicit bandpass filters such as Baxter and King's (1999), provided that the variables under consideration do not contain much variance due to low-frequency cycles (i.e. those longer than 33 quarters).

[5] The algorithm also features a smoothing step (discussed in Bry and Boschan, 1971 at p. 79) in which the length of a moving average must be chosen. We choose 6 quarters in our base case for this moving average (our main results were not affected by choices of this parameter between 4 and 8 quarters).

[6] Mabin (2010) used a "judgemental" approach to identifying medium-term exchange rate cycles, including requiring as a "general rule of thumb" that cycles should be five years or more in duration (i.e. much longer than the 5 quarter minimum cycle length used by Harding and Pagan to replicate NBER business cycle turning points for the US). She did this because she wants to avoid identifying many shorter cycles, which were not the focus of her study. By contrast, shorter cycles at the business cycle frequency are of central importance in our study, because of their importance for monetary policy conduct and for business investment planning. In the case of New Zealand, using a 5-year minimum excludes the substantial 15% drop and similarly-sized rebound in the exchange rate in 2006-07, for example. Hence, we use the 5-quarter minimum as in Harding and Pagan and Schmidt-Hebbel but also do some sensitivity testing.

[7] Effective real exchange rate and macroeconomic data used in this section were sourced from the BIS and Haver, respectively. See Klau and Fung (2006) for documentation of the BIS real exchange rate indices. The real exchange rate short- and medium-term volatilities calculated using these measures (which we choose for cross-country consistency) for New Zealand are similar to those calculated from a real exchange rate for New Zealand calculated from the official TWI and the corresponding domestic and foreign CPIs.

## 2.1 Results

### *2.1.1 Medium-term volatility*

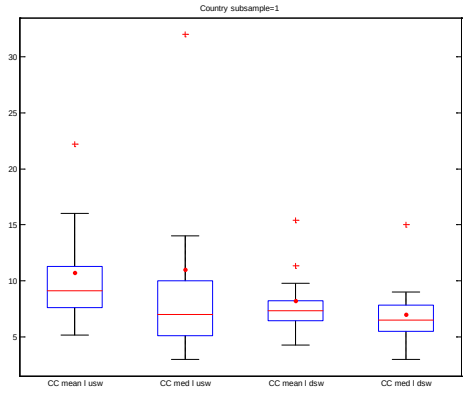
Appendix A shows the identified real exchange rate turning points for each country for the sample period January 1964 – September 2012, using the base case parameters stated above.

The number of cycles identified by the algorithm is not very large, making it difficult to say with much confidence whether there are material differences in cycle characteristics across our time, countries or exchange rate regime samples. However, an informal look at the identified turning points for each country suggests little evidence of systematic differences in cyclical characteristics along such lines.

Figures 1 to 3 below show the distribution across countries of the mean and median lengths of upswings and downswings and the number of cycles. The red dot in each figure shows the observation for New Zealand.[8]

One message from these figures is that both real exchange rate upswings and downswings in New Zealand have tended to be longer than those in the median country. Reflecting this, over the sample calculated using the BB with the parameter settings above, New Zealand (like Canada, Finland, Germany, and the Netherlands) experienced eight complete cycles, two fewer than the median of 10. Only Japan (7), Greece (6), Spain (5) and Singapore (4) experienced fewer cycles.

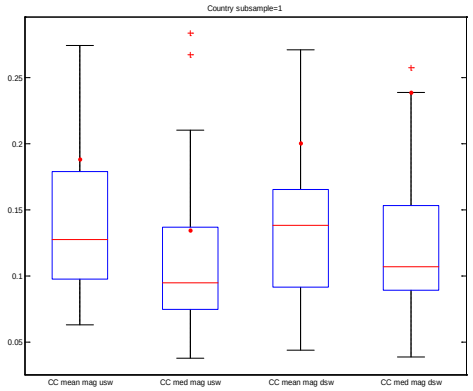
**Figure 1 – Cross-country distributions of mean and median lengths of cycles (quarters), 1964-2011**




Left to right: mean length of upswings; median length of upswings; mean length of downswings; median length of downswings. Red dot = NZ.

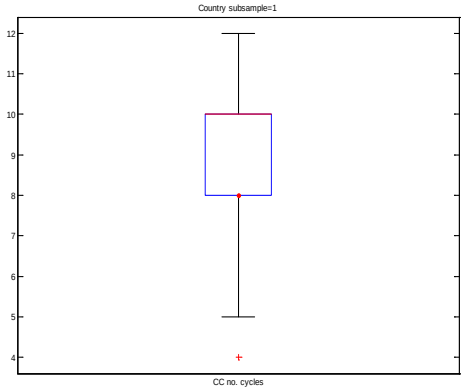
[8] The full sample is: Australia, Austria, Belgium, Canada, Chinese Taipei, Denmark, Euro area, Finland, France, Germany, Greece, Hong Kong SAR, Ireland, Italy, Japan, Korea, Mexico, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switze2rland, United Kingdom, United States.

**Figure 2 – Cross-country distributions of mean and median magnitudes of up- and downswings, 1964-2011 (percentage change from previous trough or peak)**




Left to right: mean magnitude of upswings; median magnitude of upswings; mean magnitude of downswings; median magnitude of downswings. Red dot = NZ.

**Figure 3 – Cross-country distribution of number of cycles, 1964-2011**

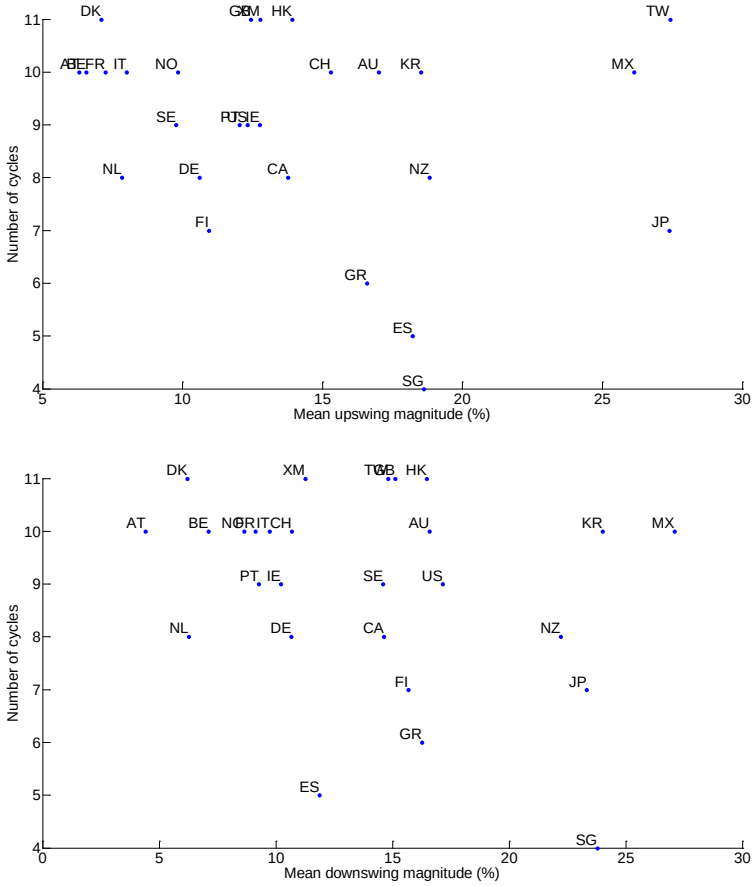



The mean and median appreciation and depreciation in New Zealand over the sample were also larger than the respective means and medians across the sample countries (median downswings particularly so). The mean upswing and downswing magnitude in New Zealand is about 18 to 20% relative to the previous trough or peak. The median country's was 12 to 14%. The countries that had magnitudes of upswings in the neighbourhoods of New Zealand's are Australia (17%), Spain (18%), Singapore (19%), Korea (19%), Mexico (19%), Japan (26%) and Taiwan (27%). Rankings for magnitudes of downswings are similar.

Finally, we combine the cycle amplitude and duration results to get a sense of how substantial overall the exchange rate cycles are across countries. Exchange rate cycles might be expected to have larger real economic effects if they are longer (so that they need to be withstood or hedged against for longer) and if they are bigger. Figure 4 below plots mean upswing and downswing magnitudes against the number of cycles for each country. Points to the southeast of the scatterplot represent cycles

that are more substantial (both longer and bigger). On this measure, New Zealand has had both longer and larger upswings and downswings than most other countries in the sample. The only exception on both dimensions (i.e. a country lying in the space to the southeast of New Zealand) in either case is Japan (particularly in the case of upswings), though Singapore also has had larger downswings and longer overall cycles.

**Figure 4 – Length and amplitude of exchange rate cycles**




See Appendix E for country codes.

To test robustness of these results, we changed the minimum peak-to-trough and peak-to-peak parameters from the base case of 2 quarters and 5 quarters respectively, to 4 quarters and 8 quarters respectively. This has the general effect of excluding more short cycles (those between 5 quarters and 2 years long peak-to-peak or trough-to-trough). The main result stands that New Zealand's real exchange rate cycles have tended to be larger and longer than most countries in the sample, but to a lesser degree. Using the stricter censoring rule, the algorithm determines that Japan, Mexico and Singapore had longer cycles, and larger upswings and downswings, than New Zealand over the sample.

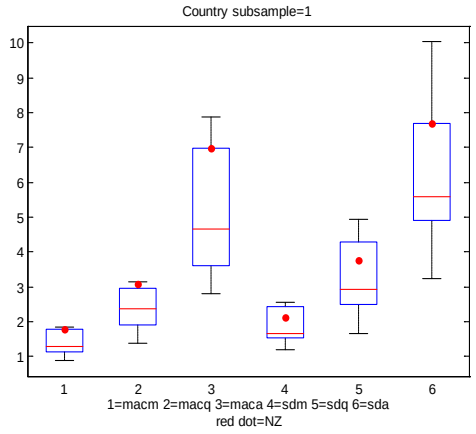
### *2.1.2 Short-term volatility*

In this section, we calculate for shorter horizons the mean absolute change (MAC) and standard deviation (SD) statistics using the "narrow" real exchange rate series (in log form) from the BIS for different groups of countries and sample periods.

First, we calculate MAC and SD statistics for the same countries and sample period in Mabin (2010),[9] and then see if the choices of frequency, summary statistic and sample change our assessment. We also then add two floating regime countries, Mexico and Norway, to the sample.

Mabin (2010) reported that for January 1999 to August 2010 New Zealand, Australia and Japan have had the highest short-term exchange rate volatilities, as measured by the MAC statistic calculated on monthly log changes. Over this period, their real effective exchange rates changed month to month by an average 1.8 to 1.9%, just over one standard deviation higher than the country sample mean of 1.4% (and at the 75$^{th}$ percentile). The cross-country relativities are about the same for quarterly and annual MACs. The standard deviations of percentage changes for New Zealand are closer to the median for monthly and quarterly movements (Korea, Japan and Australia are further from the median), but not for annual movements (where Korea occupies the top spot) (Figure 5).

**Figure 5 – Volatility measures calculated for same sample period (1999-2010) and countries as in Mabin (2010)**



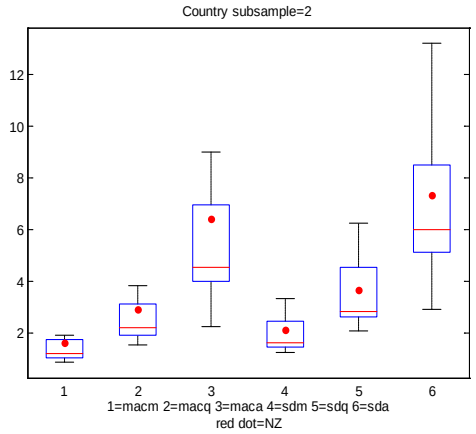

Left to right: monthly, quarterly and annual mean absolute changes; monthly, quarterly and annual standard deviations of percentage changes

New Zealand's short-term volatility compared with other countries looks broadly the same if we extend the sample endpoint to include the latest available data (but keep the starting period of January 1999) and add Mexico and Norway. However, New Zealand's distance from the median shrinks somewhat when the sample is taken

[9] Mabin's (2010) countries or currency areas are Australia, Canada, the euro area, Japan, Korea, New Zealand, Sweden, Switzerland, the UK and the US. Her sample is January 1999 to August 2010.

back to New Zealand's float in 1985 (see Figure 6).[10] This period includes the volatility in Mexico in 1994 Tequila crisis, the 1992 ERM crisis and the 1987 global stock market crash. Over the longer sample period, New Zealand's volatility measures are in absolute terms similar to those calculated on Mabin's (considerably) shorter sample, but those of Korea and Japan in particular are somewhat larger.

**Figure 6 – Volatility measures calculated for 1985-2012 and more floating countries**




Left to right: monthly, quarterly and annual mean absolute changes; monthly, quarterly and annual standard deviations of percentage changes

To summarise this section, over a long sample period and a range of exchange rate and monetary regimes, New Zealand's medium-term exchange rate cycles have been longer and larger than those in most other countries. And while New Zealand's short-term volatility has not been an outlier, it has nevertheless been relatively high.

## 3 EXPLAINING MEDIUM-TERM EXCHANGE RATE VOLATILITY

This section discusses possible explanations for the experienced medium-term exchange rate volatility in New Zealand.

Medium-term fluctuations in the exchange rate are likely to be significantly influenced by the fundamentals of aggregate demand, supply and competitiveness (see Cassino and Oxley, 2013). Importantly, these are the same fundamentals to which monetary policy also responds in targeting inflation, which means that the relationship between monetary policy and exchange rate behaviour is complex.[11]

[10] This provides 329 monthly, 108 quarterly, and 26 yearly observations.

[11] Beyond the medium term and into the long term, the now-standard view of the effects of monetary policy is that in response to a fully-understood change in the amount of money in the economy, prices, costs and expectations will adjust, so that the effect of the change on real variables eventually disappears, i.e. money is "neutral". This still leaves room for possible long-run real effects of monetary policy through its role in stabilising the economy, which is generally expressed in the negative i.e. unstable inflation is bad for long-run output. A refinement of this view is that, assuming that volatility in general is bad for output (for example because of its adverse effects on investment), and monetary policy has choices in trading off volatility in inflation against that in other variables (with the nature of this trade-off being dependent on the particular fundamental shocks under consideration), monetary policy *can* affect long-run output through its effects on volatility. Evidence on the effects of volatility on long-run growth is not especially clear. See Kneller and Young (2001) for a useful discussion.

Understanding particular outcomes in interest rates, the exchange rate, output and inflation requires identifying the deeper or "structural" shocks causing macroeconomic fluctuations and the dynamics of how the economy responds to them.

### 3.1 Understanding cyclical exchange rate movements

A standard view of the exchange rate is that it is an asset price whose value is given by expected returns available in New Zealand relative to those abroad (see, for example, Munro, 2004 and Mabin, 2011). This principle is captured in the well-known UIP (uncovered interest parity) relation.

Because expectations are core to the asset price view, expected fundamentals and not just their current values are relevant to the determination of the exchange rate. Any of the things affecting the relative economic outlooks of New Zealand and the global economy, and thus relative expected returns, will affect the currency. And because a change in expectations affects the currency, the exchange rate can move in advance of things like monetary policy decisions, fiscal policy changes and the release of data on economic outcomes, to the extent that market participants continually update their views on these factors.

As we discuss below, empirical work suggests a significant part of movements in the exchange rate can be explained by relative house prices and world commodity prices (McDonald, 2012 and Munro, 2004).[12] (Note that this says nothing about whether movements in variables like house prices are driven by underlying activity or some sort of irrational behaviour.) Monetary policy, in targeting inflation, also responds to these shocks since they influence the medium-term behaviour of inflation. Understanding moves in the exchange rate and interest rates generally requires understanding the underlying shocks. In general there is a positive co-movement of interest rates and the exchange rate, reflecting the preponderance of shocks to aggregate demand.

The macroeconomic balance (MB) view of the exchange rate offers a way to interpret exchange rate developments, by estimating the level of the exchange rate that would be consistent with definitions of internal balance (for example, output at potential or unemployment at its equilibrium rate) and external balance (the current account balance is consistent with convergence to a sustainable long run net foreign debt position).

In practice this is often interpreted as the exchange rate that would prevail in medium-term equilibrium if the foreign debt position is stable at its current level as a proportion of the economy. In this view of the equilibrium exchange rate, prices have had time to adjust and cyclical influences have been removed but debt stocks might

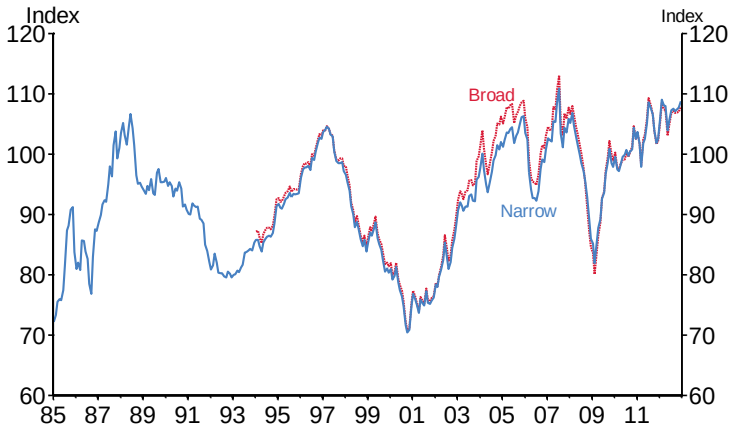
[12] Munro also observes that migration flows can help predict the exchange rate, which she suggests is because strong migration flows increase housing demand.

still be away from and converging to their long run equilibrium values (see Graham and Steenkamp, 2012). The cyclically adjusted and macro-balance equilibrium exchange rates will therefore differ to the extent that the exchange rate is driven by non-cyclical factors such as portfolio shifts, such as might be caused by changes in the perceived relative risk of New Zealand assets or of its external sustainability. After adjusting for imbalances in the internal economy or external accounts, the macroeconomic balance model tells us how much the exchange rate would have to shift to correct the imbalance, all else equal. It does not, however, shed light on how the overall economic adjustment (including that of the ER) might play out, and so is not predictive in that sense.[13]

### 3.2 New Zealand's recent cyclical experience

Sullivan (2013) deals with New Zealand history over an extended period. Here we focus specifically on cyclical behaviour of the exchange rate since the float (Figure 7), and its apparent interaction with other economic variables. Most of the discussion is drawn from the analyses of past New Zealand business cycles in Brook *et al*. (1998), Drew and Orr (1999), Reserve Bank of New Zealand (2000b and 2007), Chetwin (2012) and Chetwin and Reddell (2012).

**Figure 7 – The real exchange rate since 1985**
***(Index 2010 = 100)***




Source: Bank for International Settlements

The long economic expansion in the mid-1990s and that in the mid-2000s coincided with similarly-long periods of appreciation in the real exchange rate. Similarly, the recessions and initial period of recovery leading into the mid-1990s expansion and following the East Asia Crisis in 1997 saw the exchange rate depreciate from mid-1988 to mid-1992 from mid-1997 to the end of 2000.

[13] Note that a macro-balance framework is implicitly general equilibrium: because GDP is the sum of consumption, investment and net exports, shocks to anything of those components will affect output and the relative output gap and/or current account balance. That will affect the assessment of the "equilibrium" medium-term exchange rate.

Those sustained swings in the exchange rate make for an interesting contrast with a pair of quite sharp down-and-up movements later in the period. The exchange rate plunged and rebounded similarly-rapidly between the end of 2005 and middle of 2007. From there, it dropped again even further, bounced back quickly and then continued to climb more gradually thereafter.

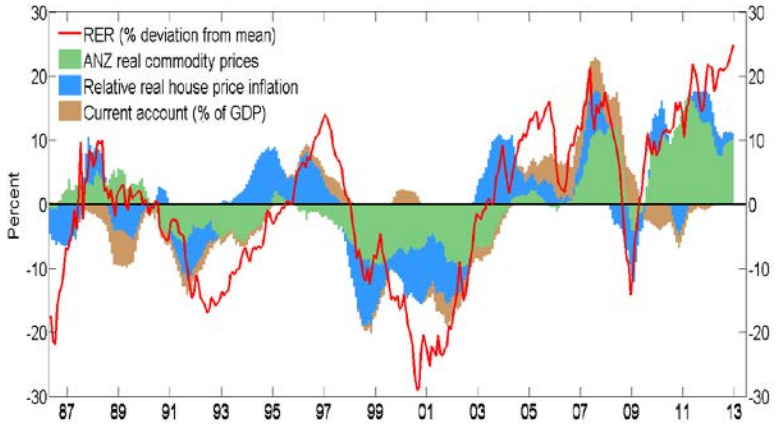
The downward leg of the v-shaped movement in the exchange rate from 2005-2007 appears to have reflected expectations that the outlook for New Zealand in particular was weakening. Cumulative tightening in monetary policy was beginning to bear on domestic demand, and real commodity prices in world terms were easing somewhat from their 2005 levels.

The plunge from late-2007 reflected a major drop in the global outlook coinciding with weakening domestic conditions (and expectations of easing monetary policy) and a reduced risk appetite. Investors appeared to perceive that the factors that had driven a long period of economic strength were falling away quickly. The rebound from the third quarter of 2009 was probably due to an investor emphasis on strong commodity prices rather than more-general strength. In spite of that quite-specific source of impetus, New Zealand's risk-adjusted outlook was strong relative to some of the major economies in the US and the European region.

Consistent with the view that the predominant real shocks in New Zealand have been aggregate demand shocks, the longer-lasting exchange rate cycles have coincided with strength in domestic property markets, global demand conditions and public spending, and in light of all those conditions, expectations of changing inflation pressure and the monetary policy stance.

McDonald (2012) provides more formal econometric evidence on a collection of variables that seems to have mattered for movements in the exchange rate since June 1986. Among a long list of candidate variables including interest rate differentials, the growth differential, commodity prices, equity prices, relative house prices and sales, immigration, and the current account balance, the analysis shows relative house price inflation, relative house sales volumes and world commodity prices – all of which can be thought of as indicators of domestic demand pressures and therefore the risk and return on holding the New Zealand dollar – as being on average the three most quantitatively important variables explaining movements in New Zealand's exchange rate (Figure 8).

**Figure 8 – Top three statistical drivers of the real exchange rate (deviation from mean)**




Source: McDonald (2012).

The models thus suggest that the exchange rate can be linked to observed macroeconomic data in a way consistent with the business-cycle view of exchange rate developments, even though substantial departures from these relationships can exist over the short term of a few months.

A significant part of the recent strength in the New Zealand dollar can be attributed to the near historic highs of New Zealand's export commodity prices.[14] Commodity prices help support spending and incomes through rural land prices and thus the wider economy. Housing market developments have also correlated strongly with the general business cycle in New Zealand and therefore also the exchange rate cycle. Current interest rate differentials tend to have low explanatory power once these other indicators are included in the models.

Consistent with the evidence in McDonald (2012), large and long rises in house prices in the mid-1980s, mid-1990s and the mid-2000s had a shape roughly similar to the climbs in the exchange rate. The same can be said of subsequent housing market downturns. The periods of house price growth were part of a story of strong domestic demand, and so the relative growth outlook, inflation outlook and interest rate outlook of New Zealand.

Aside from the global demand cycle as a dominant factor driving commodity prices, a number of large and unpredictable shocks affected New Zealand's export demand and commodity prices over the sample. These included the East Asia Crisis in 1997-98, terrorist attacks of 11th September 2011 in the USA, SARS scare in 2003, and much later the Global Financial Crisis and subsequent sovereign debt problems. These events variously kicked off, worsened or prolonged weakness in economic

[14] Chen and Rogoff (2003) also demonstrate the strong link between commodity prices and the exchange rates of commodity exporters such as Australia, Canada, and New Zealand. Preliminary work at the Reserve Bank suggests that volatility in commodity prices are an important driver of the exchange rate's volatility in New Zealand.

demand, nervousness about New Zealand's economic outlook, and reduced risk appetite, leading in all cases to sharp depreciations.

Some of those shocks, as well as domestic conditions, made for significant net migrant inflows early in each of the 1990s and 2000s expansions. In the short term, strong migration probably added more to demand for consumer durables and for housing than to supply capacity, contributing to the rise in housing markets.

Domestically, government demand played an important role at times. Late in each of the 1990s and 2000s expansions when support from abroad began easing, government spending rose, helping to extend the expansion phases and pressure on domestic resources (Brook, 2012).

Procyclical financial market conditions also contributed to the economic cycle over the sample. Rising house prices may have boosted strong private demand and investment in the rural and residential property sectors through relaxation of collateral constraints as well as wealth and confidence effects. Private borrowing increased by much more than nominal GDP. Expansions in government spending during the 1990s and 2000s growth phases meant government net saving was also falling. The mid-2000s also featured a period of compression of credit spreads worldwide amid ample global liquidity and a search for yield.

Finally, the Reserve Bank (as other economists) turns out to have underestimated the strength of the mid-2000s boom in the early years, meaning that policy rates were held lower than might have been warranted with the benefit of hindsight. That meant the boom was probably longer and stronger, meaning growth and interest rates – which respond to demand pressure on inflation – were higher for longer.

All of these factors contributed to substantial macroeconomic cycles in New Zealand. Indeed, applying the same BB algorithm as used for real exchange rates in section 2, to real per capita GDP and the unemployment rate for a range of advanced countries since 1975, suggests that cycles in those macro variables have also been larger and longer in New Zealand than in most countries in the sample. This observation suggests that the long and large exchange rate cycles in New Zealand may reflect long and large macroeconomic cycles. However, scatterplots of the relation between real exchange rate cycle characteristics and GDP per capita or unemployment rate cycle characteristics shows no particularly strong relation across countries, suggesting that the relationship is a more complex one (see Appendix B).

## 4 SHORT-TERM VOLATILITY

In this section, we look at the evidence on the degree of short-term noise in New Zealand exchange rate fluctuations – in other words, the component that is difficult to reconcile with fundamentals. As noted in the earlier subsection, in absolute terms the NZD seems to be noisier at high frequencies than many other currencies.

### 4.1 Understanding short-term volatility

Short-term exchange rate fluctuations can appear very noisy compared to the path of the overall economy, and compared to longer run considerations such as relative purchasing power. Economic modellers often invoke a range of market "frictions" that slow the adjustment of certain prices to their equilibrium levels in response to shocks, meaning that quantities and faster-moving prices take the adjustment instead. Because economists generally view the exchange rate as the fastest moving price in the economy, such frictions tend to generate increased volatility of the exchange rate in the face of certain shocks compared to the "frictionless" case.[15] For example, in the seminal Dornbusch (1976) "overshooting" model, sticky prices in goods markets imply a jumpier exchange rate in response to shocks (because goods prices by construction do not adjust as much as they would under flexible-price assumptions). Sticky prices are now a standard feature of models of business cycle dynamics (see e.g. Galí and Monacelli, 2005).

Because the exchange rate tends to jump in response to news, and news arrives daily or more frequently, the jumpiness at high frequencies appears much more related to very rapid adjustments to expectations among traders than to the slower-moving measured fundamentals of the economy. Transactions where buyers or sellers hold open positions for only very short periods (measured on intraday or daily timescales) tend to represent the majority of daily foreign exchange volumes in New Zealand currency trading, far in excess of transactions needed to settle or hedge trade in goods and services (Munro, 2004).[16]

At a short-term horizon, high-frequency foreign exchange trading therefore swamps the influence of the cyclical drivers of currencies. And while such high-frequency activity increases liquidity, it may also increase volatility by encouraging herding behaviour. Foreign exchange markets are also subject to very short term and simple trading strategies (e.g. chartist or "technical" approaches, including the widespread practice of extrapolative, or "momentum" trading).

FX traders continually update their expectations of relative rates of return across countries. These, and attitudes to risk, are in turn based on actual and expected relative interest rate settings and relative growth and inflation.

If the bulk of news is about the future, the volatility of current values of fundamentals may understate the volatility of the present value of future fundamentals. Changes in

[15] This could exacerbate the effects of exchange rate movements on the real economy and welfare. Policy aiming to reduce these frictions can help reduce volatility from this source. The horizon where rigidities are most relevant is an empirical question.

[16] The NZD gets a disproportionate share of global FX trade (at 1.6 percent, BIS 2010). Of total NZD transactions, only 36 percent are spot transactions, with the bulk being currency swaps (55 percent), according to the BIS (2010). Offshore activity accounts for around 90 percent of NZD turnover, while total daily FX trade represents over 100 percent of New Zealand's merchandise trade (McCauley and Scatigna 2011). While there appears to be a positive relationship between the ratio of FX turnover to trade compared to income per capita, New Zealand is still an outlier, with the world's second highest turnover-to-trade ratio, behind the US.

expected relative returns are capitalised immediately into the current level of the exchange rate. Flows in currency markets and the exchange rate can also be affected by changes in market sentiment or risk appetite. While bouts of waning appetite for more risky New Zealand assets might put downward pressure on the currency, an increase in uncertainty about the global economy might have the same effect as investors move funds to "safe haven" assets.

Countries with higher interest rates seem to attract more of the so-called "carry-trade" investment into domestic currency denominated bonds. Institutional factors may also have underpinned the development of NZD spot and swap foreign exchange markets and an offshore market for NZD bonds, including the credibility of New Zealand's inflation targeting regime, a general lack of intervention in currency markets and a relatively strong sovereign credit rating.[17]

### 4.2. New Zealand's recent experience of short-term volatility

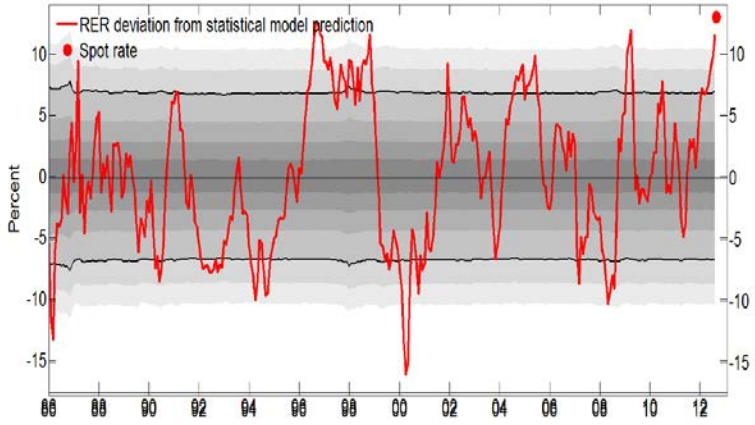
The relationship between the exchange rate and its various determinants seems to change over time. Cassino and Wallis (2010) use a regime-switching model to model how financial market participants focus on individual drivers (commodity prices, interest rates or risk appetite) of the exchange rate at different points in time. Risk appetite has, for example, at times replaced changes in relative interest rates as the key factor driving exchange rate movements at short-term horizons. However, those risk perceptions could possibly be seen as manifestations of relative fundamentals. It is also difficult to measure market expectations. This, in turn, makes it hard to assess the desirability of policy trying to lean against high-frequency volatility.

In New Zealand, noise appears at times to be as substantial a component of volatility as the fundamentals-driven component of the short-term cycle. Over the most recent past, the portion of the unexplained component of the exchange rate in the McDonald (2012) indicator model discussed in Section 3 has been unusually large (Figure 9).[18] That model suggests that 90% of the departures of the exchange rate from the model's prediction are up to 7-8% in magnitude.

This unexplained component captures unmodelled influences such as differences in traders' views of the future (which cannot be observed) compared to the view implicit in the observed indicators and model structure, any effects of the simple very short-term trading strategies mentioned above that might be only tenuously linked to fundamentals, and more general measurement and specification errors.

[17] It is unclear, though, whether offshore issuance activity contributes to exchange rate volatility. Work by Drage *et al.* (2005) suggests that issuance of offshore NZD denominated bonds do not have a large impact on the exchange rate.
[18] The indicators in the statistical models are: real commodity prices, terms of trade, real house prices, house sales, relative output gaps, current account, short-term interest rate differentials, long-term interest rate differentials, net migration, relative share market movements.

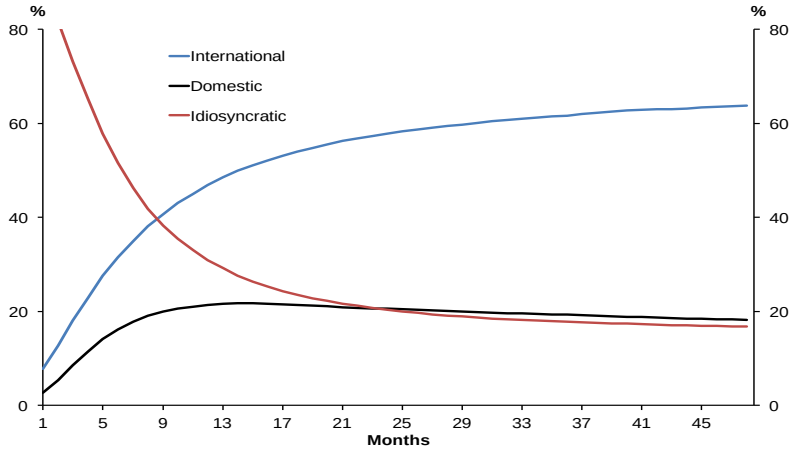
**Figure 9 – Residual component of real TWI in statistical model (% deviation)**




The three black lines indicate the 10th, 50th and 90th percentiles of the residuals from the statistical model.

An alternative "structural" approach to explaining exchange rate variance is also presented in McDonald (2012), which enables the decomposition of exchange rate movements into international, domestic and residual contributions due to unmodelled factors such as market sentiment. That model suggests that it is predominantly international factors (foreign output, prices and interest rates, as well as commodity prices) that drive exchange rate developments beyond the roughly 1-year horizon (Figure 10). Unmodelled idiosyncratic influences, such as (in this case) risk-on/risk-off sentiment, however, can explain a high proportion of exchange rate fluctuations in the very short run. While risk preferences and changes in perceptions of the global outlook might be expected to be connected to current relative fundamentals (as well as expected relative fundamentals) in some way, they also appear to be volatile and not very enduring, which is consistent with the teiling-off of their estimated influence as the horizon lengthens, as in this work.

**Figure 10 – Contribution to the variance in the real exchange rate***




Source: A structural vector autoregression (SVAR) model from McDonald (2012) was used for this decomposition.

A third means of thinking about the extent to which volatility is "warranted" by the fundamentals is to compare the volatility of the exchange rate to the volatility of its

underlying drivers. Because the exchange rate should embed expectations of all its fundamental determinants, it may have a similar volatility to its fundamentals.

Figures 1 and 2 in Appendix C compare the unconditional realised volatility of short and long-term interest rates, unemployment and output across countries. While New Zealand's volatility in real GDP is higher than the sample mean (by some measures), New Zealand's unemployment volatility does not stand out. The volatility of New Zealand interest rates and inflation have also been relatively high.[19]

This suggests tentatively that high relative short-term volatility in the exchange rate may have been "warranted" in the sense that it reflects high relative short-term volatility in the fundamentals. Very recent work by Karagedikli *et al*. (2013) using techniques to extract common factors from a large number of potential fundamental variables suggests that large parts of the exchange rate variation can be explained by fundamentals, and that the independent role of exchange rate as a source of shock is limited. This could suggest that in New Zelaand's case, at least some exchange rate responses could represent a "buffer" against the macroeconomic consequences of shocks.

The overall impression from these studies is that while current values of indicators of New Zealand's fundamentals may explain at least some, and in some cases much, of the volatility in the exchange rate, there appears to remain a material proportion unexplained. The unexplained proportion could in principle reflect bouts of irrationality or herding behaviour that are difficult to capture in economic models, as well as inaccurate measurement of the relevant fundamentals and their expectations. To that extent, the exchange rate may not always play a buffering role.

## 5 POLICY OPTIONS

A case for policy intervention to counteract volatility requires not only an understanding of the causes of volatility but also a view on its consequences. Advocates of policies aimed at reducing exchange rate volatility argue that a pure float increases macroeconomic volatility and discourages trade and productive investment, thereby permanently reducing potential output. Cassino and Oxley (2013) discuss the real economic implications of departures of the exchange rate from equilibrium levels and exchange rate volatility at different horizons. That paper argued that the evidence about the nature and overall impact of exchange rate volatility on economic performance is not conclusive.

On the one hand, there is a host of reasons why such volatility might adversely affect particular externally-exposed sectors or industries. But on the other, there will be

[19] Reviewing the New Zealand macroeconomic volatility experience, McKelvie and Hall (2012) found that macroeconomic volatility has decreased since 1987, while there has been an increase in persistence of prices and real variables.

times – particularly in the face of changes in external demand – when the exchange rate plays a beneficial buffering role by offsetting some of the effects of an adverse exogenous shock (by depreciating when export prices fall or there is external turmoil, for example). Because domestic prices are often slow to change when foreign prices change, the exchange rate helps relative prices and wages adjust, helping to reduce the impact of shocks on the economy. If the exchange rate moves because of a "portfolio" shock, however – e.g. a change in risk appetite rather than in underlying relative demand conditions – the exchange rate may not play that buffering role.

In this section we look at various policy options that could be considered in the case where damage to the economy from exchange rate volatility can be shown.

### *5.1. Choosing a different point on the trilemma*

Chetwin and Munro (2013) discuss the scope to seek more control over the exchange rate through fundamental changes to New Zealand's combination of monetary, exchange rate and capital account policies – choices in respect of the "trilemma". Moving away from the current choices of an essentially free float, open capital markets and monetary policy focused on domestic variables would imply a change in the nature of economic adjustment to shocks and changing international conditions. A less-variable exchange rate would put more of the adjustment burden on domestic prices and output, resulting in greater volatility in output and employment (see for example Stephens, 2006).

One way for policy to reduce exchange rate variability would be to try to constrain capital flows, to allow some degree of simultaneous control over both monetary policy and the exchange rate. This might be achieved either through explicit capital or exchange controls, which target the flow of capital and trading in exchange markets. However, capital controls have efficiency costs and reduce access to offshore funding, and there are questions about their ability to influence the volume of capital flows for any sustained period (e.g. Habermeier, Kokenyne and Baba, 2011). Trying to manage both interest and exchange rates with an open capital account would require a substantial stock of foreign reserves, which can be costly and expose the Government to considerable exchange rate risk.

Such a policy combination also involves increased institutional complexity, because the policy task becomes much more complex. That can come with reduced effectiveness / efficiency in the domestic operation of policy institutions and perhaps regulation. It also brings a considerably greater risk of costly policy failure (such as a financial loss on intervention and sudden sharp shifts in the exchange rate, or a loss of credibility for monetary policy allowing a rise in the level and volatility of inflation and expectations of inflation). Furthermore, capital flow measures aimed at reducing arbitrage pressure on the exchange rate would interfere with agents' access to financing and risk management tools, while a fixed exchange rate affects incentives

to manage exposure to exchange rate risk through hedging and other strategies, making for significant exposure in the event that a build-up of pressure should lead to a sudden shift in the exchange rate. Constraining capital flows might also reduce the opportunities for hedging, by removing from the market natural counterparties for those wanting to hedge.

## *5.2. Measures available in an essentially free float with open capital markets to respond to medium-term volatility*

Because the option of moving fundamentally away from NZ's current trilemma choices would have such far-reaching structural and institutional ramifications, the policy options we discuss from here take as given the current choice of a floating regime with open capital markets.

Within that framework we consider policy interventions relating to volatility attributable to fundamentals as distinct from that relating to noise. However, a general caveat is that policymakers' ability to distinguish noise-generated volatility from that driven by fundamentals is limited. Models that try to estimate the extent of "excessive" volatility of the exchange rate are inevitably subject to considerable uncertainty, as suggested by the range of results from the modelling approaches reviewed in the previous section. This makes it difficult to determine whether and exactly when to try to lean against exchange rate volatility, even if policymakers are generally prepared to lean if circumstances warrant it.

### *5.2.1. Enhancing the flexibility of the economy*

The long and large cycles in the real exchange rate evident in NZ across a number of quite different *nominal* exchange rate regimes and several decades (Sullivan, 2013) may suggest structural factors play a role. These structural factors can be barriers to New Zealand's underlying cost competitiveness generally, and to the economy's flexibility in the face of external shocks.[20] For example, there might be barriers to the economy shifting resources to and from trade-exposed sectors when relative prices change. These are factors over which monetary policy and exchange rate policy probably have little sway. However, that does not mean there are not things that could be done in other policy areas to assist adjustment and promote smooth adjustment to shocks – including topics under consideration in the work programme of the Productivity Commission.

Addressing financial frictions (such as balance sheet constraints on arbitrage, or incentives to take excessive short-term risk) that amplify the demand effects of business cycles might dampen their contribution to changes in economic momentum, reducing the work required of monetary policy. Financial regulatory

[20] As Cassino and Oxley (2013) note, for example, the flexibility of wages and prices in Hong Kong has supported adjustment in its economy when the nominal exchange rate has been unable to move in the face of shocks.

policy, for example, may help blunt risk-taking incentives (e.g. via capital and liquidity requirements) and strengthen arbitrage incentives (e.g. by promoting deep and complete financial markets).

Enhancing the supply of hedging products may help to reduce the impact of volatility on the economy. Whether more hedging instruments are ultimately stabilising may depend, however, on how expectations are formed and how agents learn (see Brock *et al*. 2009, for example).

In any economy, market expectations may fluctuate between overly optimistic or pessimistic views of relative asset returns. Policy can help by being transparent and sufficiently systematic that the market can infer reaction functions over time.

*5.2.2. Non-monetary policy stabilisation measures*

Pro-cyclical fiscal policy exacerbates demand pressure and inflation pressure in the upswing, requiring monetary policy to be more active. Electoral cycles and other pressures associated with the political process mean a risk of procyclical fiscal policy, especially in upswings, when current revenue relieves constraints on spending and, in a sustained upswing, can start to look increasingly like a structural rise in revenue rather than a cyclical one. On the low side of the business cycle, the scope to borrow for a government with a prudent debt position alleviates the contraction in government's contribution to demand pressure. Approaches to constraining the cyclical behaviour of fiscal behaviour to make it less pro-cyclical, such as the establishment of a stabilisation fund which draws in revenues during upswings and injects funds into the economy during downswings, may therefore help reduce the amplitude of the exchange rate cycle by relieving pressure on monetary policy (see, for example, Brook, 2012).

Macro-prudential policies seek to enhance financial system resilience in the face of shocks and to lean against the build-up of financial risks. Such policies can help reduce economic cyclicality, especially by cushioning the economy when large adverse shocks hit, but any effects of such measures in the upswing are unlikely to be major. To the extent that macro-prudential measures are able to constrain the contribution of the financial system to domestic cycles, they may reduce the need for monetary policy action, and this would affect interest-arbitrage incentives for money to flow into or out of the domestic currency, helping to relieve pressure on the exchange rate (see Reserve Bank of New Zealand/Treasury, 2006). If prudential measures focus on foreign exchange risk on balance sheets, they might also affect portfolio choice in ways that at the margin reduce exposure to swings in capital flows and the exchange rate, and so potentially exchange rate volatility in response to shocks.

Macroprudential tools should be seen as a complement to, not a substitute for, monetary policy as the primary tool for demand management. Likewise, the effects of financial sector interventions on capital flows are uncertain and could well be limited (Habermeier *et al*. 2011). Using such interventions to influence flows or for cyclical management would probably require quite major departures from the principle of risk-sensitivity in financial stability regulation, and thus be likely to cause rather than correct distortions.

### *5.2.3. Monetary policy measures*

The review of the medium-term exchange rate volatility experience in sections 2 and 3 emphasised that exchange rate cycles can to a large extent be explained by the cycles of real aggregate demand and supply and the fundamental domestic and foreign influences on them. Cycles of aggregate demand and supply imply variations in inflation pressure, so monetary policy also responds to them. In most countries shocks to aggregate demand tend to dominate those to aggregate supply, so interest rates and exchange rates tend to move in the same direction.

In New Zealand, as in other countries credibly committed to price stability as part of the macroeconomic policy framework, monetary policy has some discretion in responding to an economic shock. This includes the scope to take exchange rate considerations into account – within the overall constraint of maintaining price stability.

Since the passage of the RBNZ Act 1989 required monetary policy conduct to be governed by a Policy Targets Agreement (PTA), all PTAs have given operational effect to the principle of flexible inflation targeting, by which the Reserve Bank seeks to maintain price stability. Flexible inflation targeting as the organising framework for monetary policy is now mainstream in more than 20 countries worldwide (Roger, 2009), and it is not obvious that there are large potential gains in macroeconomic performance to be had from variations to the flexible inflation targeting approach. Despite some differences in inflation targeting frameworks, which appear mostly to be matters of form rather than substance, a common pattern of low and stable inflation has been established in New Zealand and other developed countries since the mid-1990s.[21]

In the New Zealand case, the PTA in essence codifies the idea of balancing constraint with flexibility, so as to stabilise inflation expectations while also allowing room for monetary policy to exercise some discretion in responding to shocks of different types as they arise. Successive amendments to the PTA have tended explicitly to allow for more flexibility (see RBNZ, 2000a for a discussion).

[21] Indeed, it is becoming more so, with the Federal Reserve Board of Governors (2012) in the US and the Bank of Japan (2012) recently announcing inflation targets.

Since it affects the future path of interest rates, the choice of monetary policy response to a shock is part of the mix determining the exchange rate response to the shock. The PTA's current policy target of "future CPI inflation outcomes between one percent and three percent on average over the medium term, with a focus on keeping future average inflation near the two percent target midpoint" provides quantitative guideposts for the extent of flexibility. PTA clause 3 illuminates further, giving examples of events with temporary effects to which the monetary policy might be expected to respond using the flexibility afforded by the policy target. Finally, clause 4(b) requires the Bank to seek to avoid unnecessary instability in output, interest rates and the exchange rate in its pursuit of price stability, which is perhaps the most obvious clause by which one might expect the Bank's choices of monetary policy response to be coloured by exchange rate volatility considerations.

The Reserve Bank has for some time used the flexibility afforded by the PTA in its responses to shocks. For example, the Bank has generally tried to look through the first round effects on inflation of exchange rate movements. The reason is that trying to offset such shocks would mean a more volatile OCR and possibly greater volatility in output and prices over the medium term than had an effort been made to reverse the exchange rate movement by shifting interest rates (e.g. Stephens, 2006 and Hampton *et al*. 2006). The judgement has been that the costs of such volatility in aggregate output and prices from such an action would tend to outweigh the benefits of the limited exchange rate smoothing that could be achieved.

More recent academic literature on monetary policy has started to explore departures from the law of one price as a reason for monetary policy to lean against exchange rate movements independently of their effects on inflation.[22] In this view, such deviations cause costly misallocations of resources and so should be considered as relevant distortions to be leaned against by monetary policy, in the same way that distortions caused by price rigidities are now accepted in mainstream monetary theory as warranting a monetary policy offset.

In most models the typical gains from adding such exchange rate considerations to monetary policy objectives are small. Balanced against these considerations are the risks of reducing the central bank's policy credibility and hence more volatile inflation expectations, if the approach causes a breach of monetary policy targets. Financial market participants act on expectations of future policy and economic conditions, and not just on the current settings. Many market participants would expect a subsequent policy reversal if settings were inconsistent with inflation objectives, and so the exchange rate might move little. At the same time, the action could damage

[22] Such deviations are sometimes viewed as resulting from delayed passthrough of changes in domestic currency import prices to retail prices, although Cavallo, Neiman and Rigobon (2012) suggest that deviations might instead reflect differences in prices when new goods are introduced, rather than reflecting stickiness in prices. Theoretical work indicates that the mechanism of price-setting and the openness of the economy are relevant to the inefficiencies caused by departures from the law of one price.

the Reserve Bank's perceived commitment to price stability and allow actual inflation to rise. The loss of credibility could raise the perceived risk of investing in the country and possibly increasing exchange rate volatility.

Trying to limit the amplitude of the exchange rate cycle by using interest rates, without carefully and transparently reorienting the Reserve Bank's objectives and underlining that the overall commitment to price stability remains, risks confusing the public about those objectives, and causing inflation expectations to become unanchored. Having said that, the emerging literature exploring distortions in markets exposed to exchange rate fluctuations and their monetary policy implications warrants continued monitoring.

### *5.3. Measures to reduce short-term volatility and its impact*

The impacts of exchange rate volatility over short-term horizons might be reduced by the availability of hedging products and perhaps by prudential policies that ensure exchange rate risk is prudently managed.

Also, despite the difficulty of identifying and successfully leaning against noise, many central banks reserve the capacity to intervene (either unilaterally or with the approval of the government) in foreign exchange markets when it is felt that noise can usefully be corrected. While FX intervention is the most commonly applied policy instrument, some countries have also used capital controls.

It is generally accepted that such measures are probably not durably effective if there are strong fundamental reasons for capital in(out)flows and appreciation (depreciation) pressure (e.g. Habermeier *et al*. 2011 on capital flow measures and Adler and Tovar, 2011 on the effectiveness of intervention). Moreover, all such non-interest rate financial policy measures can be expensive and risky (Cassino and Lewis, 2012).[23] At best, intervention may be able to reduce the amplitude of the currency's cycle around its long-term average. That is not to say that intervention might not work when the exchange rate is extremely misaligned or that it might not limit short-term volatility in the foreign exchange market during a time of market disorder or thin trading.

The Reserve Bank's intervention policy stipulates that intervention be limited to periods where there is market dysfunction or strong evidence of misalignment, as opposed to trying to engineer level shifts or keep the level of the exchange rate within certain bounds or trying to use discretionary intervention to smooth movements in the exchange rate such as in Singapore. There is a high threshold for intervention, with the requirement that it is consistent with the stance of monetary policy and that it has a high probability of success.

[23] The extent of foreign trade in the New Zealand dollar also limits the potential impact of intervention and implies that the Bank risks imposing losses on taxpayers.

## 6. CONCLUSION

In this paper we presented some simple measures of the short-term and cyclical volatility of the New Zealand real exchange rate. We showed that while New Zealand's exchange rate volatility is not so high as to make it an outlier over a short-run frequency, exchange rate volatility has been high compared to the median of the countries considered. Over a business cycle frequency, however, New Zealand's exchange rate has been more volatile than many of its peers.

We also explored the reasons for the experienced cycles and short-term noise seen over several decades in New Zealand. There is evidence that the exchange rate is prone to "overshooting", sometimes persistently, in the sense that its movements are quite jumpy, compared to observed changes in economic fundamentals. Departures of the exchange rate from its longer-run trends can be quite large and prolonged.

We argued that the volatility of domestic demand has played an important role in the volatility of New Zealand's exchange rate. The volatility is quite consistent with models of equilibration of the economy when it is hit by shocks and when there are rigidities or frictions in other parts of the economy. Policy aiming to reduce exchange rate volatility can therefore focus on addressing the domestic sources of economic volatility and the rigidities that might prevent the economy responding quickly to shocks, and improving the economy's resilience to economic and financial volatility.

Monetary policy might be able to make a difference to nominal exchange rate volatility at the margin, but it is unable to deliver persistent reductions in the path of the real exchange rate without inflation soon cancelling out its effects. Other government policies affecting demand, such as fiscal policy, are likely to have a greater and more durable impact. Measures to make the economy more flexible may also be able to reduce the reactivity of the exchange rate to shocks. Direct FX intervention measures are unlikely to make a difference to the cyclical volatility of the real exchange rate, but may be able, at times, to reduce the effects on short-term fluctuations of simplistic trading rules or poorly formed expectations.

Future work should:

- consider market measures of volatility (such as implied volatility from options prices) and especially measures of conditional volatility;

- identify different types of shocks and consider their importance in explaining exchange rate volatility – which would probably require taking a stand on the temporariness or permanence of the shocks; and

- use volatility measures in structural models to examine the potential effect of changes in volatility on aggregate and sectoral growth performance.

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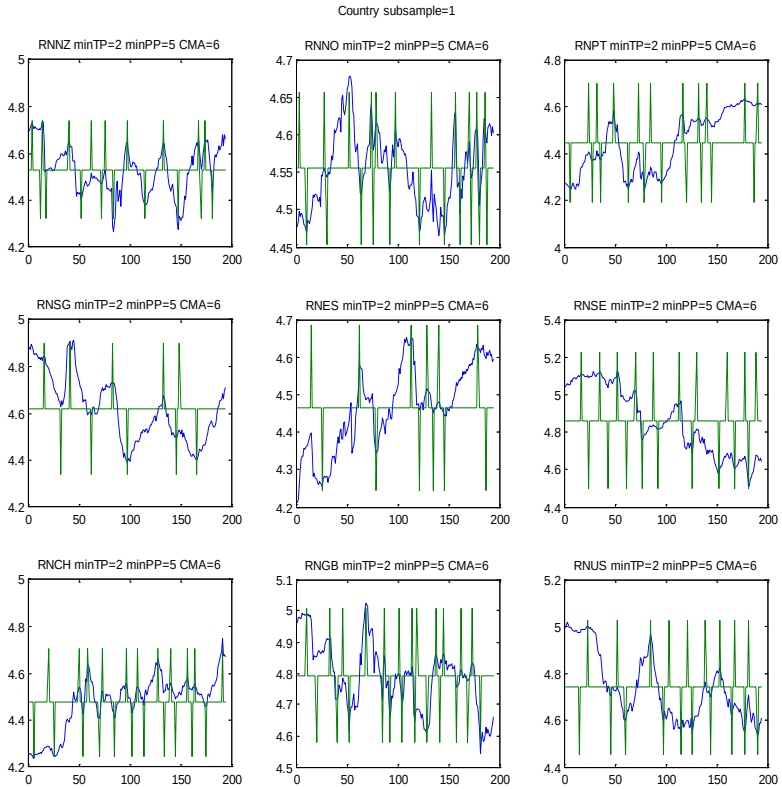
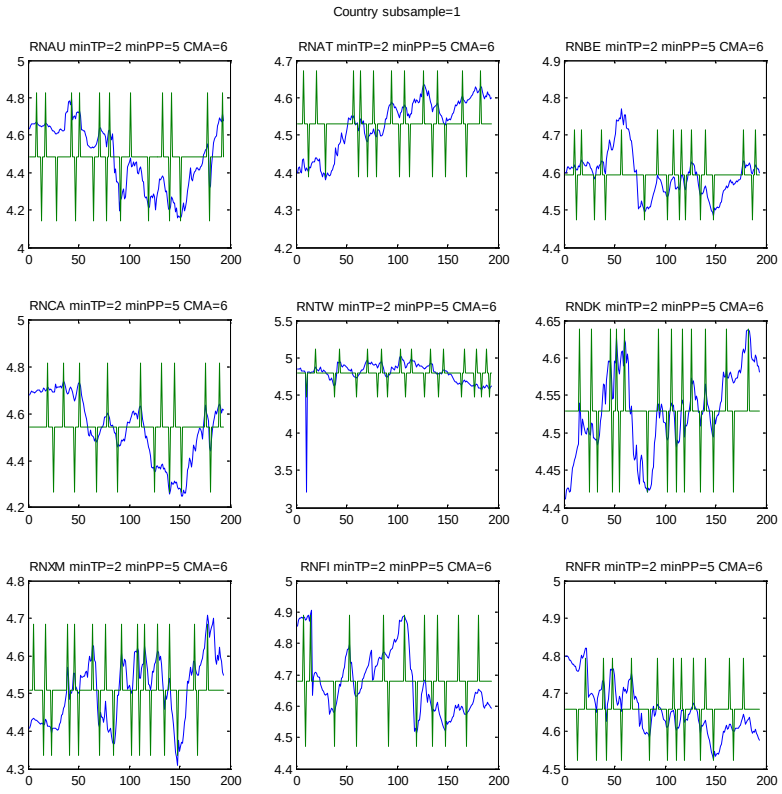
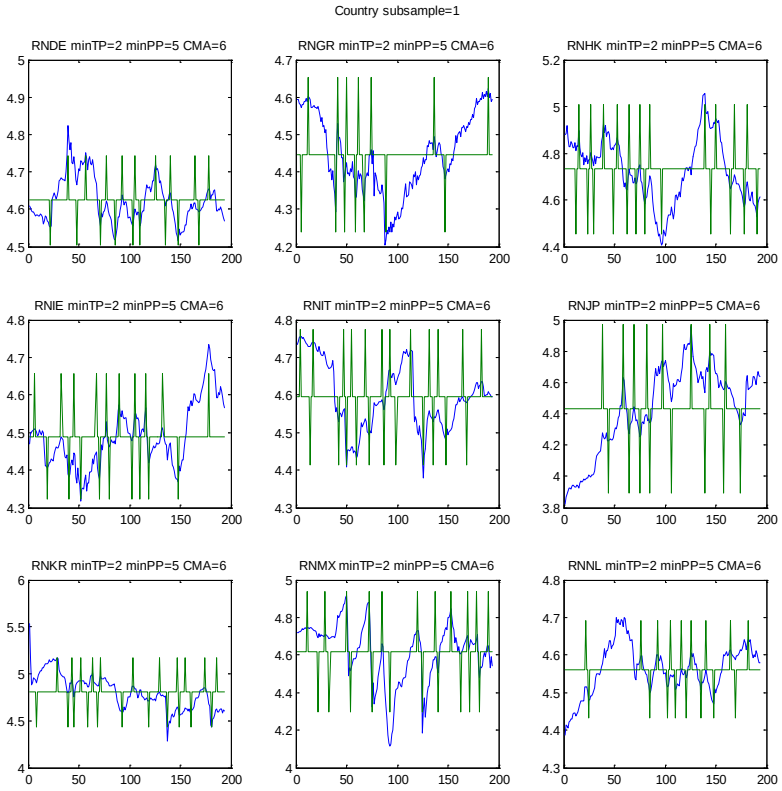
# APPENDIX A
## Bry-Boschan turning points in real exchange rates by country



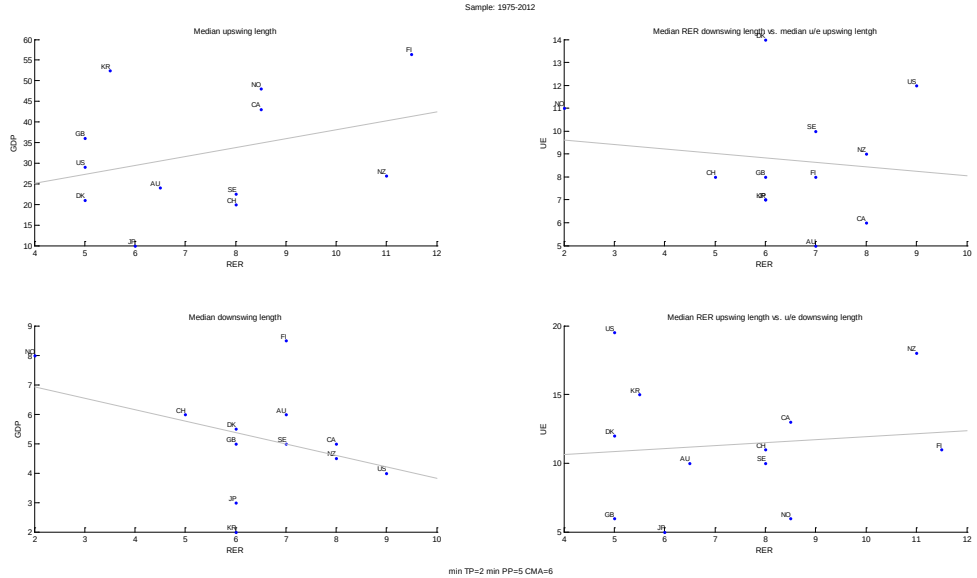



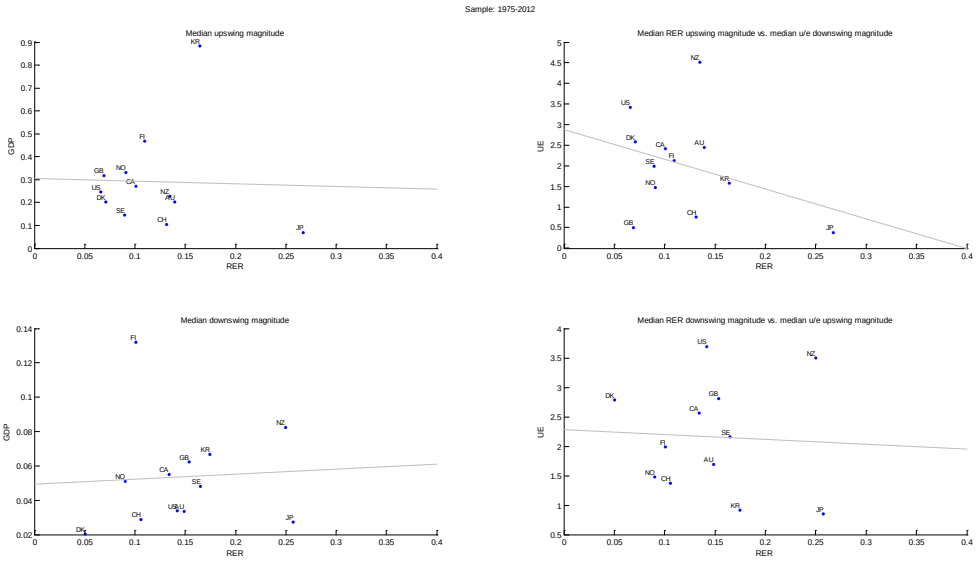



Country is given by last two letters in the first code in the title. See Appendix E for country codes. Time axis is in observation number, where 1 is 1964Q1.

# APPENDIX B

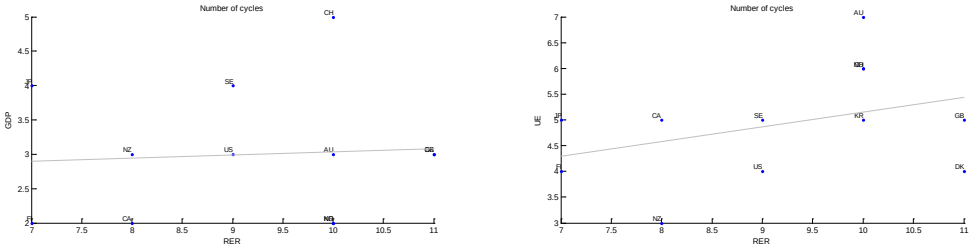
## Real cycle characteristics vs. real exchange rate cycle characteristics




See Appendix E for country codes.

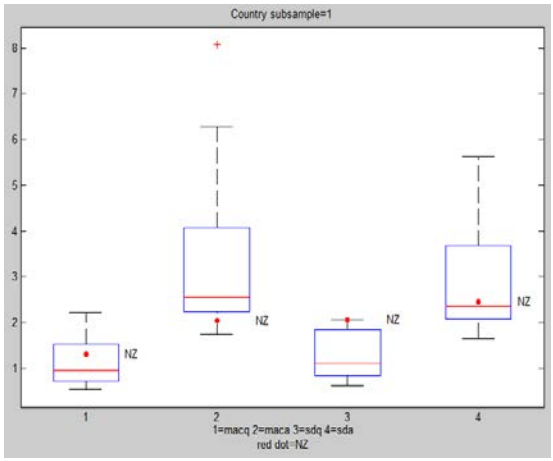
Sample: 1975-2012



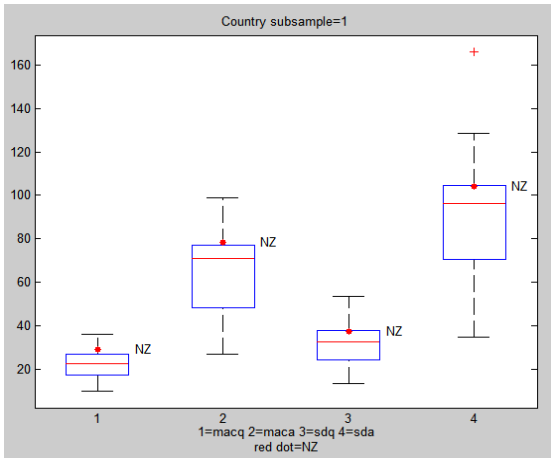

min TP=2 min PP=5 CMA=6

## APPENDIX C

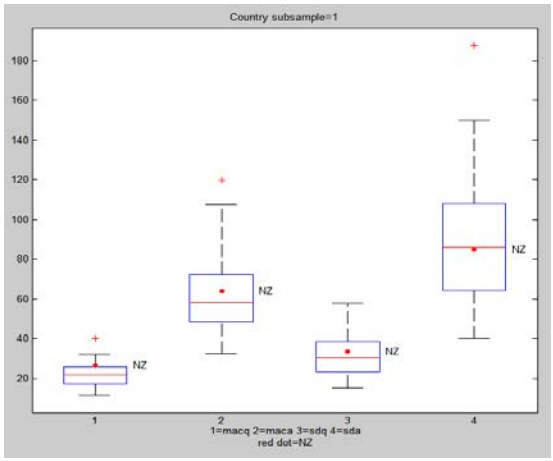
### Figure 1: Comparison of RGDP volatility (sample 1975-2012)[24]




### Figure 2: Comparison of Unemployment volatility (1981-2012)[25]




### Figure 3: Comparison of Unemployment volatility (1991-2012)[26]




[24] Countries: 1 4 5 6 8 12 15 16 17 19 20 22 24 25 26 27. See Appendix E for country codes
[25] Countries : 1 4 5 6 8 12 15 16 19 20 24 25 26 27. See Appendix E for country codes
[26] Countries : 1 4 5 6 8 12 15 16 17 19 20 22 24 25 26 27. See Appendix E for country codes

**Figure 4: Comparison of Inflation volatility (1992-2012)[27]**

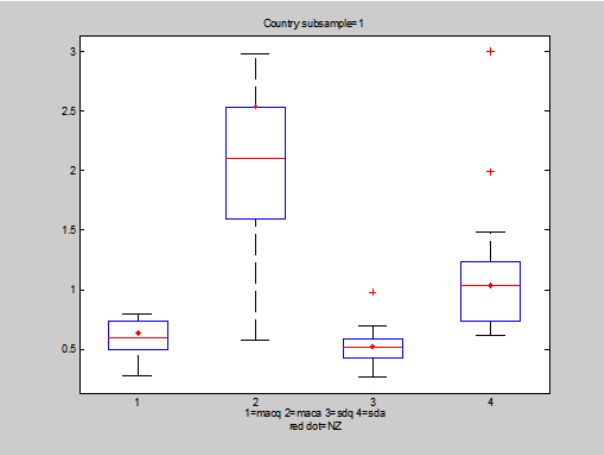



**Figure 5: Comparison of 90 day interest rate volatility (1991-2012)[28]**

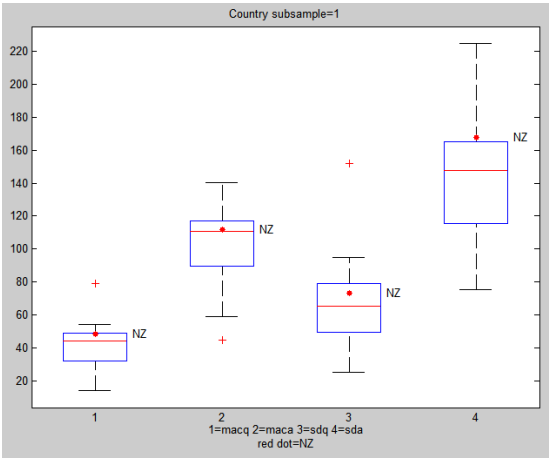
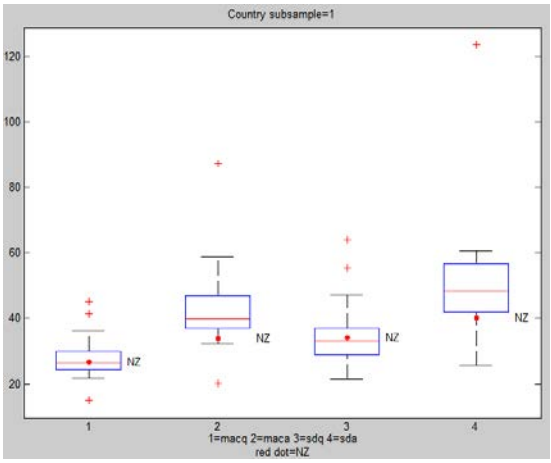



**Figure 6: Comparison of 10 year interest rate volatility (1998-2012)[29]**




[27] 1 4 5 6 8 12 15 16 19 20 22 24 25 26 27. See Appendix E for country codes
[28] 1 4 5 6 7 8 12 15 16 19 20 22 24 25 26 27. See Appendix E for country codes
[29] 1 4 5 6 7 8 12 15 16 19 20 22 24 25 26 27. See Appendix E for country codes

## APPENDIX E

### Country codes

| | | |
|---|---|---|
| 1 | AU | Australia |
| 2 | AT | Austria |
| 3 | BE | Belgium |
| 4 | CA | Canada |
| 5 | TW | Chinese Taipei |
| 6 | DK | Denmark |
| 7 | XM | Euro area |
| 8 | FI | Finland |
| 9 | FR | France |
| 10 | DE | Germany |
| 11 | GR | Greece |
| 12 | HK | Hong Kong SAR |
| 13 | IE | Ireland |
| 14 | IT | Italy |
| 15 | JP | Japan |
| 16 | KR | Korea |
| 17 | MX | Mexico |
| 18 | NL | Netherlands |
| 19 | NZ | New Zealand |
| 20 | NO | Norway |
| 21 | PT | Portugal |
| 22 | SG | Singapore |
| 23 | ES | Spain |
| 24 | SE | Sweden |
| 25 | CH | Switzerland |
| 26 | GB | United Kingdom |
| 27 | US | United States |