Westpac InstitutionalBank

A forecasting model for the NZD/AUD exchange rate

occasional paper

Dominick Stephens

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1 Introduction

This paper takes a two-step approach to forecasting the New Zealand Dollar / Australian Dollar exchange rate (NZD/AUD). First, an estimate of "Fair Value" for the NZD/AUD is developed. Fair Value reflects movements in the exchange rate that can be explained by relative interest rates and relative inflation rates, according to the theories of Purchasing Power Parity and Uncovered Interest Parity. We find that Fair Value has risen over time, from 0.82 in 1994, to almost 0.87 today. Interestingly, the monthly averages of the actual exchange rate have always been within 10% of the estimated Fair Value over the past 15 years.

Movements in the exchange rate that cannot be explained by interest rates and inflation rates are termed "Deviations from Fair Value". The second leg of the paper is a model for explaining and forecasting these Deviations. The model investigates the role of a range of economic variables, finding that commodity prices, GDP growth rates, and migration rates are the most important. We also find that the exchange rate exhibits strong momentum, but has a strong tendency to revert to Fair Value over the years.

Our particular interest in the NZD/AUD exchange rate stems from the closeness of the two economies. Goods, services, capital and labour all flow freely between Australia and New Zealand, and many regulations are either similar or actively harmonised.[1] This could make the NZD/AUD more responsive to fundamentals, as it is less affected by regulations or investor home-bias than other currency pairs.

From a New Zealand perspective, the NZD/AUD exchange rate may be the most relevant exchange rate for judging whether the NZD is overvalued or undervalued. The NZD/AUD is not affected by "third country effects" (or contagion) to the same extent as the NZD/USD. Australia looms very large on New Zealand's economic landscape – it accounts for a fifth of New Zealand's trade in goods, and is the main source of tourist visitors. NZ's migration flows are dominated by people moving back and forth across the Tasman Sea. The Australian economy also affects New Zealand in less obvious ways. For example, at the time of writing a mining and construction boom in Queensland and Western Australia is sucking-in labour and exacerbating an acute shortage of labour in New Zealand. Developments in the Australian economy profoundly affect New Zealand, and therefore they affect the New Zealand Dollar. A researcher who concentrates on New Zealand and US economic data in an effort to understand the NZD/USD exchange rate could be confounded by data developments *in Australia*.

Australia is five times larger than New Zealand by population, but New Zealand is still important to Australia. New Zealand is Australia's fifth largest trade partner, accounting for 5% of exports. It is the main source of short-term visitors, and the main destination for short-term overseas visits. The year-to-year variation in Australian migration is mainly caused by New Zealanders (other migrant flows are controlled by regulation and are therefore more stable). Contagion also affects the Australian Dollar to some extent, with data developments *in New Zealand* sometimes affecting the AUD/USD exchange rate. Most importantly, many large Australian-owned companies (including Westpac) operate in New Zealand and are affected by the NZD/AUD exchange rate.

The following section backgrounds the theories of exchange rate determination and explains how they are used to create a forecasting model. Section 3 outlines the Fair Value Model, and section 4 outlines the Deviations Model. Section 5 covers the forecasting performance of the models, and section 6 concludes.

2 Background to the forecasting approach

The estimate of Fair Value is rooted in the theories of Purchasing Power Parity (PPP) and Uncovered Interest Parity (UIP), which dictate the relationship between interest rates, inflation, and exchange rates.

2.1 Inflation and exchange rates – Purchasing Power Parity

Inflation is the process of money steadily losing its value. A currency experiencing inflation is gradually becoming less useful for purchasing goods and services, and will therefore be less favoured on foreign exchange markets. That, in a nutshell, is the theory of PPP.

[1] Free trade in goods and services was established in the 1983 Closer Economic Relations Agreement. Tariffs were completely eliminated by 1990, with only a few remaining exceptions such as apples, television broadcasting and coastal shipping. Other agreements cover the harmonisation of regulations in goods and services markets, the mutual recognition of occupational standards, and reciprocal social security payments.

Since 1993 Australia has experienced a cumulative total of 42.4% inflation (excluding the effect of GST), while New Zealand has experienced 38.9%. Thus the "purchasing power" of the New Zealand dollar has risen by the difference, 3.5%, compared to the Australian Dollar. Lower inflation in New Zealand is the main reason that our estimate of Fair Value has trended up over time.

Empirical research has generally found PPP to be a useful guide to the long-run level of exchange rates. PPP asserts itself only slowly for most exchange rate pairs, but may be faster-acting in the case of the NZD/AUD. Luo and Plantier (2003) estimated that deviations from PPP have a half-life of 1.6 years for the NZD/USD, but only 0.6 years for the NZD/AUD, consistent with our later finding that the NZD/AUD has generally been close to Fair Value for the past 15 years.

2.2 Interest rates and the exchange rate – Uncovered Interest Parity

It is more valuable to hold a currency that pays a high rate of interest than to hold a currency paying a low rate of interest. Therefore, when interest rates rise in one country, its exchange rate tends to appreciate. The relationship between interest rates and exchange rates is governed by UIP.

The predictions of UIP are widely misunderstood, so it is worthwhile briefly reviewing them. A straightforward comparison of the *level of* interest rates in two countries is not meaningful for the exchange rate. Interest rates incorporate a "risk premium" component that compensates the lender for the risk of default. Risk premia vary between countries, and can vary over time. Interest rates in New Zealand average about 0.9% higher than in Australia because lending to New Zealand is a riskier prospect. That 0.9% extra interest is not an attraction to invest in New Zealand, it is merely compensation for extra risk.

Suppose that New Zealand interest rates rise over and above the risk premium. Australians would be incentivised to purchase New Zealand Dollars, put the money in a bank, and enjoy higher interest rates. This would create demand for the NZD and drive the NZD/AUD higher.

The *extent* of exchange rate appreciation depends on the size and expected duration of the interest differential. Suppose that New Zealand rates are 1% higher than normal, and are expected to remain so for one year, then the NZD should appreciate by 1%. The total "carry" benefit from switching out of AUD into NZD is 1%. But carry is only half the story – investors also have the future exchange rate to consider. Investors would buy NZD only if they expected any exchange rate depreciation to be less than 1% over the year. No rational investor would chase a 1% yield advantage if they anticipated losing more than 1% on the exchange rate! The corollary is that investors will continue to bid the exchange rate up until the exchange rate is 1% above whatever they are expecting the exchange rate to be in a year's time. Figure 1 overleaf is the normal illustration of UIP.[2] If investors assume the exchange rate will return to its previous level when the interest differential expires, then the total exchange rate appreciation should be 1%.

A vast literature has attempted to verify UIP using time series data, and has broadly failed.[3] This is hardly surprising. To verify UIP one would need to know the market's exchange rate expectation which is unobservable and could depend on future inflation, future commodity prices or future productivity levels.

Theory suggests that the exchange rate should rise in anticipation of interest rate increases, and then fall, in the fashion of Figure 1. But in practice, interest rates and exchange rates are positively correlated.[4] This observation does not invalidate UIP. Third factors could be systematically affecting both interest rates and long-term exchange rate expectations. For example, New Zealand's exchange rate could rise because of an increase in export prices (see section 2.4 for an explanation of why). In addition to their direct effect on the exchange rate, higher export prices might create inflationary pressure, causing interest rate markets to price in hikes from the Reserve Bank. And higher interest rates would have their own effect on the exchange rate. The net result would be higher interest rates, and a higher exchange rate, with the exchange rate rising by more than predicted by UIP – exactly what we tend to observe in practice. Figure 2 overleaf illustrates how changes in exchange rate expectations could exaggerate the apparent relationship between interest rates and the exchange rate.

[2] This diagram was adapted from Munroe (2004).

[3] Munroe (2005) contains a comprehensive review of both international and New Zealand theory and evidence surrounding UIP.

[4] For recent New Zealand examples of estimated relationships between interest rates and exchange rates, see Munroe (2005), Conway and Franulovic (2002), and Stephens (2004). The estimated relationship between interest rates and the exchange rate varies between studies.

Figure 1: Exchange rate behaviour following an unexpected interest rate increase, according to UIP, assuming that exchange rate returns to previous level once interest differential has passed

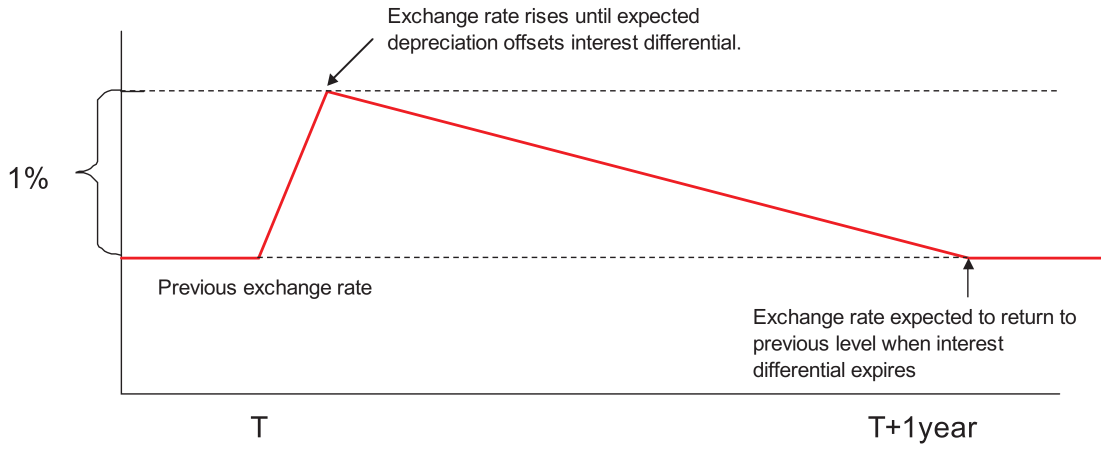
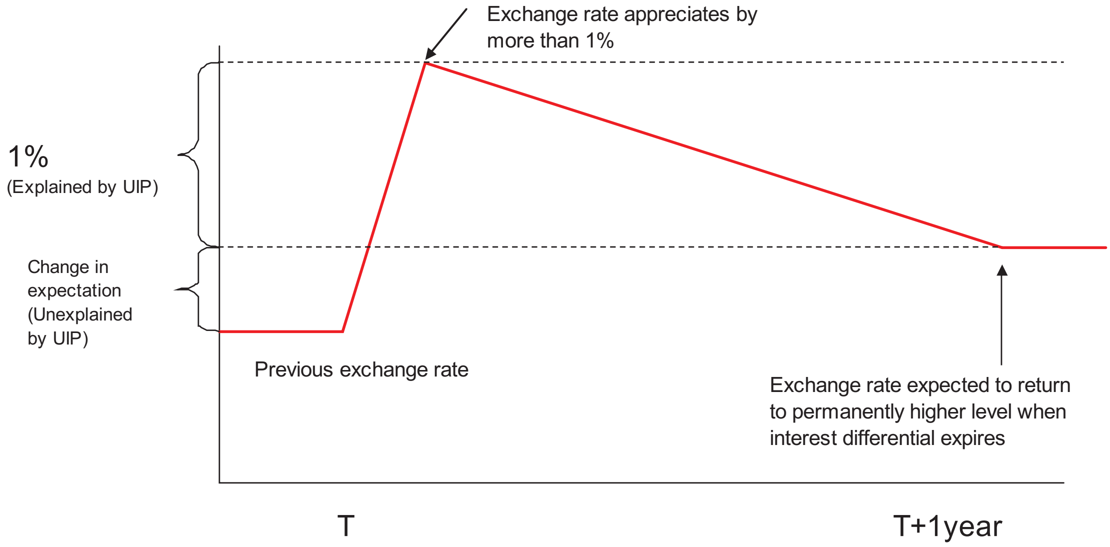


Figure 2: Exchange rate behaviour following an unexpected interest rate increase, according to UIP, if exchange rate is expected to settle at a permanently higher level once interest differential has passed



2.3 Using the theory to predict exchange rates

This paper uses the UIP relationship in slightly novel manner. We *assume* that UIP holds, and use it to define the market's implied exchange rate expectation. For example, if New Zealand's risk-adjusted after-tax 2-year interest rate is 1% higher than Australia's, then foreign exchange markets must be expecting the exchange rate to depreciate by 2% over the next two years. Thus, we use the yield differential to tell us the market's rational exchange rate expectation. Having derived the rational exchange rate expectation, the second part of the paper examines the causes of *changes* to that expectation.

To implement this strategy, we first isolate the changes in the exchange rate that are consistent with inflation and relative interest rate movements, according to the theories of UIP and PPP. These changes are categorised as movements in Fair Value.

Any other movements in the exchange rate are termed "Deviations from Fair Value". Most Deviations from Fair Value represent the market reassessing the long-run expected exchange rate in response to news about future productivity, future commodity prices, or future inflation (PPP). The Balassa-Samuelson Effect is one important theoretical explanation for variations in long-run exchange rate expectations, as described below.

Deviations from Fair Value could also occur when the market reassesses the risk premium on lending to a country, or they could even occur randomly. Whatever the causes, the currency is traded on the basis of historical data. So we investigate the relationship between observable data that is available to currency traders and Deviations from Fair Value.

Table 1 below illustrates how we break exchange rate changes down between Fair Value and Deviations, using May 2004 as an example. In that month, Fair Value rose by 0.3% chiefly as a result of higher interest rates in NZ. But the exchange rate rose by 1.3%, leaving 1.0% as a change in the Deviation from Fair Value, to be explained in the deviations model.

Table 1: Example of splitting exchange rate movement into Fair Value and Deviation

		Effect on "Fair Value"
Change in NZ 2-Year Swap Rate	+0.3%	+0.6%
Change in Australian 2-Year Swap Rate	+0.1%	-0.2%
NZ inflation (month)	+0.2%	-0.2%
AU inflation (month)	+0.1%	+0.1%
Total Change in Fair Value		**+0.3%**
Actual Change in Exchange Rate		**+1.3%**
Change in Deviation from Fair Value		**+1.0%**

2.4 The Balassa-Samuelson Effect – why commodity prices and economic performance can affect the exchange rate[5]

Both the New Zealand Dollar and the Australian Dollar are considered "commodity currencies", because export commodity prices are highly correlated with the exchange rate in both countries. More generally, the economic prospects of a country, including productivity levels and export prices, are important for exchange rates. Countries that have low productivity and/or low-value exports generally have "low" exchange rates, making local prices seem cheap to visitors from countries with high productivity and/or high-value exports. (Poor countries seem "cheap" to visitors from rich countries, at least for non-tradable goods and services.) The Balassa-Samuelson Effect explains why. Very briefly, the theory can be summarised as follows:

- Workers are able to create more value per hour in some countries' export industries than in others. For example, financial service workers in London create more value per hour than coffee workers in Ethiopia.
- Workers in the high-value export industry are paid more. Their higher wages translate into higher wages for other industries in that country, *even if those industries are equally productive in the two countries.* A hairdresser in London would be paid far more than a hairdresser in Ethiopia for the same haircut, because the London hairdresser's alternative is to become a higher-value financial service worker, whereas the best alternative in Ethiopia is to be a lower-wage coffee worker. Similarly, London property prices are higher because the land could be used for higher-productivity export activities – all industries must pay the higher rent, even if they are no more productive than their Ethiopian counterpart.
- Higher wages and other costs for non-exported goods and services make the consumer prices higher in the countries with high-value exports. The price level differential manifests itself in the exchange rate.
- Now, suppose that the price of coffee on world markets were to triple. Suddenly, the workers in Ethiopia's coffee industry would be creating much more value per hour. In time, their wage rate would rise, and that would transmute itself to the wages of other Ethiopian workers. Similarly (or alternatively), the value of land in Ethiopia would rise.

[5] The importance of commodity prices for the long-run exchange rate is explained in alternative fashion in Reserve Bank of New Zealand (2007), which notes that commodity prices affect the equilibrium exchange rate in a macro balance model, via the current account deficit.

- The real exchange rate between Ethiopia and the UK would rise, making Ethiopia seem less cheap to a Brit. There are two possible ways the real exchange rate could rise – either prices would rise in Ethiopian Birr (inflation), or the Ethiopian nominal exchange rate would rise (effectively giving Ethiopian workers greater purchasing power).

One crucial point is that foreign exchange markets are forward looking. If markets believe that a country's tradable industry will become more valuable or more productive in the future, the exchange rate will be bid up now (so long as markets believe that inflation will remain in check). The election of a business-unfriendly government results in immediate exchange rate depreciations, even before any policies are implemented. Exchange rate expectations are constantly changing with a country's economic fortunes.

The importance of the Balassa Samuelson Effect for the NZD/AUD exchange rate is that both New Zealand and Australia are commodity exporters. Expectations about the future value of each country's commodity exports will affect expectations around the exchange rate of each country, and therefore the NZD/AUD cross rate.

2.5 Using the theory to predict exchange rates – algebraic restatement

Non-technical readers can safely skip this section. To add precision to the discussion in sections 2.1 – 2.4, we restate our forecasting approach using algebraic notation.

The PPP condition is written as:

$$e_t = p_t^{AU} - p_t^{NZ} + \alpha_t \qquad (1)$$

Where *e* is the log nominal exchange rate, *p* is the log price level (with superscripts to denote the countries), and alpha is the difference in price level between Australia and New Zealand.

The UIP condition can be written as:

$$e_t = E_t(e_{t+1}) + E_t(i_{t+1}^{NZ} - i_{t+1}^{AU} - rp_{t+1}) \qquad (2)$$

Where E_t represents the expectation at time *t*, *i* is the nominal interest rate (with country superscript), and *rp* is the risk premium on NZ interest bearing assets over Australian securities. Expectations are not necessarily rational. Iterating equation 2 forward, UIP states that the current exchange rate equals the sum of expected future interest rate differentials plus the exchange rate that would prevail in the infinite future.

$$e_t = i_t^{NZ} - i_t^{AU} - rp_t + \sum_{k=1}^{\infty} E_{t+k}(i_{t+k}^{NZ} - i_{t+k}^{AU} - rp_{t+k}) + E_t(\bar{e}_\infty) \qquad (3)$$

We can safely interpret e-bar as the exchange rate that would prevail when there is no expected risk-adjusted interest rate differential. If there was no interest rate differential, then E-bar is given by the PPP condition that would prevail in the infinite future:

$$\bar{e}_\infty = p_\infty^{AU} - p_\infty^{NZ} + \alpha_\infty \qquad (4)$$

And the expected future PPP exchange rate is given by today's PPP exchange rate plus the sum of future expected inflation rates, plus any expected changes to the price level differential (the exchange rate "wedge" explained in section 2.2, which can vary over time).

$$\bar{e}_\infty = p_t^{AU} - p_t^{NZ} + \alpha_t + \sum_{k=1}^{\infty} E_{t+k}(\Delta p_{t+k}^{AU} - \Delta p_{t+k}^{NZ} - \Delta\alpha_{t+k}) \qquad (5)$$

Substituting equation (5) into equation (3) and rearranging, we arrive at the final equation for the current exchange rate:

$$e_t = i_t^{NZ} - i_t^{AU} + p_t^{AU} - p_t^{NZ} - rp_t - \alpha_t + \sum_{k=1}^{\infty} E_{t+k}(i_{t+k}^{NZ} - i_{+kt}^{AU} - rp_{t+k}) + \sum_{k=1}^{\infty} E_{t+k}(\Delta p_{t+k}^{AU} - \Delta p_{t+k}^{NZ} - \Delta\alpha_{t+k}) \qquad (6)$$

Equation (6) illustrates that the relationship between the exchange rate, inflation, and interest rates is complex, and depends on a wide range of unobservable factors. Only the first four terms in equation (6) are actually observable. Most studies of UIP are forced to make simplifying assumptions about the remaining, unobservable, terms. We take a different approach – the definition of Fair Value corresponds to the observable parts of equation (6):

$$FairValue = i_t^{NZ} - i_t^{AU} + p_t^{AU} - p_t^{NZ} - \overline{rp} - \overline{\alpha} \qquad (7)$$

And Deviations from Fair Value are simply the sum of the unobservables in equation (6), which we estimate by reduced form:

$$Deviation = (rp_t - \overline{rp}) - (\alpha_t - \overline{\alpha}) + \sum_{k=1}^{\infty} E_{t+k}(i_{t+k}^{NZ} - i_{+kt}^{AU} - rp_{t+k}) + \sum_{k=1}^{\infty} E_{t+k}(\Delta p_{t+k}^{AU} - \Delta p_{+kt}^{NZ} - \Delta\alpha_{t+k}) \qquad (8)$$

3.0 Fair Value

Fair Value is defined as the movements in the exchange rate that would be predicted according to the theories of PPP and UIP. Restating equation (7):

$$FairValue = i_t^{NZ} - i_t^{AU} + p_t^{AU} - p_t^{NZ} - \overline{rp} - \overline{\alpha}$$

All data is monthly.

i_t is the two-year interbank swap rates, average for the month. Two-year swaps were chosen because short-term interest rate variation is often anticipated by the market – when a fully anticipated hike is delivered, it should not affect the exchange rate. Two-years is long enough to capture most of the anticipated monetary policy cycles. Longer interest rates would be even better, but New Zealand's long-term interest rate market has historically been very illiquid.

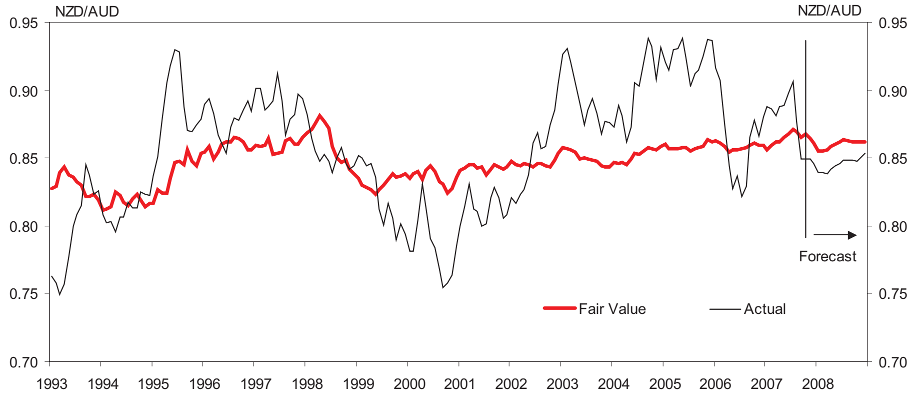
$\overline{rp}$ is the average difference between NZ and Australian interest rates, 0.9%.

p_t is the log of the CPI, linearly interpolated from quarterly to monthly data. The NZ CPI is CPI ex-interest before 1999Q3. For Australia, we adjusted the official CPI for the introduction of GST, following the Reserve Bank of Australia's recommended adjustment.

Alpha is a normalisation factor that ensures the average Fair Value equals the actual average of the exchange rate over the past 15 years, and is meant to capture the average price level difference between Australia and New Zealand.

Figure 3 below shows that Fair Value has risen over time, since New Zealand has experienced less inflation. This gradual rise in Fair Value can be expected to continue into the future, since the Reserve Bank of New Zealand's inflation target (1% - 3%) is lower than the Reserve Bank of Australia's inflation target (2% - 3%). If both central banks were to keep inflation at the mid-point of their respective target bands on average, Fair Value of the NZD/AUD would be 0.9 by 2018. In reality, both central banks tend to run inflation in the top quarter of their respective bands – Australian inflation has averaged 2.8% over the past 5 years, while New Zealand has averaged 2.6%, giving an inflation difference of 0.2% per annum. But even this small inflation differential, if continued, will accumulate over the years and drive Fair Value up by 2% per decade.

Figure 3: NZD/AUD Fair Value and forecast of actual exchange rate



Most of the month-to-month variation in Fair Value has been due to interest rates. One period that stands out is 1998, when New Zealand's 2-year swap rate fell sharply. The resulting fall in Fair Value explains more than half of the total depreciation of the NZD/AUD in 1998. In today's environment Australian interest rates are widely expected to rise relative to New Zealand's. If these forecasts are correct, Fair Value will fall slightly over the next year.

4.0 Deviations from Fair Value

The actual exchange rate is more variable than Fair Value, as expected. But it is very interesting to note that the exchange rate has been within 10% of Fair Value for the past 15 years. Deviations from Fair Value are stationary, meaning that the exchange rate has a tendency to return to Fair Value over time.

We take a reduced-form approach to estimating the causes of Deviations from Fair Value, adopting a general-to-specific search among variables that could affect market perceptions of the value of the New Zealand Dollar or the Australian Dollar. The aim was to ensure that the final specification consisted of *robust* relationships with the exchange rate, meaning that estimated coefficients are not sensitive to slight changes in sample period or slight changes to the overall specification. The final specification was an error-correction framework.

$$\Delta Ln(Deviation_t) = \alpha + \beta_1 \Delta Ln(Deviation_{t-1}) + \beta_2 Ln(Deviation_{t-1}) + \beta_3 \Delta Ln(RelativeCommodityPrice_{t-1}) +$$

$$+ \beta_4 \Delta(RelativeGDP_{t-3}) + \beta_5 (NZMigration_{t-1})$$

Table 2: Regression results

		Coefficient	T-Statistic
β_1	ΔLn (Deviation$_{t-1}$) (Momentum)	0.26	(3.77)
β_2	*Ln* (Deviation$_{t-1}$) (Reversion to Fair Value)	-0.09	(3.43)
β_3	Relative Commodity Prices	0.13	(2.18)
β_4	Relative GDP growth	0.0036	(2.01)
β_5	NZ Annual Migration	0.00021	(2.46)
α	Constant	-0.0017	(1.08)
R-sq		0.18	
Durbin's-*h* test for autocorrelation		1.43 (crit val = 1.645)	
Sum of squared errors		0.04	
Sample period		Jan 1993 to Aug 2007	

Momentum

Deviations from Fair Value exhibit strong momentum. If the exchange rate appreciates in one month, it is more likely to appreciate the next month.

Reversion to Fair Value

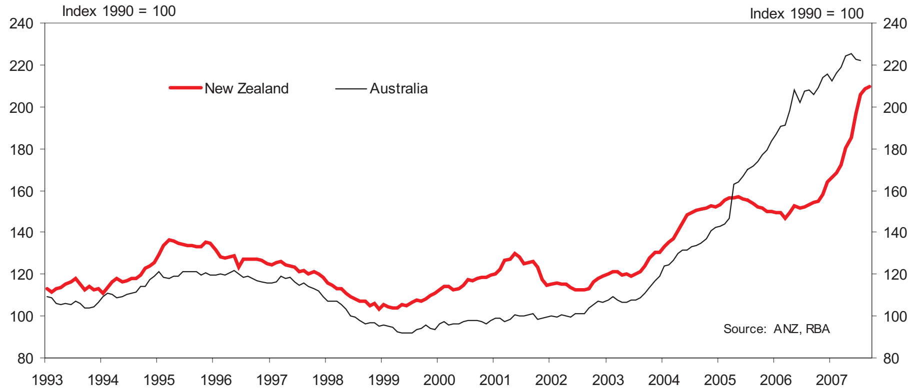
The negative coefficient on the last month's Deviation from Fair Value captures the NZD/AUD tendency to gravitate back towards Fair Value over time.

The momentum term and the reversion-to-fair-value terms together imply "overshooting". The exchange rate may gather momentum and overshoot Fair Value. But as the degree of overshoot gets very large, Fair Value exerts a greater influence, and the exchange rate will tend to revert.

Commodity prices

Commodity prices are important determinants of the NZD/ AUD. New Zealand's exports are dominated by "soft" commodities such as dairy, meat and wood, and Australia's exports are dominated by "hard" commodities such as coal, iron ore, and metals. Soft commodity prices and hard commodity prices are often correlated, but there have been important periods of divergence.

Figure 4: Australian and New Zealand World Commodity Price Indexes



The variable included in the final specification was the contemporaneous change in the relative commodity price. If New Zealand commodity prices rise faster than Australian commodity prices then the NZD/AUD should appreciate.[6]

Relative GDP growth

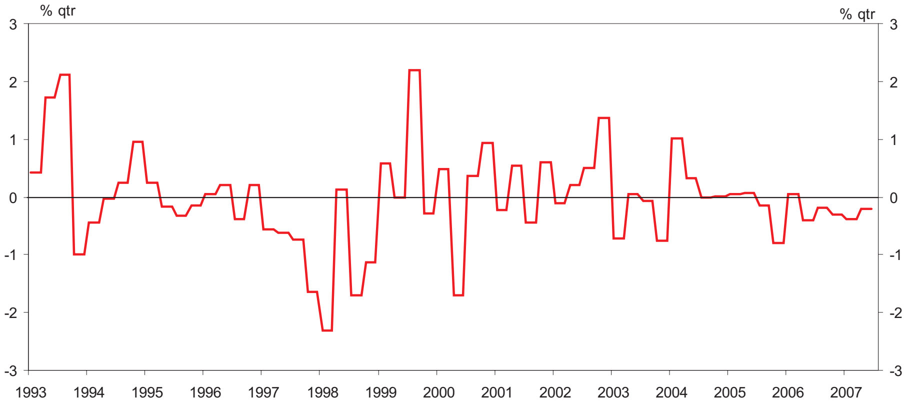
The change in relative GDP growth rates has a very robust relationship with changes in the exchange rate. This appears to be an announcement effect – the NZD/AUD reacts in the month that GDP data is released, not the months in which the growth actually took place (both New Zealand and Australia release quarterly GDP data three months after the end of the quarter). The exact variable included was:

$$\mathrm{Re}\,lGDP = \Delta(\Delta GDP_t^{NZ} - \Delta GDP_t^{AU})$$

Where ΔGDP_t^{NZ} is the country-specific quarterly GDP growth rate, applied to all three months of the quarter.

[6] In some specifications, and over some time periods, New Zealand commodity prices were estimated to have a greater effect on the NZD/AUD than Australian commodity prices. However, this feature of the relationship was not *robust*, and was therefore dropped in favour of symmetrical commodity price effects in the final specification.

Figure 5: Relative GDP growth rates, NZ less AU



For example, if Australia is growing faster than New Zealand, and continues to grow faster then the exchange rate is not affected. But if New Zealand closes the gap, then NZD/AUD rises. The impulse response function (Figure 9) shows the effect of New Zealand growth accelerating by 1%.

New Zealand's annual net migration

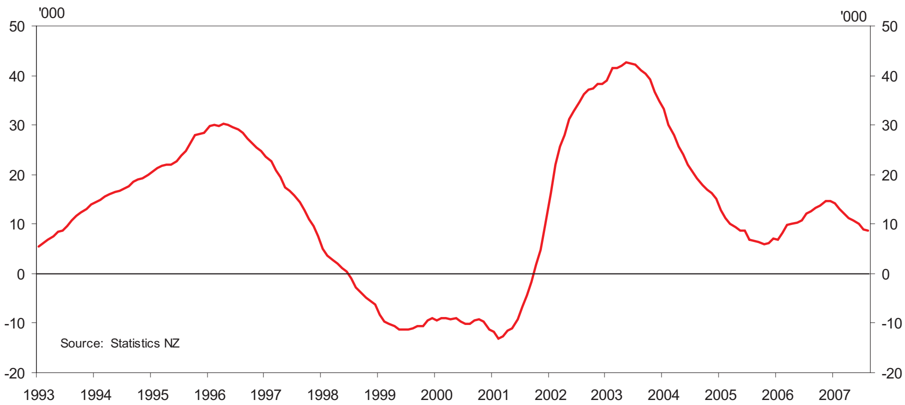
The level of net migration into/out of New Zealand, expressed as a running annual total, appears to have a strong effect on the NZD/AUD exchange rate. There are two key reasons for including only New Zealand net migration:

- Immigration is much more volatile in New Zealand than it is in Australia. New Zealand's annual net immigration total has ranged from -13,000 to +46,000, or -0.3% to +1.1% of the total population. Those two extremes were two years apart. By contrast, net migration for Australia is more stable, ranging from +0.25% to +0.7% of the total population over the sample period.

- Movements between Australia and New Zealand are more important than immigration from outside the region, for both countries. Trans-Tasman migrant flows are volatile because they are unrestricted by immigration law, whereas movements from outside the region are heavily restricted and are more stable. Therefore, the net migration statistics of the two countries tend to mirror one another to some extent. New Zealand's loss is Australia's gain.[7]

Migration is expected to play a role in exchange rate determination since the flow of migrant funds could affect supply and demand for currencies. Munroe (2004) proposes that migration flows have an outsized effect on the housing market, which causes large flows of funds, and also affect the exchange rate indirectly via interest rates.

Figure 6: Annual Migration in New Zealand



[7] Australia is by far the biggest destination for New Zealand emigrants, and is the second-biggest source of immigrants to New Zealand. Similarly, New Zealand is the biggest source of immigrants into Australia, accounting for 20% of all migrant arrivals. Figures refer to 1993 – 2007. New Zealand migration statistics relate to the country of last permanent residence, whereas Australia's statistics record country of birth. Immigration to and from the UK is also significant for both Australia and New Zealand. All other source/destination countries are insignificant by comparison.

Impulse responses

These graphs map the exchange rate response to various shocks.

Figure 7: Exchange rate response to 10% commodity price increase in New Zealand

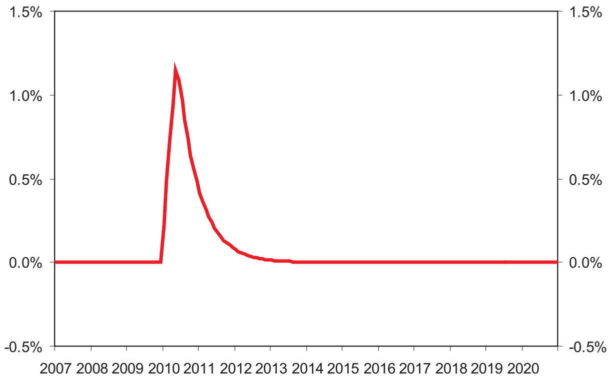


Figure 8: Exchange rate response to extra 10,000 migrants over one year, in NZ

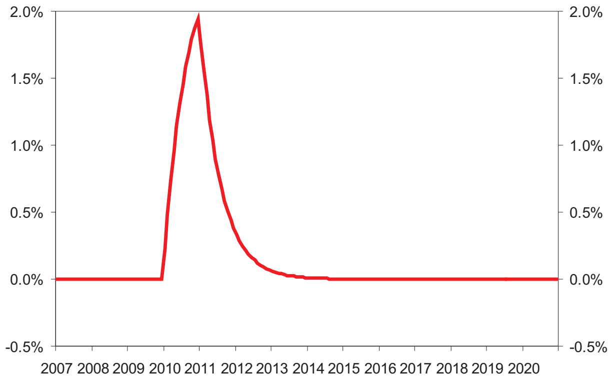
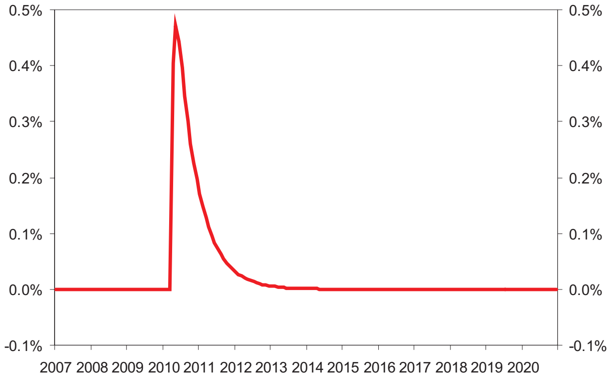


Figure 9: Exchange rate response to 1% growth pickup in NZ



Alternative Variables

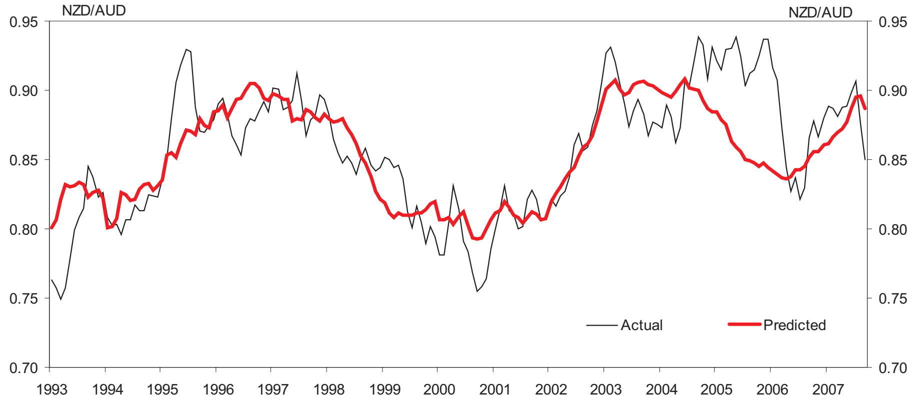
The other variables tested, but not included in the final specification, included:

- Relative house prices
- Relative current account deficits
- Relative labour productivity
- NZ monthly immigration
- VIX index of financial market volatility

Forecasting performance

Figure 10 shows the predicted exchange rate versus the actual. The predictions are based on actual data for commodity prices, GDP, migration, inflation and interest rates, and use the coefficients estimated on the full sample. The predicted values make no use of actual exchange rate data.

Figure 10: Predicted versus actual exchange rate



The model picks up most of the broad movements in the exchange rate well, with 2005 an unusual period of divergence. The model correctly predicts the direction of the next monthly change in the exchange rate 61% of the time. It correctly predicts the direction over the next 6 months 73% of the time (relying on perfect knowledge of the independent variables).

Figure 10 is an in-sample test. It tests the historical performance of a model that was estimated using contemporaneous data. But a researcher in 2000 would not have had access to 2005 data in order to build the model, so in-sample tests are unrealistic. A better test is “out-of-sample forecast performance”, which assesses the forecast performance using only the data that would have been available to the forecaster at the time. Out-of-sample forecasting involves re-estimating the model for each historical period using only data that would have been available to a researcher at the time. Figure 11 below shows successive out-of-sample forecasts from 1999 to today. The out-of-sample forecasts appear to have been remarkably accurate most of the time, in particular picking the appreciation in 2002 very well, and picking the depreciation in 2003. However, as with the in-sample forecasts, the model would have predicted a lower exchange rate in 2005 than actually prevailed.

Figure 11: Out of sample forecasting performance

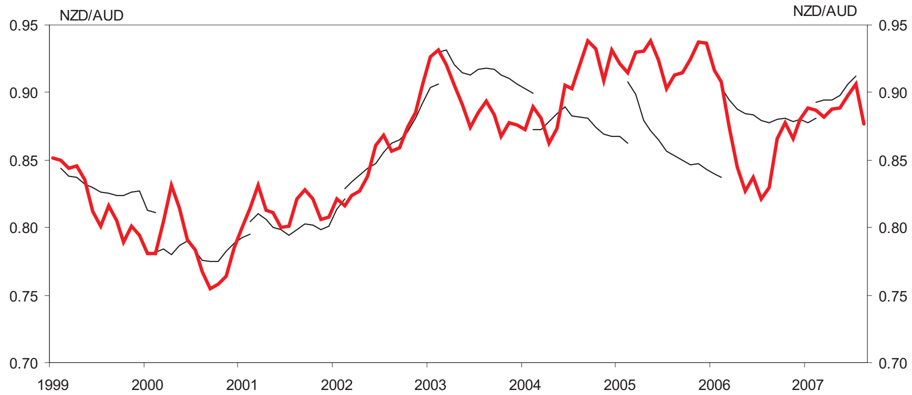


Table 3 compares the model’s forecasts to a random walk forecast. (A random-walk forecast is one that assumes tomorrow’s exchange rate will be the same as today’s). The measure of comparison is the root mean squared error (RMSE) from out-of-sample forecasts. The ability to beat a random walk forecast, out of sample, is considered the benchmark for exchange rate models – and the benchmark is very rarely exceeded. In our case, the model does appear to produce better forecasts than a random walk, out of sample. But the test is not entirely fair, as we have “given” knowledge of future interest rates, inflation, commodity prices etc to the model. Never-the-less, we are able to conclude that the model will give exchange rate forecasts that are more consistent with our economic forecasts than a random-walk forecast of the exchange rate.

Table 3: Out of sample RMSE of model forecasts, compared to random walk

Sample period: 1993m1 – 2007m6 First out of sample forecast: 1999q1			
Months Ahead	1	2	6
RMSE – Model	1.30	2.41	3.33
RMSE – Random Walk	1.47	2.87	3.65

Conclusion

The approach taken in this paper has succeeded in producing a useful model for forecasting the NZD/AUD exchange rate. Exchange rate variation was broken down into "Fair Value" according to inflation and interest rates, and "Deviations from Fair Value", which are movements that cannot be explained by the theories of PPP and UIP.

Current Fair Value of the NZD/AUD was estimated at 0.87. Fair Value had risen from 0.82 15 years ago, mainly because New Zealand has experienced less inflation than Australia. Fair Value was predicted to fall to 0.855 within a year, as Australia's interest rates rise relative to New Zealand's. Over the longer run, Fair Value was predicted to resume its gradual increase, since New Zealand is expected to experience less inflation on average than Australia.

Actual monthly averages of the exchange rate have remained within 10% of Fair Value for the past 15 years. We also showed that the exchange rate exhibits a tendency to return to Fair Value over time, proving that Fair Value is a useful exchange rate concept. However, Deviations from Fair Value exhibit strong momentum – if the NZD/AUD begins moving away from Fair Value, it can be expected to continue moving in the same direction.

We developed an empirical model to explain the causes of Deviations from Fair Value, settling on a robust model that included relative commodity prices, migration, and relative GDP growth rates. Other variables often thought to affect the NZD/AUD, such as relative house prices, current account deficit, and market volatility, all proved statistically insignificant.

Combining the Fair Value and Deviations models into one forecast of the exchange rate produced a successful forecasting model. As with all forecasting models of this nature, there are caveats and health warnings. The model is unlikely to pick major turning points in the exchange rate very well, primarily because such turning points normally result from unforeseen events. And the Deviations model is a reduced form, meaning it would not be robust to a major structural change in the economy such as a new central banking regime. Nevertheless, the model outperformed a random walk in out of sample tests, which is the benchmark for success in exchange rate forecasting. It should prove to be a useful tool for forecasting the NZD/AUD exchange rate.

References

Conway, P and R Franulovic (2002), "Explaining the NZ-Australian Exchange Rate" Westpac Occasional Paper, April 2002.

Luo, C and C Plantier (2003). "The persistence of NZ dollar misalignments relative to purchasing power parity", Auckland University of Technology, Faculty of Business, Research Paper Series, Paper 09-2003.

Munroe, A (2004). "What drives the New Zealand Dollar" R*eserve Bank of New Zealand Bulletin* Vol 67 No 2.

Munroe, A (2005). "UIP, Expectations and the Kiwi" *Reserve Bank of New Zealand Discussion Paper* DP2005/05.

Reserve Bank of New Zealand (2007). *Monetary Policy Statement, September 2007*.

Stephens, D (2004). "The equilibrium exchange rate according to PPP and UIP", *Reserve Bank of New Zealand Discussion Paper* DP2004/03.