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ESTIMATING THE GLOBAL COMPONENT OF NEW ZEALAND INTEREST RATE MOVES

Michelle Lewis and Lauren S. Rosborough
Reserve Bank of New Zealand
PO Box 2498
Wellington 6140
Telephone: (04) 471 3699, (04) 471 3967
Email: michelle.lewis@rbnz.govt.nz, lauren.rosborough@rbnz.govt.nz

Abstract

This paper uses principal component and regression analysis to examine the effect that global bond yields have on New Zealand's bond yields. We extract the first principal component of global yields, based on a sample of twelve developed countries using 10-year bond yields from 1994, and use it to create a World Interest Rate. Changes in New Zealand's bond yields are assumed to be a function of the World Interest Rate and the idiosyncratic elements of New Zealand's top two trading partners, Australia and the United States. This modelling approach allows us to distinguish between worldwide trends impacting on global interest rates and country-specific influences on New Zealand's yields.

We estimate the global contribution of changes in New Zealand's bond yields and find that 62 percent of the variation in New Zealand's 10-year bond yields can be attributed to offshore factors. The remaining variability (38 percent) is assumed to be caused by domestic factors (and the residual). Australia-specific idiosyncrasies are significant and positive, while those from the United States are not.

We extend this work and compare New Zealand to Australia, and find that global elements and the World Interest Rate have a slightly stronger influence on Australian yields. We conduct the same analysis for New Zealand's two-year bond yields and find that just 36 percent of the variation of changes in domestic two-year yields can be explained by global factors. This suggests that the short end of the New Zealand bond curve is primarily anchored by domestic policy and reacts to domestic-specific factors, such as data and news releases. Daily changes in bond yields were also considered, and after accounting for the behaviour of financial markets with respect to time zones and the impact of major trading partner idiosyncratic factors, 38 percent of daily changes in New Zealand's 10-year bond yields can be accounted for by offshore influences.

JEL classification
C22, G12, G14

Keywords
Principal components, regression, government bonds, information acquisition

1 Introduction and motivation

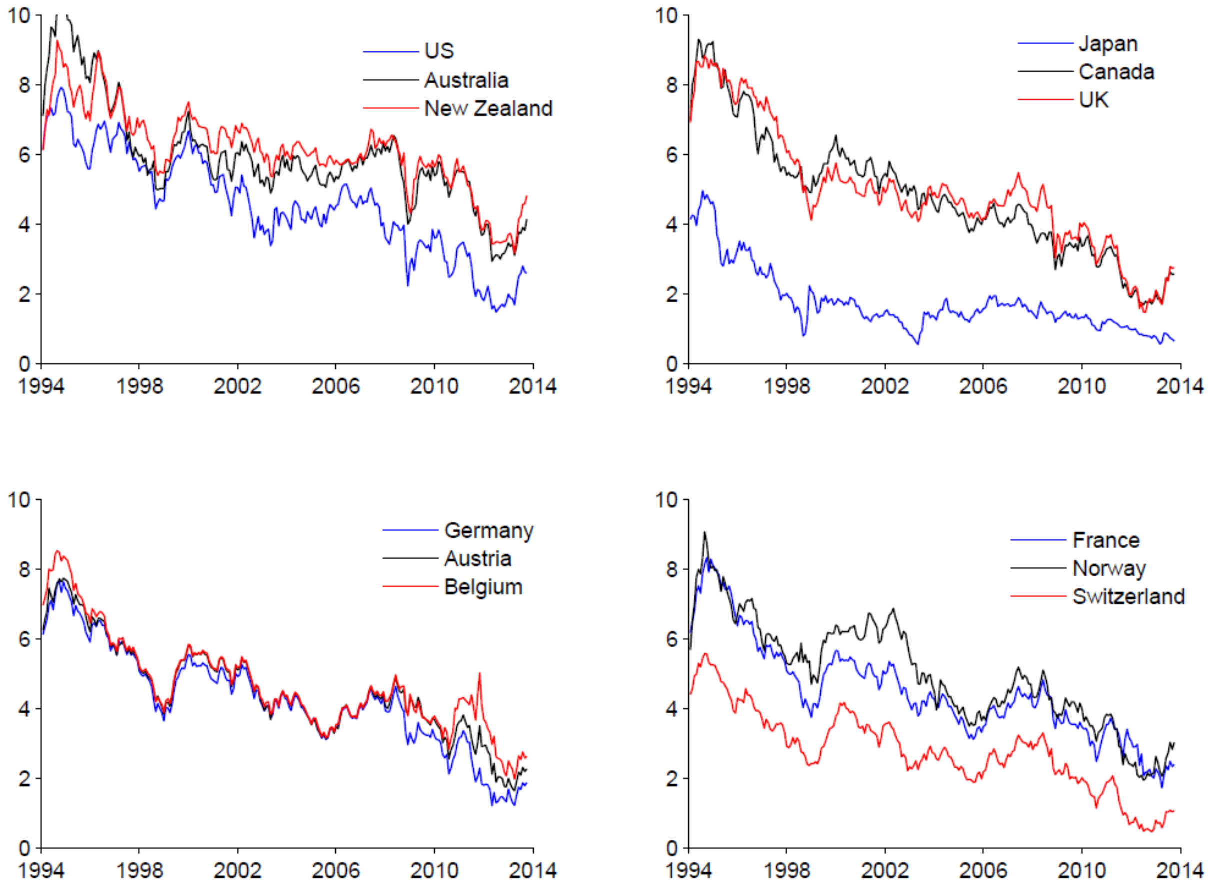
Determining the level of interest rates is well documented. Economic models assume that the underlying long-run level of bond yields is the sum of short-term interest rates plus a time-varying term premium (Lee and Prasad 1994). Interest rates can also be determined by macroeconomic factors, monetary policy and inflation, fiscal policy (and a country's credit rating), and a risk premium (Hol 2006). The derivation of bond yields can be considered in an uncovered interest parity framework, whereby local interest rates are a function of their offshore equivalent, risk and exchange-rate adjusted (Eckhold 1998). In all cases, once the level of interest rates is derived, rate movements are typically assumed to be the result of new information (such as change to activity or policy) or by changes to risk premia.

Over the past decades financial linkages have become more prominent in influencing the direction of financially traded instruments, such as bonds and equities (although trade channels continue to be key, Forbes and Chinn 2004). These financial transmissions are often explained by the behaviour of one country's asset price movements being expressed in the context of another's. For example, changes in small open economies' interest rates are often compared to changes in larger countries' yields. In the case of New Zealand, interest rate movements are often compared with the United States (US) as well as Australia.

The results from previous published work estimating the impact of US and Australian yields on New Zealand's interest rates are mixed. Conway and Orr (2002) built a model of quarterly 10-year rates for eight countries including New Zealand based on actual and expected inflation, government debt, current account levels, and a country's beta (against a global bond portfolio). The model consists of a long-run equation with a short-run error correction model, estimated on a quarterly basis from 1986 to 2002. For New Zealand, the US is not a significant driver of New Zealand's interest rates in either the long- or the short-run. Grimes (1994) found a similar result. Grimes (1994) estimated the level of New Zealand's 10-year and five-year bond yields in the long- and short-run, using domestic and global macroeconomic factors – including Australian and US interest rates – as dependent variables. The results failed to find a significant impact on New Zealand's rates from US 10-year bond yields. By contrast, Australia is found to be a significant driver. In the long-run 10-year yield model, a 100 basis point rise in Australian bond yields was found to increase New Zealand's equivalent by 47 basis points, while in the short-run relationship a 100 basis point rise in the Australian 10-year bond yield raises New Zealand's 10-year bond yield by 25 basis points. Eckhold (1998) found that Australian bond yields impact across different points on the New Zealand yield curve, whereas the US is only significant as a driver of New Zealand's yields at the three-year tenor. Guender and Rimer (2007) sources Australia as the driver of New Zealand's 90-day interest rate. Summarising these results, Australia appears to be consistently a driver of New Zealand rates, while the US is not.

However, the results may be a function of the model setup. Figure 1 charts the generic 10-year bond yield for twelve countries (New Zealand, the United States, Australia, Japan, Canada, the United Kingdom, Germany, Austria, Belgium, France, Norway and Switzerland). We observe that there are similar trends across all countries. For example, since 1994, 10-year bond yields have trended lower. In the medium-term (one to two years) yields have tended to move in a similar fashion, for example in the period during 1997-1998 and from July 2008. On a day-to-day basis, financial centres frequently follow the direction of the previous time zone's interest rates (for example, New York follows London, and Asia follows New York), to varying degrees. These trends could be characterised by a global interest rate (the World Interest Rate). A World Interest Rate and country-specific factors are not segregated in previous studies, possibly complicating the interpretations of the results.

Figure 1: Generic 10-year bond yields, monthly, January 1994-September 2013
Percent



Source: Bloomberg

Groth and Zampolli (2010) create a global benchmark interest rate using principal component analysis (PCA) from monthly interest rates in eighteen countries. They find that the US bond yield is less correlated with other countries' yields. This paper also applies principal component analysis in order to obtain the World Interest Rate (WIR). New Zealand interest rates movements are then decomposed into three global elements: the World Interest Rate and the idiosyncratic behaviour of New Zealand's top two trading partners. The remainder is deemed to be the domestic element (plus residual).

By creating a World Interest Rate (WIR) and deriving the idiosyncratic (country-specific) component of trading partner bond yields, we seek to find the source and the individual contribution of these offshore movements to changes in New Zealand's bond yields.

This research adds to the body of literature in multiple ways. The paper applies principal component analysis to capture the global element of bond yields and then estimates a global versus domestic contribution to yields. Within this global contribution, the elements are further segregated into the WIR and individual country-specific drivers of changes in domestic bond yields. When evaluating daily changes, the paper takes into account time zones to capture the behaviour of financial market trading across time zones. The framework easily allows an expansion of our dataset for any choice of country in our sample.

2 Methodology and Data

1.1 The World Interest Rate (WIR)

We create the World Interest Rate (WIR) by applying principal component analysis on a data set of generic bond yields.[1] For 10-year monthly data, we use the government generic bond yields from January 1994 to October 2013. The countries utilised are the United States, the United Kingdom, Germany, Austria, Belgium, France, Norway, Switzerland, Japan, Canada, Australia, and New Zealand. For 10-year daily data, the full sample of countries is used but due to data difficulties the sample period is reduced to 5 January 1995 until 9 October 2013. The benchmark interest rate was taken as given from Bloomberg LP data provider. For two-year monthly data, due to data restrictions, the sample period is January 1995 to October 2013 and Austria is removed from the sample. The benchmark interest rate was taken as given from Bloomberg, except for the New Zealand data, which are from RBNZ/Reuters.

Principal components exhibit the underlying common factors that best explain fluctuations in the data. The main advantage of principal component analysis is that no *a priori* structure to the model is assumed. In this way, influences such as expectations of future events and economic growth, relative policy stances, macroeconomic outturns, and market structure differences such as liquidity or 'safe-haven' characteristics do not have to be explicitly modelled for. We assume that the relevant information from the macroeconomy is reflected in global and domestic bond yields rapidly.

We create the WIR by taking a weighted average of the individual countries' bond yields, using the factor loadings from the first principal component. Three WIRs are created: a 10-year and a two-year WIR at the monthly frequency, and a 10-year daily WIR.

1.2 Model specification

After calculating the WIR, we estimate its impact on changes in domestic bond yields. To better represent the behaviour of interest rate moves, and to distinguish between global and country-specific influences, we add the idiosyncratic rate movements of the country's top two trading partners.[2] In turn, these are derived as the residual movement in its interest rates after the world interest rate contribution has been taken into account.

The equation is:

$$\Delta y_t^A = \beta_1 + \beta_2 \Delta y_t^{WIR} + \beta_3 idio_t^B + \beta_4 idio_t^C + \varepsilon_t \quad (1)$$

where

$$idio_t^B = \varepsilon_t^B = \Delta y_t^B - \gamma_1 - \gamma_2 \Delta y_t^{WIR} \quad (2)$$

and

$$idio_t^C = \varepsilon_t^C = \Delta y_t^C - \rho_1 - \rho_2 \Delta y_t^{WIR} \quad (3)$$

y_t is the 10-year generic bond yield at time t defined in basis points, with Δ the first difference operator, and A, B, and C denote the domestic, first trading partner, and second trading partner respectively, WIR is the world interest rate, idio is the idiosyncratic term for each country, and ε_t is an error term.

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[1] Principal component analysis (PCA) is a mathematical technique that reduces the dimensions of data in a number of correlated variables into a smaller number of uncorrelated variables, called principal components (Jolliffe, 2002).

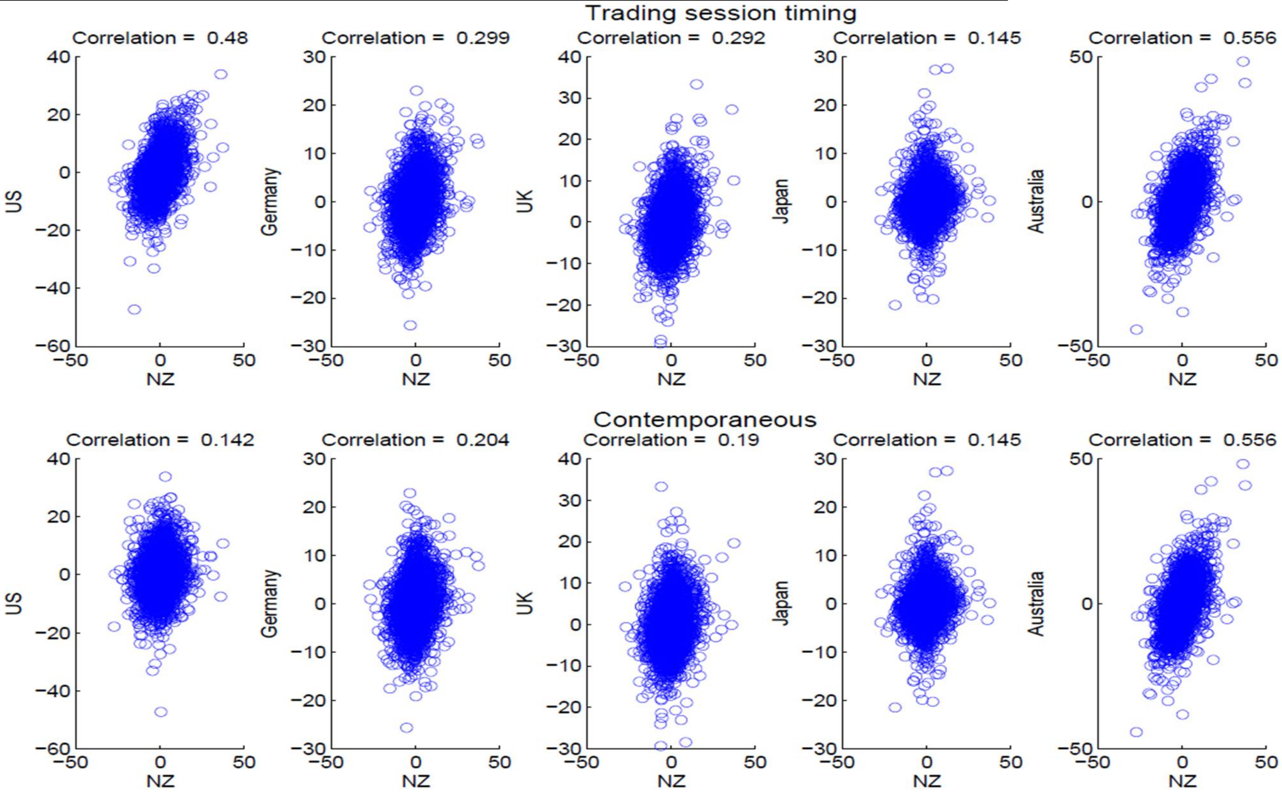
[2] Limited to our sample. The trading partner figures were sourced from the CIA's World Factbook.

Three specifications for New Zealand are estimated: monthly changes in 10-year bond yields, monthly changes in two-year bond yields, and daily changes in 10-year bond yields. The estimation is repeated for Australia, using monthly data with 10-year bond yields.

1.3 Trading session timing for daily data

When considering daily changes in New Zealand's bond yields, financial market trading behaviour tells us that New Zealand responds to offshore movements that occur in New Zealand's evening/night, so the chronological order of market movements is important. For example, in a typical trading session, the market opens in London, news develops, then the US session opens (in London's afternoon), and more news or information is released. European and US markets price in these developments, and in most cases these bond markets close having priced in news outturns from both centres.[3] Hence, European and US bond yields price contemporaneous to each other. After the US has traded, New Zealand opens and prices in the global information, then Australia opens, and lastly Japan. Because the New Zealand, Australian, and Japanese sessions overlap, markets tend to price in one another's developments before they close for their trading days. For this reason, we keep these markets contemporaneous, so changes in New Zealand, Australian, and Japanese bond yields are lagged one trading day to the rest of the sample. This assumes that New Zealand has little impact on global interest rates and that the trading day starts in London and ends in the Southern Hemisphere. Figure 2 illustrates this trading session timing via correlations with New Zealand interest rates. The increase in correlations between New Zealand and the northern hemisphere (top row relative to bottom row) demonstrates how the timing of trading sessions matters for daily changes in interest rates.

Figure 2: Correlation between changes in selected 10-year bond yields
Percent



Source: Bloomberg, RBNZ calculations

[3] Two key exceptions are from the United States, with the Federal Open Market Committee statement and minutes, which are released after London trading ends; and the Federal Reserve Beige Book, which is released after all three markets are closed.

For the estimation based on daily data, we use the trading session timing to extract the WIR and to estimate equation (1). For the estimation based on monthly data, these data are contemporaneous.

2 Results

2.1 The World Interest Rate

In all three specifications of the WIR, the first principal component explains at least 87 percent of the variance in global interest rates (results in the Appendix), with the second principal component falling to less than five percent. We are comfortable that the first component captures the information that we require to represent the WIR (and an evaluation of the Eigen values support this). Factor loadings for the first principal component based on monthly data for 10-year bond yields are in Table 1 (loadings for the other specifications are in the Appendix). All countries have a positive influence, which raises our confidence that the first principal component represents the WIR. Perhaps surprisingly, the analysis shows that the United States is not the primary driver of the first principal component; however the factor loadings for the top six countries are all large and similar in magnitude.[4] New Zealand's factor loading is smaller, confirming expectations that New Zealand is less likely to be a driver of the global interest rate.

Table 1: Factors loadings of the world interest rate
Monthly frequency, 10-year bond

United States	*0.30*	*Austria*	*0.28*
Australia	*0.30*	*Belgium*	*0.28*
Japan	*0.17*	*France*	*0.29*
Canada	*0.36*	*Norway*	*0.31*
United Kingdom	*0.35*	*Switzerland*	*0.23*
Germany	*0.30*	*New Zealand*	*0.23*

Source: RBNZ calculations

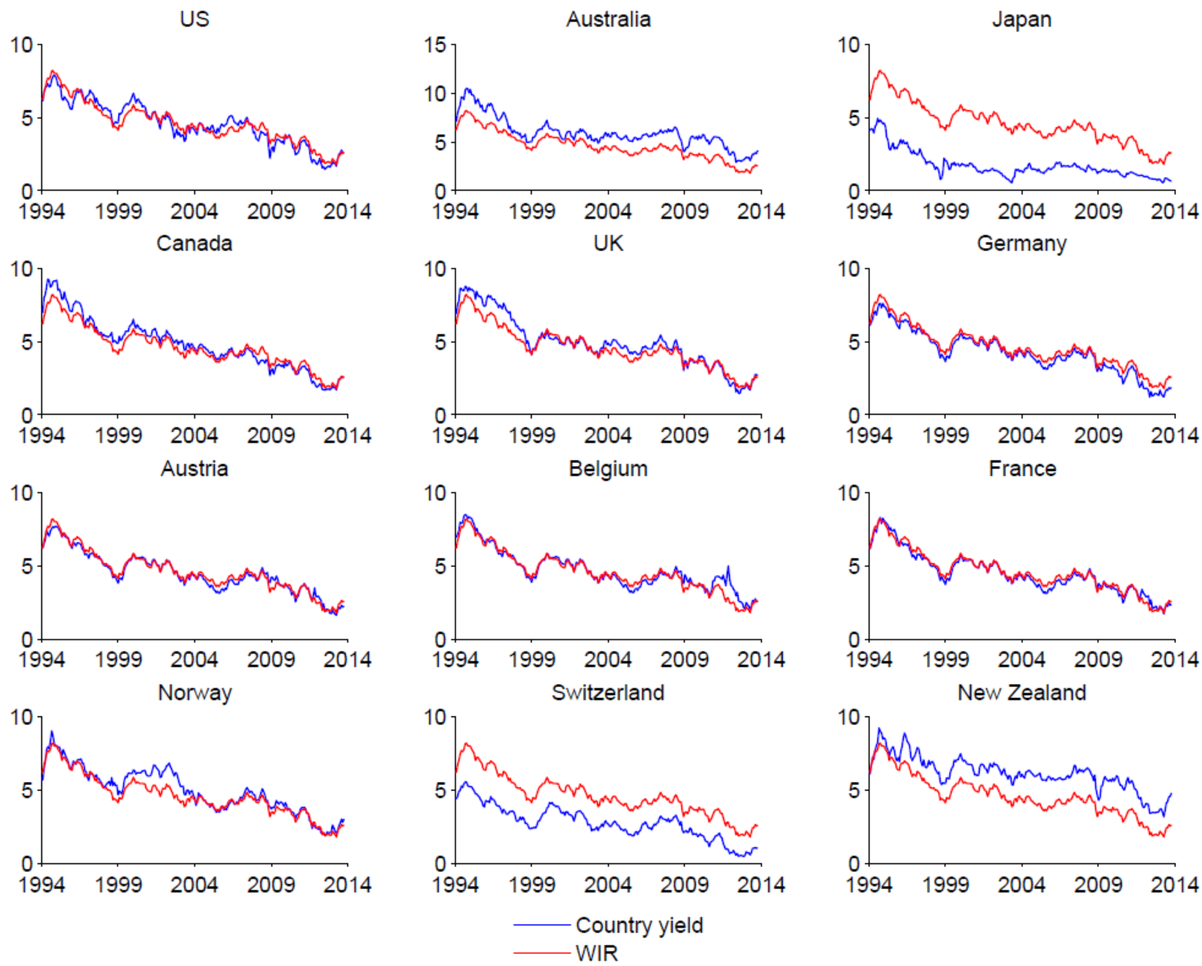
Figure 3 illustrates the WIR compared with each country's 10-year bond yield.[5] The trend and profile of country and WIR yields are similar. We note other observations, such as New Zealand and Australian interest rates have been consistently above the WIR, while Switzerland and Japanese interest rates have been consistently below. The remaining countries' interest rates have tracked the global rate more closely.[6]

[4] To check if the level and variance of bond yields were influencing the factor loadings, yields were standardised and an augmented WIR was created using principal component analysis. The rankings of counties in the factor loadings of the augmented first principal component were unchanged.

[5] The monthly and daily charts look identical, with the exception of the period frequency.

[6] To test the sensitivity of the principal component calculation to the 2007-2009 global financial crisis, we split the sample on 12 September 2008, when Lehman Brothers Holdings moved into Chapter 11 bankruptcy. We find that even with the severe interest rate movements during this time, the estimate of the WIR is unchanged.

Figure 3: Individual bond yields versus the World Interest Rate
10-year bond, monthly, percent



Source: Bloomberg, RBNZ calculations

2.2 Monthly changes in bond yields

The results for the monthly estimations are shown in Tables 2 - 4. The idiosyncratic components from the United States (US) and Australia are included in the estimation for New Zealand. For Australia, the US' and Japan's idiosyncratic factors were estimated.

The regressions look broadly well behaved, with the signs and relative sizes of the coefficients as we might expect and Durbin-Watson statistics around 2. The estimations were tested for structural breaks. At the monthly frequency, the null hypothesis of no structural break was accepted using the Quandt-Andrews unknown breakpoint test (results can be found in the Appendix).

We find that global factors explain 62 percent of the moves in New Zealand interest rates. The results also show that when the WIR increases 10 basis points, New Zealand's 10-year yield increases 11 basis points. The direct effect from the idiosyncratic components has a much smaller effect. The US has a positive but not significant effect, consistent with Conway and Orr (2002). Australia has a positive and significant impact on domestic yields, in line with Eckhold's (1998) analysis. When the Australian component rises 10 basis points, New Zealand's yield increases 5 basis points on average; a similar magnitude to Grimes' (1994) results.[7] The notable impact of Australian yield changes on New Zealand is consistent with Australia as New Zealand's largest trading partner and the tight economic cycles between the two economies.

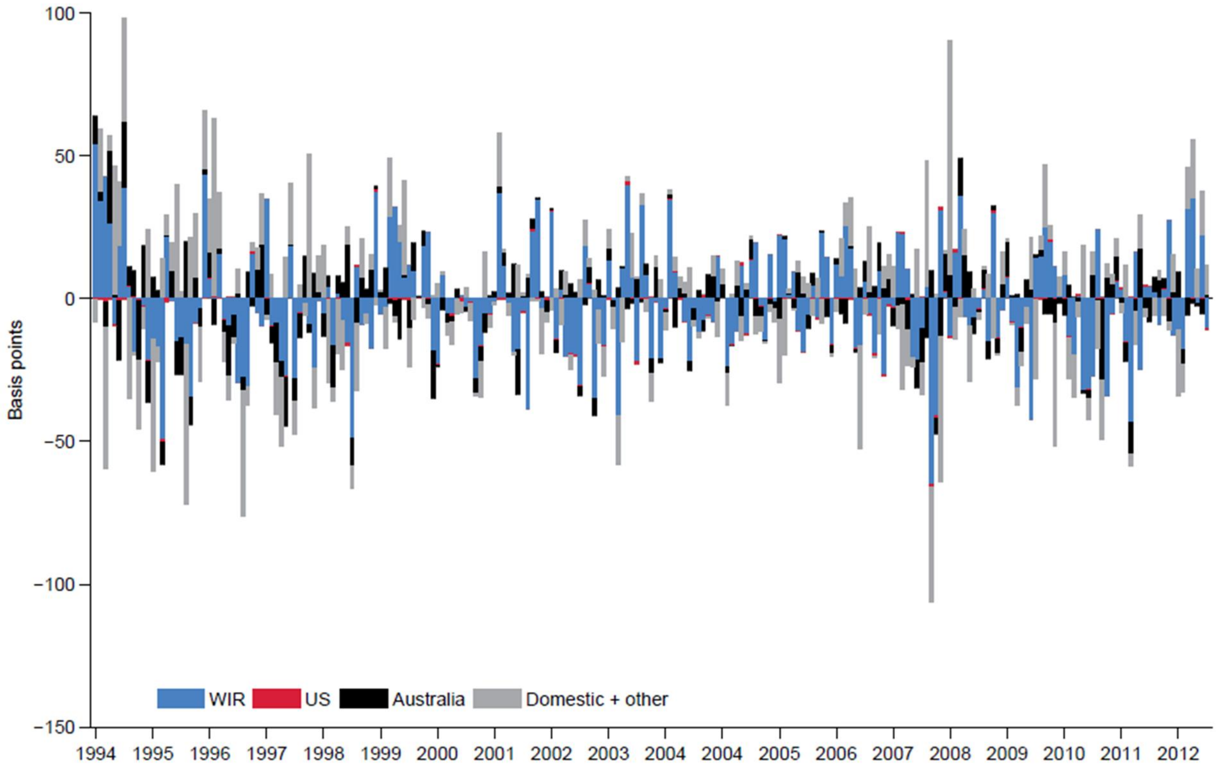
Table 2: New Zealand 10-year bond yield model

Variable		Coefficient	T-statistic	p-stat
Constant	β_1	0.98	0.89	0.3757
y^{WIR}	β_2	1.05	17.94	0.0000
$idio^{US}$	β_3	0.03	0.39	0.6973
$idio^{AU}$	β_4	0.48	7.16	0.0000
Adjusted R^2		0.618	*Durbin-Watson*	2.16

Source: RBNZ calculations

Figure 4 illustrates monthly changes in New Zealand rates decomposed into its global and domestic elements.

Figure 4: Decomposition of New Zealand 10-year bond movements
Basis points, monthly



Source: RBNZ calculations

The effect of the WIR on Australian yields is slightly stronger than in New Zealand's case, with an adjusted R^2 of 0.68 compared to 0.62. The direct affect from the WIR is larger than in the New

[7] Grimes (1994) and Eckhold (1998) do not estimate a World Interest Rate directly; however we can compare the coefficients β_3 and β_4 in equation (1) with their results. By substituting (2) and (3) into (1) and rearranging, equation (1) can be re-written as: $\Delta y_t^A = (\beta_1 - \beta_3\gamma_1 - \beta_4\rho_1) + \beta_3\Delta y_t^B + \beta_4\Delta y_t^C + (\beta_2 - \beta_3\gamma_2 - \beta_4\rho_2)\Delta y_t^{WIR} + \varepsilon_t$.

Zealand estimation, with a 10 basis point increase leading to a rise of 13 basis points in Australia. The size of the US coefficient is similar to Tarditi (1996), who finds that a 10 basis point rise in US 10-year yields equates to a 5 basis point rise in the Australian equivalent, whereas in our regression the idiosyncratic contributions from trading partners are not significant.

Table 3: Australian 10-year bond yield model

Variable		Coefficient	T-statistic	p-stat
Constant	β_1	0.67	0.63	0.5338
y^{WIR}	β_2	1.27	22.37	0.0000
$idio^{US}$	β_3	0.06	0.73	0.4691
$idio^{JP}$	β_4	0.04	0.63	0.5321
Adjusted R^2		0.680	*Durbin-Watson*	2.23

Source: Bloomberg, RBNZ calculations

At the two-year duration (Table 4) the regression model is less well explained, with an adjusted R^2 of 36 percent, suggesting the variability in New Zealand's two-year interest rate is dominated by domestic factors. The results suggest that when the WIR increases 10 basis points, New Zealand's yield increases 10 basis points, which is a similar magnitude as the 10-year model. However, the key difference is in the idiosyncratic components. In this case the Australian contribution is not significant, which is somewhat surprising given the economic ties between the two countries. The US idiosyncratic factor has a negative and significant, impact on domestic yields. This could potentially reflect risk sentiment.

Table 4: New Zealand two-year bond yield model

Variable		Coefficient	T-statistic	p-stat
Constant	β_1	0.13	0.08	0.9388
y^{WIR}	β_2	1.02	10.76	0.0000
$idio^{US}$	β_3	-0.28	-2.48	0.0140
$idio^{AU}$	β_4	0.05	0.64	0.5224
Adjusted R^2		0.358	*Durbin-Watson*	2.26

Source: RBNZ calculations

Overall, this suggests that different parts of the curve are, to a degree, affected by different factors. Global events appear more likely to impact the long-end of the curve, potentially via its impact on inflation, expectations, and strong trading partner links, while the short-end of the curve is anchored by domestic factors such as monetary policy.[8] Across both monthly specifications for New Zealand, the WIR has the same sized impact on changes in domestic yields.

[8] Notwithstanding that short-dated interest rates influence on long-dated rates too.

2.3 Daily changes in New Zealand bond yields

The daily WIR is applied to daily changes in 10-year bond yields in New Zealand, in addition to Australian and US idiosyncratic factors. The estimation results have a poorer fit, likely reflecting higher volatility at the daily frequency (Table 5). However similar trends can be seen. The effects from changes in the WIR and the Australian idiosyncratic component remain substantial but smaller than in the monthly model. The US idiosyncratic component is significant and positive, in contrast to the monthly model.

Table 5: New Zealand ten-year bond yield model, daily data

Variable		Coefficient	T-statistic	p-stat
Constant	β_1	0.02	0.26	0.7943
y^{WIR}	β_2	0.84	48.59	0.0000
$idio^{US}$	β_3	0.10	6.68	0.0000
$idio^{AU}$	β_4	0.27	24.18	0.0000
Adjusted R^2		0.383	*Durbin-Watson*	2.21

Source: RBNZ calculations

Diagnostic tests on parameter stability are mixed. The Quandt-Andrews unknown breakpoint test points to a break on 6 December 2007 (results in the Appendix). It is not surprising to find a lack of parameter constancy in daily changes in bond yields and the breakpoint date occurs during the global financial crisis: a time where a structural break could reasonably have occurred. However, we are cognisant that recursive estimates of the parameters settle down relatively quickly and the data sample could exhibit a ‘too large sample size problem’ (Kennedy, 2008). Consequently, the daily estimation may be more reliable than the Quandt-Andrews result suggests in isolation, although it is unlikely that the power of the test would be dramatically different.

3 Conclusions and future work

This paper uses principal component analysis to examine the role that global bond yields have on changes in New Zealand’s yields. We find that the first principal component explains at least 87 percent of the variance of global interest rates. We use this to derive World Interest Rates. Monthly changes in the 10-year World Interest Rate have a one-for-one impact on New Zealand yield movements and Australian idiosyncratic events are significant and positive. Global factors explain 62 percent of the variation in New Zealand’s bond yields.

In the case of daily movements, after accounting for the behaviour of financial markets with respect to time zones and country-specific idiosyncratic factors, 38 percent of the changes in New Zealand 10-year bond yields can be attributed to offshore factors. We extend this work to consider whether the global factor impacts more on long- or short-dated interest rates. We conduct the same analysis for two-year bond yields and find that 36 percent of the variation of changes in domestic New Zealand two-year rates can be explained by global factors. This reveals that, most likely, the short end of the New Zealand curve is primarily anchored by domestic policy and reacts to domestic data releases.

The results are similar to Grimes (1994) and Conway and Orr (2002), where the US is not a significant driver of domestic interest rates at the long-end of the curve. Australia is found to be a significant contributor, consistent with Grimes (1994) and Eckhold (1998).

Further work to explore the relationships between these variables is warranted. The number of countries in our sample could be widened in the principal component analysis to better represent the World Interest Rate. It could also be worthwhile to explore the interpretation of the second principal component of global interest rates. If the daily sample is expanded to incorporate five trading time zones, this may enable a greater understanding of the relationship between global factors and domestic interest rate changes between time zones. Finally, the causality of interest rate movements in Australia and New Zealand can also be assessed.

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Appendix

Table A1: Variance explained by each principal component (%) and the associated Eigen values

	Monthly data 10-year yield		Monthly data Two-year yield		Daily data 10-year yield	
Principal component	*Variance explained*	*Eigen value*	*Variance explained*	*Eigen value*	*Variance explained*	*Eigen value*
1	*93.92*	*23.5*	*87.48*	*25.28*	*93.14*	*19.12*
2	*1.99*	*0.50*	*4.45*	*1.29*	*2.3*	*0.47*
3	*1.62*	*0.40*	*3.46*	*1*	*1.95*	*0.4*
4	*0.86*	*0.22*	*1.48*	*0.43*	*0.84*	*0.17*
5	*0.53*	*0.13*	*1.28*	*0.37*	*0.61*	*0.13*
6	*0.45*	*0.11*	*0.62*	*0.18*	*0.8*	*0.1*
7	*0.25*	*0.06*	*0.46*	*0.14*	*0.26*	*0.05*
8	*0.15*	*0.04*	*0.38*	*0.11*	*0.16*	*0.03*
9	*0.11*	*0.03*	*0.17*	*0.5*	*0.12*	*0.03*
10	*0.05*	*0.01*	*0.14*	*0.04*	*0.06*	*0.01*
11	*0.03*	*0.01*	*0.09*	*0.03*	*0.03*	*0.01*
12	*0.03*	*0.01*			*0.03*	*0.01*

Source: RBNZ calculations

Table A2: Factors loadings of the first principal component

Monthly data 10-year yield		Monthly data Two-year yield		Daily data 10-year yield	
Canada	*0.36*	*Canada*	*0.34*	*Canada*	*0.36*
United Kingdom	*0.35*	*United Kingdom*	*0.44*	*United Kingdom*	*0.36*
Norway	*0.31*	*Norway*	*0.29*	*Norway*	*0.32*
United States	*0.30*	*United States*	*0.40*	*United States*	*0.31*
Germany	*0.60*	*Germany*	*0.29*	*Germany*	*0.31*
France	*0.29*	*France*	*0.30*	*France*	*0.29*
Australia	*0.30*	*Australia*	*0.24*	*Australia*	*0.29*
Austria	*0.28*	*Austria*		*Austria*	*0.28*
Belgium	*0.28*	*Belgium*	*0.26*	*Belgium*	*0.26*
New Zealand	*0.23*	*New Zealand*	*032*	*New Zealand*	*0.24*
Switzerland	*0.23*	*Switzerland*	*0.20*	*Switzerland*	*0.23*
Japan	*0.17*	*Japan*	*0.05*	*Japan*	*0.14*

Source: RBNZ calculations

Table A3: Quandt-Andrews structural break tests, sup F-statistic, Wald test

	Value	p-stat*	Breakpoint
NZ 10-year, monthly	12.68**	0.171	N/A
NZ 2-year, monthly	13.56**	0.129	N/A
AU 10-year, monthly	10.91**	0.293	N/A
NZ 10-year, daily	55.78	0.000	6 December 2007

*Notes: the null hypothesis assumes no breakpoints. The trimming percentage is 15%. * From Eviews, based on Hansen (1997). ** denotes 5% significance levels.*