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Determinants of New Zealand Bond Yields

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Abstract

This paper examines the driving factors of New Zealand bond yields over the 1988-1997 period. The results indicate that:

- The general analytical framework implied by the Uncovered Interest Parity (UIP) relation finds some support in the data.
- In the long run, short term real bond yields are related to US real bond yields, currency expectations and expectations of the future stance of domestic monetary policy vis a vis the stance offshore.
- Long-term real bond yields are related to Australian real bond yields, currency expectations, inflation uncertainty and relative monetary policy expectations.
- In recent years, domestic bond yields have been more closely related to offshore yields suggesting increased integration between the domestic and international capital markets.
- Increased perceptions of political risk appears to have played an important role in the rise in domestic long bond yields during the first half of 1996.

1. Introduction

The last decade has, at times, seen periods of turbulence in the domestic bond market. Since 1987, New Zealand 10 year Government bond yields have fluctuated through a remarkably wide range, peaking at around 17 percent in 1987 before touching their lows of around 5.5 percent in early 1994.

Many factors are likely to be relevant in explaining why New Zealand bond rates have moved through such wide ranges. This paper attempts to uncover these factors for New Zealand within an augmented Uncovered Interest Parity (UIP) framework. This framework in essence posits that bonds in different currencies are at least partially substitutable so that investors set bond yields such that risk-adjusted returns are equalised across countries. This implies that the yield on any bond is given by:

$$r_i = \alpha + \beta r_F + \delta \dot{e}_i \tag{1}$$

where r_i is the yield on country i's bonds;

r_F is the rate of return on a foreign bond or portfolio of foreign bonds for which the bonds of country i are at least partially substitutable;

$\dot{e}_i$ is the expected rate of depreciation of the currency of country i versus the currencies of the countries included in the portfolio r_F over the maturity of the bond;

α represents a premium that investors require over (or potentially under) relevant offshore yields to hold the bonds of country i;

β represents the sum total of the impact of changes in offshore bond rates on domestic rates and should equal 1 if UIP holds;

δ represents the elasticity of changes in the rate of expected exchange rate depreciation of domestic bond rates and should equal 1 if UIP holds.

The framework implied by equation (1) allows us to test the degree of substitutability or integration of the New Zealand bond market with foreign markets. It also allows us to investigate the determinants of the premium, α, which likely reflects macroeconomic factors such as inflation differentials, debt levels or national savings and investment levels. This premium may also reflect expectations of the future stance of monetary policy in one country relative to another and hence expected future real interest rate differentials.

The paper continues as follows: Section 2 reviews empirical work on the determination of bond yields both overseas and in New Zealand. Section 3 details the analytical framework adopted and outlines the testable hypothesises which follow from that framework. Section 4 discusses the data used and the results of the empirical analysis while Section 5 analyses the behaviour of domestic bond yields since 1996 in the context of the predictions of the models estimated in Section 4. Section 6 concludes with an overview and suggestions for further work.

2. The Determinants of Bond Yields – Previous Work

2.1 Overseas Evidence

Much of the work conducted in offshore markets attempts to identify the underlying long-run determinants of real bond yields since the 1960s or 1970s. In general, researchers have focused mainly on answering the questions "Why did real bond yields rise in the 1980s from their relatively low levels in the 1970s?" or "Why did global bond rates rise dramatically in 1994?" This work concludes that factors related to the balance of savings and investment, the returns to capital, the government's finances, market risk factors and monetary policy all have a role to play in determining the level of bond yields.

An example is the work of Howe and Pigott (1991) who examine both short and long-run influences on the real bond rates of Japan, Germany, the UK, France and the US over the 1970s and 1980s. Using quarterly data, they estimate real bond yield specifications which separate out long-run trend influences from shorter-run cyclical influences. They find that the trends in real rates are quite similar across countries with most experiencing a rise in real long rates from the 1970s to the 1980s. Much of this rise in real rates is found to be related to long run factors such as rising national debt levels, increasing returns to capital and increasing market risk.[1]

Short run factors such as the stance of monetary policy and fiscal policy also play a role in determining trends in world bond yields. These factors are proxied using the level of real short rates and the level of the budget deficit/GDP. These variables are included as short-run influences on the argument that in the long run, real bond yields should only reflect risk factors (ie, market risk, default risk) along with the return on capital. Fiscal and monetary policy influences are argued to be only of a transitory nature (in the long run the fiscal and monetary stance is neutral).

Further work at the OECD by Orr, Edey, and Kennedy (1995) builds on Howe and Pigott's approach in an attempt to explain why real world bond rates rose significantly in 1994. As with Howe and Pigott (1991), Orr et al. (1995) separate the influences on real long rates out into short and longer-run influences. As with the earlier work, Orr et al. (1995) use the rate of return on capital, market risk and Government debt/GDP as long-run determinants of bond yields. But they also include other variables designed to capture the effects of investment and savings imbalances in the economy such as total investment and household savings as a percentage of GDP. They also use inflation uncertainty (measured as a long-term average annual inflation rate less current inflation expectations) to proxy for credibility effects. Orr et al. (1995) argue that it takes some time for expectations to adjust to a low inflation environment if the country has a long history of high inflation rates. Those countries which once had high rates of inflation, continue to pay a premium over others who do not for some time until agents are sure that the new low inflation environment is permanent. Orr et al. (1995) also include the current account deficit as a percentage of GDP as a proxy for the currency risk on a country's bonds and the budget deficit/GDP as long-run determinants of real bond rates. Shorter run influences include that of monetary policy (proxied as the change in the real short rate) and first differences of the long run determinants described above.

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1 Market risk is measured as the 'beta' coefficient on a bond portfolio relative to the market portfolio comprising both bonds and equities.

Orr et al. (1995) use a pooled time-series and cross-sectional model of 17 OECD countries using quarterly data from 1981-1994. The influences of long-run determinants are restricted to be identical across countries but the influences of the shorter-run determinants are allowed to vary. Orr et al. motivate the use of the cross-sectional analysis on the grounds that previous time-series based methods had been unsuccessful in isolating the relationships between macroeconomic fundamentals and real bond rates. Orr et al. argue that three main factors mitigate against the success of time-series based techniques:

- there is more variation in macroeconomic fundamentals across countries than through time. Thus cross-sectional methods potentially have more information available to them and thus may provide more powerful results;

- many time-series based studies use sample periods which are short relative to the length of time required for macroeconomic fundamentals to change meaningfully;

- the quantitative impact over time of many macroeconomic fundamentals is likely to be small relative to the impact of other short-run influences on real bond rates. This alone could easily mitigate against the time-series analysis finding significant results.

As expected by Orr et al., the results show that all of the long-run determinants described above have the hypothesised effects on world bond yields. Additionally, shifts in monetary policy are found to have an important short-run impact on bond yields.

Work by Ford and Laxton (1995) backs up these findings. Ford and Laxton investigate the impact of fiscal policy on world real interest rates and find that OECD net public debt (a proxy for world debt levels) is positively related to real bond yields in industrialised countries. Note however that this result has only found mixed support in other work. For example, studies by Evans (1985) and Barro and Sali i Martin (1990) both fail to find a link between debt levels and real bond yields.

Tarditti (1996) examines the determinants of Australian long-term bond yields using the general framework suggested by Orr et al. (1995). Tarditti finds that the rate of return on capital, along with inflation uncertainty are useful in explaining the long-run behaviour of Australian 10 year yields. The other factors found by Orr et al. to be useful in a cross-sectional context were not found to be significant in the single equation analysis used.[2]

As regards the impact of monetary policy on real bond yields, evidence from Lee and Prasad (1994) and Wright (1995) suggests that the level of real short rates plays an important role in determining the level of real bond rates. Lee and Prasad (1994), in a study of the responsiveness of real long rates to shifts in short rates finds that the responsiveness of US long rates to changes in monetary policy as proxied by changes in the US Federal funds rate has doubled since the late 1980s. In particular they find that over the 1955-1980 period, 10 year yields changed by around 33 percent of the change in the Federal funds rate on average, whereas since 1980 this proportion has increased to over 50 percent. Wright (1995) tests the profitability of simple trading rules in the US bond market. His rules, which are based on the presumption of mean reversion in short-term interest rates, provide risk/reward combinations which outperform those available on naive buy and hold strategies applied to either bonds or

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[2] Although if criticisms of time-series based techniques levelled by Orr et al. are well founded, then Tarditti's results are to be expected.

equities. He says this result represents the tendency for the bond market to "understate the stabilising impact of monetary policy" or, in other words, the market expects policy shifts to persist for much longer than is actually likely. Hence a rule which recognises that monetary policy is essentially mean-reverting makes significant risk-adjusted profits.

2.2 The New Zealand Evidence

The New Zealand work has typically focused on developing shorter-term forecasting models of bond yields to answer the questions of "Which world yields are relevant in determining New Zealand yields?" and, more recently, "Which macro-economic factors explain movements in the spread between New Zealand and offshore bond yields?" These models are akin to Uncovered Interest Parity models augmented with other variables designed to model time-varying the risk premium in New Zealand bond yields.

Dyer (1994) models New Zealand 10 year yields as a function of global bond yields, short-term interest rates and currency expectations. He adopts a two step estimation procedure where he first estimates the weights in a portfolio of foreign real yields which best follows movements in New Zealand yields. Dyer then applies this implied 'world' real interest rate to a regression of the form:

$$y = \beta_1 (r - y)\Sigma + p^e + wr + \Delta + \beta_2 X^e \tag{2}$$

where y is the nominal 10 year bond yield

r is the 90 day interest rate

Σ is the elasticity of 10 year bond prices with respect to the current yield

p^e is the expected CPI inflation rate for the next year.

wr is the measure of global real yields previously constructed

Δ is a constant risk premium

X^e is the number of basis points that the 10 year bond would have to change to give a change in the capital price equal to the expected change in the currency over the next year.

β_1 and β_2 are estimated parameters.

Dyers specification is essentially a UIP equation augmented with a 'slope of the yield curve' effect $(r - y)\Sigma$. He posits that this term accounts for a non-linear effect between changes in monetary policy via short rates and bond yields. He argues that this effect is stronger when bond yields are higher (and hence bond durations shorter) than when the absolute level of yields is lower. Both inflation expectations and currency expectations (in this case TWI expectations over the next year) come from the Reserve Bank of New Zealand (RBNZ) quarterly survey of expectations. The model is estimated using monthly data from 1989 to 1994. Inflation and TWI expectations data are interpolated from a quarterly to a monthly frequency.

Dyer's results indicate that US and Australian real 10 year yields are the most important in explaining New Zealand yields. Short rates are a significant determinant of bond yields along with expected TWI movements.

Grimes (1994) adopts the Campbell and Shiller (1987) term structure equation to model 5 and 10 year nominal bond yields using monthly data from 1985 - 1994. The basic relation tested is:

$$i_{LNZ} - i_{SNZ} = f\left(E\Delta i_{SNZ}\right) + K \tag{3}$$

where i_{LNZ} is the nominal bond yield

i_{SNZ} is the nominal 90 day rate

$E\Delta i_{SNZ}$ is the average expected change in the 90 day rate over the life of the bond

K is a risk premium

Grimes uses the levels of US and Australian bond yields and 90 day rates, the actual and expected CPI inflation rate, and the real exchange rates with the US and Australia as potential determinants of the expected change in domestic short rates. The ratio of foreign debt/GDP is used as a determinant of the risk premium. Thus his final estimated relation is:

$$i_{LNZ} = f\left(i_{LAU}, i_{LUS}, i_{SAU}, i_{SNZ}, i_{NZ}, i_{ENZ}, e_{AU}, e_{US}, FD\right) \tag{4}$$

where i_{LX} refers to country X's nominal bond rate

i_{SX} refers to country X's 90 day rate

i_{NZ} refers to the actual inflation rate

i_{ENZ} refers to the expected inflation rate over the next year as given by The National Bank of New Zealand Limited (NBNZ) survey of expectations

e_x is the New Zealand dollar real exchange rate versus country X

FD is the foreign debt/GDP ratio.

The specifications are estimated using the Engle-Granger 2-step co-integration method which estimates long-run and short-run relationships separately.

Grimes' 5 year long-run model is:

$$i_{LNZ} = -21.75 + 0.23 i_{LAU} + 0.28 i_{LUS} + 0.50 i_{SNZ} + 5.02 FD \tag{5}$$

Thus in the long run, New Zealand 5 year rates are found to be determined by Australian and US rates in roughly equal proportions. Monetary policy, as represented by the New Zealand 90 day rate plays a role, as does the foreign debt/GDP ratio.

Grimes' short-run specification (not reproduced here) shows that the long-run equation shows evidence of cointegration (error-correction coefficient of -0.34). In addition he finds that short run movements in 5 year rates are influenced by lagged changes in domestic 5 year and 90 day rates, current changes in 90 day rates and Australian 5 year rates, and changes in inflation expectations.

Grimes' 10 year long-run model is:

$$i_{LNZ} = 27.85 + 0.47 i_{LAU} + 0.18 i_{SNZ} + 0.35 i_{ENZ} + 6.33 FD + 4.16 e_{US} \tag{6}$$

This equation is notable for the absence of US 10 year yields in the relation. As with the 5 year model, monetary policy and foreign debt/ GDP are relevant but differences arise in that the real exchange rate versus the US dollar and the level of current inflation are also relevant. The short-run relation shows evidence of cointegration in the long-run equation (error correction coefficient of -0.26) along with influences from changes in Australian 10 year rates and New Zealand 90 day rates. Lagged changes in 10 year rates are also relevant.

Rae (1995) updates the work of Grimes (1994) adding a 3 year model to the 5 and 10 year models previously estimated. Rae makes a few technical changes to the data with main differences being the extension of the sample to December 1994 and the revision of the gross foreign debt series to become net foreign debt. He also estimates daily equations to augment the monthly relations estimated.

The long-run 10 year model estimated was:

$$i_{LNZ} = -3.80 + 0.24 i_{LAU} + 0.37 i_{LUS} + 0.38 i_{SNZ} + 11.33 FD \tag{7}$$

Thus both US and Australian rates are found to be relevant with the US rates being slightly more dominant. Monetary policy effects are still found to be relevant as is net foreign debt.

The short-run equation exhibits cointegration (error correction co-efficient of -0.27) along with significant influences from changes in Australian 10 year and New Zealand 90 day rates. Lagged changes in New Zealand 10 year yields are also relevant.

Rae's 5 year model is given by:

$$i_{LNZ} = -2.65 + 0.47 i_{LUS} + 0.53 i_{SNZ} + 9.50 FD \tag{8}$$

Thus US 5 year rates, New Zealand 90 day rates and net foreign debt are all found to be relevant determinants of long-run trends in New Zealand 5 year yields. The short-run model shows evidence of cointegration in the long-run specification (error correction coefficient –0.25) along with short-run influences from Australian 5 year yields, New Zealand 90 day yields, and lagged changes in New Zealand 5 year yields. Rae's work differs from Grimes' in that US rates play a more dominant role. Note also that the exchange rate expectations and inflation terms in the Grimes' 5 year specification no longer appear in Rae's specification.

Rae's 3 year long-run specification takes the form:

$$i_{LNZ} = 1.59 + 0.32 i_{LUS} + 0.68 i_{LNZ} + 5.50 FD \tag{9}$$

Once again, only US rates are relevant in the long-run and short rates plus and the net foreign debt variables all play important roles. Note also that as the maturity of the bond gets shorter the effect of short rates increases which is intuitively plausible. The effect of net foreign debt gets larger as the bond maturity lengthens.

The short-run model shows cointegration in the long-run specification (error correction coefficient of -0.29) and short-run effects from Australian short rates, current and lagged New

Zealand short rates, and the change in the difference between NZ 180 day and 90 day interest rates (the latter term being a proxy for expected monetary policy).

The final piece of New Zealand work comes from O'Donovan, Orr and Rae (1996). O'Donovan et al. estimate a multi-country simultaneous equation model of quarterly real 10 year bond yields using data in 17 OECD countries including New Zealand. The method used builds on the work done by Orr, Edey and Kennedy (1995). Variables such as inflation uncertainty, the current account balance/GDP, net government debt/GDP, and market risk factors are all found to be relevant as with the previous work. In the case of New Zealand yields, Australia's real rates are found to be important suggesting omitted variables in the New Zealand section of the model. Net government debt/GDP is found to have a non-linear relationship with real bond yields.

2.3 Implications for further New Zealand work

The literature generally fits into two separate stands – both of which have strengths and weaknesses. The offshore evidence generally fits into one strand in that much of it has focused on identifying the driving factors behind trends in real interest rates that persist for quarters or years. Unfortunately such models tell you little about shorter run movements in bond rates – the interpretation and understanding of which are key to the formulation and implementation of monetary policy and the under-standing of the financial markets.

The New Zealand evidence fits into the second strand which is more heavily focused on modelling shorter-term trends in bond rates. The approaches used take advantage of the high correlation between short and long term interest rates both within and between countries. The theoretical bases for these models broadly fit the Uncovered Interest Parity relation or the Campbell-Schiller (1987) term structure relation. Notwithstanding this however, the work extant potentially has deficiencies which might have influenced the empirical results found. Examples of these issues include:

- the treatment of inflation expectations in some of the previous New Zealand work has not been ideal. In some cases proxies for short-term inflation expectations have been used in long-term interest rate models (eg, Grimes (1994), Rae (1995), Dyer (1994)). In addition, some of the estimated specifications do not include domestic inflation expectations in a coherent way (eg, Dyer's (1994) model implicitly allows real bond yields to move with inflation expectations) or does not include inflation expectations at all (both the Grimes (1994) and Rae (1995) models have no foreign inflation expectations terms). Hence movements in foreign nominal bond rates due to changes in foreign inflation expectations are assumed to result in higher domestic nominal interest rates.

- the treatment of the effects of monetary policy is not ideal. Often actual, rather than expected short rates are used (eg, Dyer (1994). Also, foreign expected short rates are omitted. Thus the implied spread between domestic and foreign bond yields misses an important determinant in that the spread should be positively related to the differential between expected short rates.

- the Grimes (1994) and Rae (1995) work is theoretically based on the Campbell-Schiller (1987) term structure relation while the empirical application bears much more resemblance to a Uncovered Interest Parity type model. In particular it is posited that factors such as the spread between foreign nominal bond rates and the domestic 90 day rate are related to the expected change in the 90 day rate over the life of the bond being modelled. Whilst one can make an argument for why this could be the case, it seems much more plausible that foreign bond rates affect domestic bond rates via UIP. Given this, this implies that adjusting the Grimes (1994) and Rae (1995) methods to make them consistent with a UIP interpretation will result in more robust empirical results.

- in the case of O'Donovan, Orr and Rae (1996), the New Zealand component of the system does not seem to work as well as other parts of the system. This is noted by the authors in the discussion of the significance of Australian bond yields in the New Zealand specifications.

The best model will likely marry the best aspects of both strands of the literature into a coherent consistent model of the determinants of bond yields. In this paper, it is hypothesised that a better approach to modelling bond yields is to use the information in foreign financial prices to model the bulk of the short-term movements in bond yields. At the same time I attempt to use the insights gained from the macroeconomic influences on bond yields to model the medium-term deviations (ie, quarterly or longer deviations) of domestic bond yields from offshore yields. The details of the framework employed are described in Section 3 below.

3. Analytical framework

Uncovered Interest Parity implies for real rates:

$$R_{NZ} = \sum_{i=1}^{n} \beta_i \, R_i + \sum_{i=1}^{n} \beta_i \, E\left(\Delta X_i\right) + \alpha \qquad (10)$$

where R_{NZ} is the real New Zealand bond yield

R_i is the real bond yield in country i

$\mathrm{E}\left(\Delta X_i\right)$ is the expected real exchange rate change of the New Zealand dollar versus currency i over the life of bond

β_i is the elasticity of New Zealand bond yields relative to changes in the bond yields of country *i*. The greater the degree of substitutability between the bonds of country *i* and New Zealand, the higher β_i will be.

Redefining (10) in terms of α we have:

$$\alpha = R_{NZ} - \sum_{i=1}^{n} \beta_i \, R_i - \sum_{i=1}^{n} \beta_i \, E\left(\Delta X_i\right) \qquad (11)$$

✂ in equation (11) represents the exchange rate expectations adjusted premium that New Zealand bond yields need to yield relative to comparable world yields for investors to be indifferent between holding New Zealand and foreign bonds.

This premium α is assumed to be time varying and dependent on a number of factors including both medium term macroeconomic factors related to savings and investment, risk factors and monetary policy.

In particular α is hypothesised to be a function:[3]

- Government debt/GDP (DEBT)
- Budget Deficit/GDP (BUDGET)
- Current Account Deficit/GDP (CURACT)

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3 Foreign measures of these factors were also included to see if the differential between New Zealand and foreign real bond yields was a function of New Zealand macro factors relative to offshore factors. For example, in the case of debt/GDP it may be that domestic debt levels have risen, but at a lower rate than the rest of the world. Hence domestic bond yields should fall *relative* to offshore rates. This effect would not be picked up by including only the New Zealand debt ratio in the analysis. However it is also possible that the foreign data used in the analysis may not be of sufficient quality, or that there may be other factors explaining offshore bond yields that may mitigate against finding significant coefficients on foreign macro variables in the estimated equations. Thus to the extent that New Zealand macro variables are not perfectly correlated with foreign macro effects, then including only domestic variables will provide an adequate explanation of the long-term trends in the exchange rate expectations adjusted risk premium.

- Inflation Uncertainty (INFU)
- Rate of Return on Business Capital (ROC)
- Household Savings Ratio (SAVRAT)

Monetary policy is also hypothesised to play an important role in determining the trends in real bond yields relative to the trends in offshore markets. According to the expectations theory of the term structure, long-term interest rates are averages of expected future short term interest rates. It is through these expectations of future short rates that monetary policy can gain leverage over the bond curve. I argue that agents have a tendency to project anticipated changes in the stance of monetary policy, and hence short-term interest rates, as if these moves are permanent. This means that bond rates and expected short-rates should be positively correlated via the expectations theory relation. Thus the monetary authorities can place a 'wedge' between domestic and foreign bond rates in the same way as they can do so for short-term rates when changing the stance of policy.[4]

The effects of this 'wedge' in domestic bond rates are included by including a measure of expected 90 day interest rates six months into the future. Specifically, the difference between domestic and offshore real short rates six months in the future should be a key determinant of the α term in equation (11) and hence domestic real bond rates. Domestic and offshore expected short rates are included separately so the hypothesis that the coefficients are equal and opposite in sign – ie, the future short rate differential explains bond rate differentials – can be tested.

Thus the final general long-run specification estimated is:

$$\begin{aligned} R_{NZ} = \sum_{i=1}^{n} \overset{+}{\beta}_i R_i + \sum_{i=1}^{n} \overset{-}{\delta}_i E(X_i) + \overset{+}{\varepsilon}_{NZ} XMP_{NZ} + \sum_{i=1}^{n} \overset{-}{\varepsilon}_i XMP_{i\,i} \\ + \overset{+}{\Delta}_{NZ} DEBT_{NZ} + \overset{-}{\psi}_{NZ} BUDGET_{NZ} + \overset{-}{\gamma}_{NZ} CURACT_{NZ} \\ + \overset{+}{\mu}_{NZ} INFU_{NZ} + \overset{+}{\sigma}_{NZ} ROC_{NZ} + \overset{-}{\tau}_{NZ} SAVRAT_{NZ} \end{aligned} \tag{12}$$

while all variables are defined as above except for XMP_i which is the expected short-term interest rate in six months in country *i*. Hypothesised signs are given immediately above each parameter. Testable restrictions are that:

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4 It is also possible to think of monetary policy as having an impact on bond rates via an effect on the expected exchange rate depreciation over the life of the bond. Given UIP, higher short rates due to tighter domestic monetary policy imply an increase in the rate of depreciation of the currency. But if good empirical proxies for exchange rate expectations are not available on a frequent enough basis then such effects may be difficult to detect empirically. Thus the FRA based expected monetary policy proxies used in this work may be interpreted as picking up some of the impact of exchange rate expectations on bond rates.

- $\sum_{i=1}^{n} \beta_i = 1$ if the combination of foreign bond rates included corresponds to a substitutability weighted world interest rate.

- $\varepsilon_{NZ} - \sum_{i=1}^{n} \varepsilon = 0$ ie, the differential between expected future short rates explains the exchange rate expectation adjusted differential between domestic and offshore bond yields.

Note also that pure UIP implies that the coefficients on the foreign bond and exchange rate expectations terms should be equal and offsetting (ie, $\beta_i = \delta_i$ for each country *i*).

The final specifications should only include the expected future short rates of countries who have a significant impact on our own bond yields. For example, it makes little sense to have the spread between Irish and New Zealand expected short rates explaining New Zealand bond yields if Irish bond yields themselves are not significant determinants of New Zealand yields. The next section details the estimation method, data, and results obtained.

4. Data and results

4.1 Data sources and measurement

Data from 10 countries was used in the analysis. Countries included are:

- the United States
- Australia
- Canada
- the UK
- Germany
- Japan
- Ireland
- Sweden
- Norway
- Spain

The first three countries represent the group commonly referred to as the 'dollar bloc' countries. Assets denominated in dollar bloc currencies are generally thought of as being closer substitutes with each other than with the assets of other countries. The UK, Germany and Japan are included as they represent the three other major capital markets in the world. The others are included as they generally fit into the 'small OECD' group of countries and are, in that sense, similar to New Zealand. If world investors place assets into classes based on a 'small OECD' type criterion, then it may be that the yields on these country's bonds have closer relationships with each other than with other larger markets.

4.1.1 Indebtedness proxies

A variety of measures of indebtedness are used in the empirical analysis including:

- Gross and Net government debt as a percentage of GDP.
- Gross and Net foreign debt (economy-wide) as a percentage of GDP.
- Gross and Net debt (economy-wide) as a percentage of GDP.

Theoretically, net debt measures should be superior but gross measures are tried for completeness. Foreign data are collected at an annual frequency from the statistical annexes in the *OECD Economic Outlook.* These annual data are then (linearly) interpolated to a weekly frequency for the final empirical analysis.

New Zealand data are collected from the RBNZ database and interpolated to a weekly frequency from quarterly data.

The use of interpolated macroeconomic data is justified on the grounds that the underlying factors these variables proxy should only effect the long-term trends in real bond rates. The use of annual data may actually be superior to using data of higher frequencies (for example quarterly data). This is because the noise in quarterly series due to revisions, transitory factors etc which should not be useful in explaining trends in bond yields will be filtered out.

4.1.2 Internal balance

The government budget deficit as a percentage of GDP is used as a measure of government's savings influence on the economy and hence real interest rates. Foreign data are collected from the *OECD Economic Outlook* at an annual frequency whilst New Zealand data are collected from the RBNZ database. All data are linearly interpolated to a weekly frequency.

4.1.3 External balance

The current account balance/GDP ratio is used to proxy the effects of external imbalances and/or currency risks on real bond yields. Foreign data are collected from the *OECD Economic Outlook* whilst NZ data come from the RBNZ database. In the case of New Zealand, the Statistics New Zealand structural current account balance is used in the hope that it will filter out any noise in what can be a series subject to considerable revision.

4.1.4 Return on capital

In the long-run, a major determinant of bond yields should be the return on capital – the prime substitute for investment funds. This variable is proxied by the OECD measure of the return on business capital as found in the *OECD Economic Outlook.* The OECD do not actually include New Zealand in the statistical annex so I created a proxy using capital stock and operating surplus data from the RBNZ database.

4.1.5 Household savings behaviour

The household savings ratio is included as a proxy for the supply of capital from households. Foreign data are obtained from the *OECD Economic Outlook* while New Zealand data are obtained from the RBNZ database. As with the other data, these are interpolated to weekly data from annual data.

4.1.6 Exchange rate expectations

The specification to be tested requires measures of real exchange rate expectations. Unfortunately little quality data are available as proxies. The data that does exist exists for nominal exchange rates. The RBNZ survey of expectations includes surveys of:

- the NZ dollar – US dollar rate in three quarters
- the NZ dollar – Australian dollar rate in three quarters
- the TWI in one year.

These data are available on a quarterly basis since 1987. Additionally, the AON survey (formerly Alexander Consulting) of economists contains data on the expected level of the TWI in one, four and seven years time. These data are available on a monthly basis from

1992. The approach adopted in this paper was to try each of these series individually as proxies for real exchange rate expectations. As the exact level of the currency is not known when the survey is conducted, this is approximated using the monthly average (in the case of the AON data) or the quarterly average (in the case of the RBNZ data) of the currency concerned. The expected appreciation/depreciation is then calculated. Some noise is generated into these series due to not having the exact current levels available when the respondents are filling in the surveys which is removed by smoothing the resultant series.

In the case of the AON survey data, the series was backdated to 1987 by splicing the series to the RBNZ one year ahead expectations of the TWI. Whilst this is not ideal, casual empiricism suggests that the expectations over the one, four and seven year horizons tend to move together but with different levels. If this is also the case before the survey started in 1992, then any errors introduced due to splicing the series will be small.

4.1.7 The stance of monetary policy

The expected stance of policy is proxied by the level of the 90 day rate expected in six months time. Actual futures data is available for New Zealand, the US and Australia since 1988 from the New Zealand Futures and Options Exchange and Datastream. For the other countries considered, this series is estimated by calculating implied 90 day rate in six months using six and nine month bill yields in these countries. Where nine month bill rates are unavailable 12 month rates are used and the assumption made that the implied 90 day rates in six and nine months time are the same. Six, nine and 12 month bill rate data are obtained from Datastream. The real expected 90 day rate for each country is used in the final analysis so the nominal rates calculated above are adjusted for inflation expectations. The method of estimating inflation expectations is described below.

4.1.8 Inflation expectations

Inflation expectations data are only available for New Zealand. Several surveys are available including the RBNZ survey of expectations, the NBNZ survey and the AON survey. The RBNZ survey of expectations offers quarterly data starting in 1987 on CPI inflation expectations one and two years into the future. The NBNZ survey offers monthly data on CPI inflation expectations one year into the future from 1983. The AON survey offers monthly data on CPI inflation expectations one, four and seven years into the future from 1992.

Theoretically, when estimating real bond yields then long-term inflation expectations should be used. Two approaches are adopted in this paper:

(1) AON four and seven year inflation expectations backdated to 1987 using the RBNZ two year ahead inflation expectations data are used to estimate real 3, 5 and 10 year bond yields.

(2) A measure of trend inflation derived from a Hodrick-Prescott filter of actual inflation excluding GST and interest costs is also used to estimate long term inflation expectations and hence 5 and 10 year real rates.

The use of the second method is motivated by two factors, these being:

- much of the previous literature uses these types of trend measures of inflation expectations

- the behaviour of longer term inflation expectations seems to differ from that of shorter term expectations. A comparison of the one, four and seven year expectations series from the AON survey shows that shorter-term expectations are much more variable than longer-term ones. This raises some concerns over the appropriateness of splicing four and seven year expectations to one year expectations when backdating the longer term series. This is especially true given that the backdating occurs over a period when inflation was relatively variable. This may mean that the variability of long-term inflation expectations is overstated in that earlier period.

Foreign long-term inflation expectations are estimated using the Hodrick-Prescott filter as described above.

Short-term inflation expectations are used to calculate short-term expected real 90 day interest rates. For the countries excluding New Zealand, these are estimated as a centred moving average of the actual CPI outcomes in the year around the observation. For New Zealand, the spliced four year ahead inflation expectations series described above is used.

4.1.9 Nominal bond yields

Models are estimated for 3, 5 and 10 year yields. These data were collected from a variety of sources which are detailed in the table below:

Bond Yield Sources

	Maturity		
Country	**3 years**	**5 years**	**10 years**
New Zealand	From 1987-1993 NBNZ. From 1993 onwards the RBNZ	RBNZ	RBNZ
Australia	Bain and Co	Datastream	RBNZ
United States	Datastream	Datastream	RBNZ
Canada	Datastream	Datastream	Datastream and RBNZ
UK	Datastream	Datastream	RBNZ
Germany	Datastream	Datastream	RBNZ
Japan	Datastream	Datastream	RBNZ
Sweden	Datastream	Datastream	Datastream
Norway	Datastream	Datastream	Datastream
Ireland	Datastream	Datastream	Datastream
Spain	Datastream	Datastream	Datastream

All data are benchmark or generic maturities. RBNZ data are collected daily from the Reuters and Telerate services. The models are all estimated at a weekly frequency using weekly averages of daily rates.

4.2 Method and Results

Models of 3, 5 and 10 year real bond yields are estimated from January 1988 to March 1996. Approximately one year of data are left aside for out of sample testing.

4.2.1 Estimation Approach

The estimation approach employed is that of 1-step error correction modelling. This method of estimation is been found to be superior to the Engle-Granger 2-step method – the other main approach to modelling long-run relationships in a single equation context – as it allows both long-run and short-run parameters to be estimated at the same time. This joint estimation approach makes it easier to extract more reliable long-run estimates. Wong (1993) gives more details on the 1-step approach and its advantages over other approaches. The estimation procedure involves beginning with a general model which includes all of the long-run variables for each country along with up to four lags of each dynamic regressor. Only financial prices were used as dynamic regressors. This was done on the grounds that:

- most of the macroeconomic data has been interpolated to weekly data from annual data. Hence there is no information value to first differences of this data; and

- the macroeconomic variables are included to account for slow-moving shifts in trends over time. It is implausible that changes in inflation expectations, the return on capital etc have any discernible effect on week to week changes in bond yields. Thus on this basis it makes little sense to include them as any significant parameters will almost certainly be spurious.

Insignificant variables and lags are then deleted sequentially and the specification re-estimated until only significant variables remained. Coefficients with signs inconsistent with theoretical priors are also deleted from the specification. Variables are then sequentially added back into the specification to test whether the order of deletion has an effect on the final specification. Estimation ends when no further significant explanatory variable can be found. In general, the final specifications seem robust to the addition of new regressors.

4.2.2 Model Estimates

General specification issues
Full Short-Run Specifications

	3 Years	**5 Years**	**10 Years**
Parameter Estimates			
USBOND $_{-1}$	0.0742	N.A.	N.A.
	2.94***		
AUBOND $_{-1}$	N.A.	0.0314	0.0368
		3.64**	3.40***
NZBOND $_{-1}$	- 0.1048	- 0.0413	- 0.0468
	5.70***	3.49*	3.72*

US90DFR $_{-1}$	- 0.0596	N.A.	N.A.
	- 2.77***		
AU90DFR $_{-1}$	N.A.	- 0.0105	- 0.0100
		- 2.05**	- 1.89*
NZ90DFR $_{-1}$	0.0786	0.0164	0.0141
	5.39***	2.36***	2.62***
NZTWIEXP $_{-1}$	- 0.0133	N.A.	N.A.
	- 2.03**		
NZINFU $_{-1}$	N.A.	N.A.	0.0219
			2.56***
ΔNZ90DFR	0.7123	0.5284	0.3805
	22.30***	16.07***	12.63***
ΔAUBOND	0.1037**	0.0862	0.1941
	3.72	2.75***	5.49***
ΔAUBOND $_{-1}$	3.72	0.0754	N.A.
	N.A.	2.27**	
ΔUSBOND	N.A.	N.A.	0.1308
			2.78*
ΔLOG (NZTWI)	N.A.	- 1.4493	- 1.5262
		2.33**	2.62***
ΔUKBOND $_{-2}$	0.0598	N.A.	N.A.
	2.25**		
ΔNZBOND $_{-1}$	0.0831	0.1426	0.2036
	2.68***	4.07***	5.79***
CONSTANT	0.0748	0.0166	- 0.0870
	1.72*	0.65	1.76*
Model Diagnostics			
R^2	0.66	0.55	0.52
σ	0.09387	0.09634	0.08883
DW[1]	1.90	1.88	1.81
Autocorrelation[2]	0.94	1.27	2.03*
ARCH[3]	3.16***	3.10***	3.70***
Normality[4]	107.56***	27.18***	20.59***
Omitted Variables[5]	2.22	0.91	0.70

Sample: 1988w3 – 1996 w15 Observations 429

* denotes significance at the 10% level
** denotes significance at the 5% level
*** denotes significance at the 1% level
t statistics are adjusted for heteroskedasticity using the technique described in White (1980)

1 Durbin-Watson test for Autocorrelation
2 LM test for Autocorrelation from lags 1 to 7 distributed F (7,412)
3 ARCH test for orders 1 to 7 distributed F (7.405)
4 Jarque-Bera test distributed χ^2 (2)
5 Ramsey Reset test distributed F (1,418)

The table above shows the final estimated specifications for 3, 5, and 10 year real bond yields (*t* statistics are given in the row immediately below the parameter estimate concerned). All the models exhibit cointegration (ECM *t* statistics are all significant for cointegration at the 10 percent level) and fit the data reasonably well (R^2 statistics range between 52 and 65 percent). The equation standard errors suggest that the models predict weekly movements in bond rates within 20 basis points 95 percent of the time. All of the models exhibit heteroskedasticity – possibly in the form of ARCH. For this reason, *t* statistics are calculated using standard errors adjusted for heteroskedasticity using the method developed in White (1980). The exact form of the heteroskedasticity appears to be ARCH (1). Most of the coefficients in the model are unaffected by this as models estimated with an ARCH (1) correction term show similar parameter estimates to those shown above. The exceptions to this are some of the dynamic regressors which seem to appear in the final model in an attempt to model the ARCH process. The parameters affected are the lagged UK and Australian bond yield terms in the three and five year equations. These terms become insignificant once an adjustment for ARCH is made. The lagged dependent variable coefficients also seem to be affected, although these remain significant after ARCH effects are accounted for. The long-run coefficients are unaffected by the ARCH process. The models all fail normality tests at conventional significance levels but pass autocorrelation and omitted variables tests at the 5 percent level. Overall, most of the coefficients seem reasonably stable given the Hansen instability tests and recursive parameter plots (both not reported). Exceptions include the change in foreign bond yield terms in the short-run dynamics of the estimated specification. These terms appear to get larger over time. It is posited that these changes in coefficients represent the effects of an increase in the degree of integration between New Zealand and offshore bond markets over time. This concept is explored further later in the paper.

Long-run determinants
Unrestricted Long-run Specifications

	3 Years	**5 Years**	**10 Years**
USBOND	0.708	N.A.	N.A.
AUBOND	N.A.	0.761	0.787
NZ90DFR	0.750	0.397	0.302
US90DFR	0.569	N.A.	N.A.
AU90DFR	N.A.	- 0.255	- 0.212
NZTWIEXP	- 0.127	N.A.	N.A.
NZINFU	N.A.	N.A.	0.467
CONSTANT	0.714	0.403	- 1.859

Restricted Long-run Specifications

	3 Years	5 Years	10 Years
US Bond Yields	1.00	0	0
Australian Bond Yields	0	1.00	1.00
Expected Short rate differential to the US	0.78	0	0
Expected Short rate differential to Australia	0	0.35	0.30
Expected TWI appreciation over the next year	- 0.07	0	0
Inflation Uncertainty	0	0	0.60
Constant	0.07	- 0.10	- 3.30

The above two tables detail the long-run components of the specifications estimated. The first table shows the unrestricted long-run estimates. The second shows the estimates after the model is restricted such that:

- The coefficient on the foreign bond yield equals one. Thus the foreign bond yield may be interpreted as the ‘world’ interest rate.
- The coefficients on the expected future real short rate terms are equal and opposite in sign. This implies that New Zealand real bond differentials are determined by expected future short rate differentials.

Both of these restrictions are tested individually and jointly and are accepted at conventional significance levels.

New Zealand real bond yields to be a function of foreign (ie, Australian and US) bond yields, expected real short term interest rates both here and abroad, TWI expectations over the next year and inflation uncertainty. Three year real bond yields are found to be set at a wedge over (or under) equivalent US 3 year real rates with that wedge:

- increasing in the differential between expected domestic real short rates and US expected short rates, and
- decreasing in the expected appreciation in the Trade Weighted Index over the next year.

Five and 10 year real bond yields are set at a wedge over (or under) Australian real bond yields. The wedge is also an increasing function of the expected future real short rate differential between New Zealand and Australia. In the case of 10 year real yields, inflation uncertainty plays a role (cf Orr et al. (1994)). This implies that, because New Zealand has a history of high inflation, borrowers continue to pay a premium to borrow in New Zealand dollars despite the fact that inflation is now lower.

Short-run determinants

Short-run movements in New Zealand real bond yields are determined by a variety of factors including:

- *changes in expected future real short term interest rates.* An upward revision to the expected profile of short rates leads to higher bond yields.

- *foreign bond yields*. Changes in Australian bond yields have important short-run influences in all of the models estimated. Changes in US bond yields are also important in the 10 year bond yield equation. Lagged Australian and UK bond yields also prove significant but, as noted earlier, these become insignificant after ARCH effects are accounted for.

- *the TWI*. Changes in the TWI prove to be a significant short-run factor in the 5 and 10 year bond models. An appreciation in the currency is associated with a fall in bond yields.

- *lagged changes in New Zealand bond yields*. Some of this effect seems due to the ARCH process although even after accounting for this these terms remain significant short-run determinants.

4.2.3 Comparison across maturities

The table below summarises the key aspects of the three 3 models estimated.

New Zealand bond models - key aspects

	3 Year	5 Year	10 Year
Long-run aspects			
Error-correction coefficient	- 0.105	- 0.041	- 0.047
Australian bond yields	0	0.031	0.037
US bond yields	0.074	0	0
NZ Expected 90 day rates	0.079	0.016	0.014
Australian Expected 90 day rates	0	- 0.011	- 0.010
US Expected 90 day rates	- 0.060	0	0
TWI expectations	- 0.013	0	0
Inflation Uncertainty	0	0	0.014
Short-run aspects*			
ΔAustralian bond yields	0.104	0.086	0.194
ΔUS bond yields	0	0	0.131
ΔNZ bond yields	0.083	0.143	0.204
ΔExpected NZ 90 day rates	0.712	0.528	0.381
ΔTWI	0	- 1.450	- 1.526
<u>Fit</u>			
R^2	0.65	0.55	0.52
σ	0.09	0.10	0.09

* Except for the change in NZ bond yields, only current period coefficients are examined.

Several issues arise from the comparisons made in the table above including:

Australian bond yields have a pervasive influence on domestic yields both in the short and long runs.

This is an enduring theme throughout the analysis. Only in the case of 3 year yields is there a long run relation between US and New Zealand yields and even here, Australian bond yield movements feature in the dynamics of the equation. On the face of it, this result seems paradoxical as both practitioners and theorists tend to focus on the US market not the Australian market as the ‘world’ interest rate. Further thought sheds some light on why this intuition may not be correct.

The first relevant point is that Australian bond yields are almost undoubtedly driven by developments in other international markets – and most probably the US. Thus to interpret the results of this paper as implying that New Zealand yields evolve independently of US yields is a nonsense. Essentially the ultimate effect of a change in world yields on our own likely comes through directly (as in the 3 year model and the dynamics of the 10 year model) as well as indirectly through changes in Australian yields through to our own. Thus the general modelling method adopted in the paper seems ill-suited to addressing the question of “How much effect does a change in US yields have on New Zealand yields?” as there are simultaneity and endogeneity issues that need to be addressed. Rather, that issue would be better addressed in a multi-equation context (eg, a VAR or more likely a VECM). This is left to further research.

The second point is that these results make perfect sense from an asset allocation perspective. International investors typically put markets into ‘buckets’ or groups which have similar characteristics. Examples of this include the ‘dollar bloc’ and ‘deutschemark bloc’ groupings. The results here suggest that investors place New Zealand and Australian bond assets in the same ‘bucket’. Implicitly, this means that investors treat New Zealand and Australian assets as being more substitutable with each other than with those of other countries. This interpretation makes sense when you consider the similarities between the New Zealand and Australian economies.

The impact of the expected monetary stance declines as the term to maturity of the bond increases.

This result seems to hold both in the long and short runs and is exactly as expected. Essentially this result suggests that, while agents generally expect changes in the stance of policy to persist for some time, they do not view these changes as being permanent. For example, the real yield curve steepens (ie, becomes more inverted) and rises when policy in expected to firm over the coming year.

The effects of the currency on bond yields fluctuates with the bond maturity

Uncovered Interest Parity posits that real bond yields should be inversely related to ex ante currency expectations (ie, countries with relatively high real rates should have currencies which are expected to depreciate). Unfortunately this effect seems to only be relevant for 3 year bond yields. Overall, this general lack of significance of currency expectations is not really unexpected – after all there is a long list of studies which have similarly failed to find such effects in other markets. But the question that needs to be addressed is "Why are currency expectations relevant at the shorter maturity and not the longer ones?" There are potentially two explanations, these being:

- the data on long-term currency expectations is of a lower quality as data from the AON survey had to be spliced to one year ahead expectations in the RBNZ survey to generate a long enough series; or

- the significant result in the three year model does not reflect the effects of UIP at all, rather it reflects aspects of the monetary policy implementation framework in New Zealand.

Expanding on this second point, note that short-run increments in the TWI do inversely affect 5 and 10 year yields. In New Zealand, the overall policy stance is better described by a measure of monetary conditions that includes both the TWI and interest rates rather than just interest rates alone. An inverse relationship between interest rates and the TWI is possible if agents act to hold overall conditions relatively constant in the face of a shock to the TWI. Thus short-term interest rates fall as the currency rises. If these shocks are viewed as being relatively persistent, then longer-term rates will be affected also. Hence the finding of significant TWI effects in the long-run of the three year model and in the short-run of the five and 10 year models may simply reflect the nature of New Zealand's monetary policy implementation framework rather than UIP as such.

A second possibility is that the data on exchange rate expectations are not good enough to accurately identify the effect. The exchange rate expectations data is interpolated from monthly or quarterly data which may not be fine enough to pick up the effects in the weekly models estimated. As noted earlier in the paper, it is possible that the expected monetary policy variables (which are available at a weekly frequency) are picking up at least some of the impact of short-term changes in exchange rate expectations.[5]

Movements in real bond yields are persistent

All of the models estimated feature lagged changes in domestic bond yields as significant short-run explanatory factors. This suggests that short-term trends in bond yields are persistent which is a violation of the weak form of the efficient markets hypothesis. This effect gets stronger as the maturity of the bond lengthens (the strength of the effect more than doubles going from 3 to 10 years).

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[5] It is possible that the overall lack of significance of the exchange rate expectations terms in the long-run specifications relates more to the possibility that the real exchange rate is stationery. If this is the case then it would be more appropriate to include the exchange rate expectations term in the short-run of the specification rather than in the long-run. Experimentation with this idea did not result in an increase in significance in the exchange rate expectations terms suggesting that the stationarity of exchange rate expectations is not a key issue here.

4.2.4 Comparison versus previous research

In general, the types of factors found to be important in determining New Zealand's real bond yields are also found to be relevant in other studies also. What is interesting, however, are the factors that are *not* found to be useful which a-priori were expected to be significant. Examples of such factors include most of the medium term macroeconomic factors included such as the proxies for the fiscal stance, the return on capital, the current account and the measures of government debt. These results are at odds with the international evidence discussed earlier and the New Zealand evidence in the case of the debt proxies.

Some of the differing results from previous work may reflect the quality of the data and the length of the time period examined (eight years is a relatively short sample when compared with the international work which used samples up to 30 years in length). Notwithstanding the above however, these results suggest that much of the recent rhetoric suggesting that the improvements to the general macro policy framework in recent years have led to significant reductions in the risk premium on New Zealand real bond yields has little empirical support from this study.[6]

The finding that New Zealand longer term bond yields have a long-run relation with Australian bond rates is consistent, at least in the case of the 10 year model, with Grimes (1994) and also Orr et al. (1995). However the results do contrast somewhat with the later work of Rae (1996) who finds both US and Australian rates to be relevant in determining New Zealand 5 and 10 year rates. There are a number of reasons why the results may diverge, including the slightly different sample periods used and the use of nominal rather than real rates in Grimes (1994) and Rae (1996). While all of the above factors may have some role to play in explaining the divergent results, some evidence suggests that the method of estimation used here has played a relatively important role also.

As noted above, 1-step error correction modelling is used in favour of the 2-step Engle-Granger approach used in the earlier work. The 1-step approach is adopted as it has been found to produce more accurate estimates of long-run parameters as both the long and short-run parameters are estimated jointly resulting in some informational efficiencies. Indeed, it is found in many cases that using the 2-step approach results in different models which tend to involve a more pronounced long-run role for US real bond yields. But it is also found that these models were inferior to the 1-step models in two respects. Firstly, there is considerable evidence to suggest that most of the long-run coefficients in the 2-step models are very unstable over the sample. On the other hand there is no evidence of instability in the overall structure of the long-run components of the 1-step models. Secondly, in some cases the 1-step models actually encompassed the 2-step models using standard encompassing tests. In layman's terms, this means that the 2-step models make more errors, on average, than the 1-step models make. In fact, in the cases where the 1-step models encompassed the 2-step models, this suggests that the variables included in the 1-step models actually explain some of the errors that the 2-step models make. Together, these results suggest that the method of

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[6] However obviously nominal bond yield differentials have diminished significantly reflecting the large fall in inflation expectations since the late 1980s in response to the increased focus on price stability.

estimation is an important issue and that the approach adopted in this paper produces more reliable results (at least in-sample).

The speed of error-correction found in this study is slightly slower than that found in Rae (1996) and Grimes (1994). This does not appear to reflect the absence of debt variables in the long-run components of the estimated specifications as none proved to be significant.

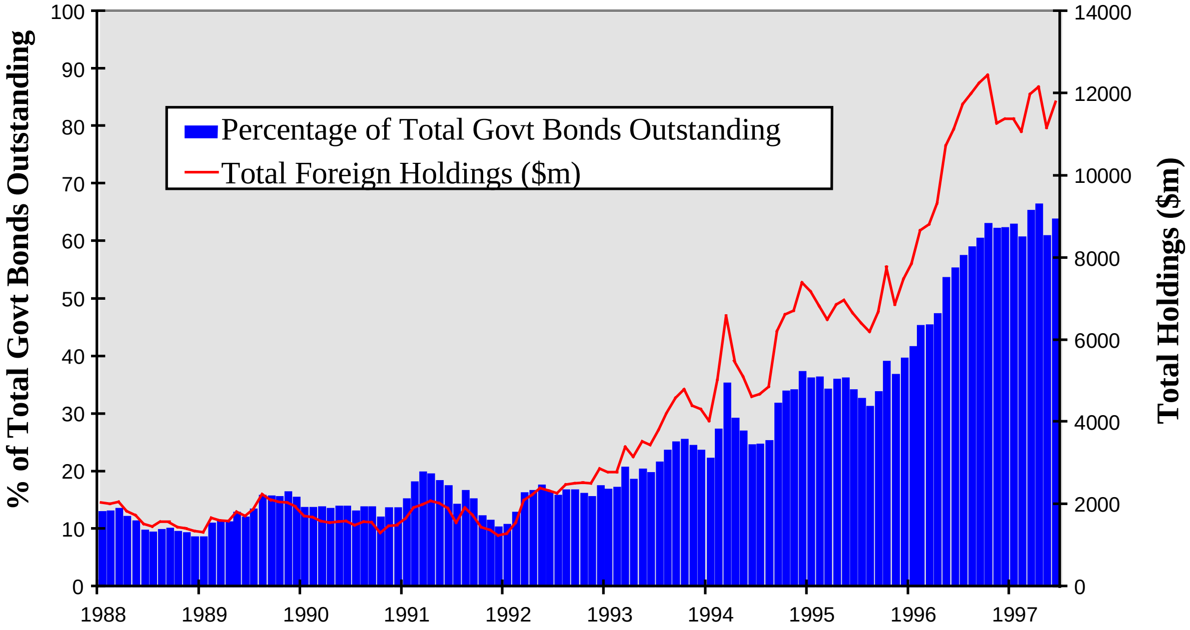
The qualitative impact of the effects of monetary policy is similar to that found in other work. Rae (1996) also finds that the impact of his monetary policy variable rises as the maturity of the bond concerned shortens.

4.3 The degree of integration between the domestic and world bond markets

The basic framework used here to model real bond yields relies on the proposition of open capital markets and some degree of integration between the New Zealand and offshore bond markets. The fact that this paper show success in modelling New Zealand bond yields in this framework suggests that some degree of market integration exists. The question that one then asks is "Has that degree of integration changed over time?" A priori it is expected that some increase in integration has occurred over the last 10 years due to the ongoing reform process at the time and the steady maturing of the New Zealand financial markets after their liberalisation in the mid-1980s.

Some evidence to suggest increased integration if our bond market with the world comes from the trends in the ownership of the stock of government bonds. Total foreign ownership of New Zealand government bonds has increased in recent years from $1644m or 15 percent of the stock in 1991 to around $11966m or 65 percent currently. The graph below shows the trend in this series over time. A steady upward trend emerges which is consistent with the idea of increased market integration over time.

Offshore investment in the domestic bond market



The analysis presented in this paper also allows some scope to examine the market integration issue. Potentially, changes in integration will be revealed in three ways:

- The overall predictive power of the framework should increase with integration, that is, foreign financial prices should play a more important role relative to other factors in explaining movements in bond yields.

- The long-run relationship between domestic and offshore financial prices should get stronger as integration increases. Empirically, this would be represented by a higher error correction co-efficient as integration increases.

- Short run movements in domestic and world bond yields should be more strongly correlated if integration has increased.

These issues are examined by estimating the final specifications detailed above over different time periods to assess the degree to which the overall predictive power and the coefficients changed over time. As the sample size shortens some of the parameter estimates become less precise, but overall it is found that the models retain similar long-run properties in the sub-samples as they had in the overall sample. Some key statistics associated with these regressions are reported in the table below:

Sub-Sample Regression Testing of Integration

	Overall sample 1988 - 1996	2nd Subperiod 1994 - 1996	lst Subperiod 1992 - 1996
Error Correction Coefficients			
3 year model	- 0.105	- 0.089	- 0.093
5 year model	- 0.046	- 0.161	- 0.062
10 year model	- 0.047	- 0.138	- 0.097
Change in US Bond Yield*			
3 year model			
5 year model	-	-	-
10 year model	-	-	-
	0.131	0.278	0.210
Change in Australian Bond Yield*			
3 year model	0.104	0.210	0.132
5 year model	0.086	0.214	0.161
10 year model	0.194	0.329	0.284
R^2 Statistic			
3 year model	0.65	0.66	0.71
5 year model	0.54	0.65	0.61
10 year model	0.52	0.69	0.63

* Note that only current period changes are examined here.

The results show that the speed of error correction increases as the sample period rolls forward (at least in the case of the five and 10 year models). Similarly, the short-run movements in foreign and domestic bonds are more highly correlated as the sample period rolls forward. In addition the overall predictive power of the models increase over time (this effect is less pronounced for the three year model). Thus overall, these results are broadly supportive of the proposition that the domestic and foreign bond markets have become more integrated over time. Note however that the structure of the long-run relationships do not seem to have changed markedly over time. This is evidenced by tests of the restrictions that the coefficient on the foreign bond yield is one and that the coefficients on the expected short rate terms are equal and opposite in sign which are all generally supported by the data (test statistics not reported).

5. The behaviour of bond yields over the last year

This section analyses the movement in New Zealand bond yields over the last year in the context of the predictions made by the models estimated above.

5.1 3 Year Bond Yields

The table below reports the results of estimating the three year model using the full sample available up to 1997w13, that is, with an additional 50 observations. In sample coefficients are also reported for comparison.

3 Year Bond Yields - Full Sample Estimation

	Full-Sample Coefficient	**In-Sample Coefficient**
$NZ3YR_{-1}$	- 0.089	- 0.105
$US3YR_{-1}$	0.085	0.074
$NZ90DFR_{-1}$	0.071	0.079
$US90DFR_{-1}$	- 0.075	- 0.060
$NZTWIEXP_{-1}$	- 0.004	- 0.013
ΔNZ90DFR	0.709	0.712
ΔAU3YR	0.109	0.104
$\Delta UK3YR_{-2}$	0.068	0.060
$\Delta NZ3YR_{-1}$	0.079	0.083
	0.008	0.075
Constant		
R^2	0.65	0.65
σ	0.093	0.094

Parameter Stability Tests*

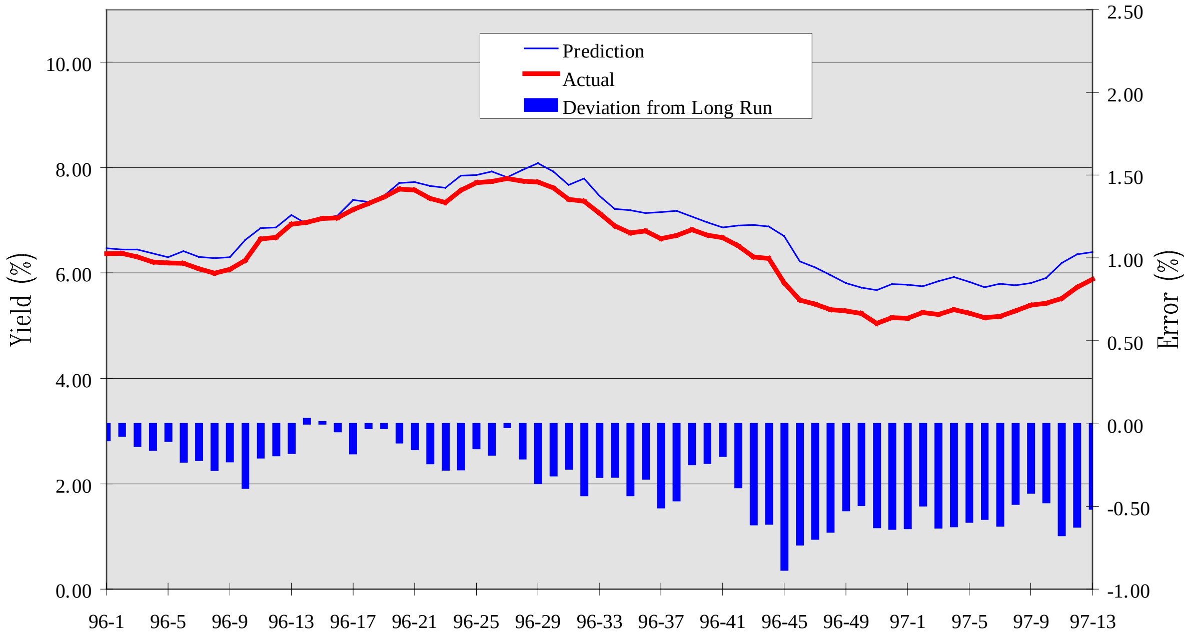
Residual Variance Stability	x^2 (50)	= 48.60	(0.53)
Chow Test of Parameter Stability	F (50,419)	= 0.83	(0.79)

* Note that P values are reported in parentheses.

The results show that the addition of the last year of data has made little change to the overall shape of the model. The main change is in the size of the coefficient on the expected TWI appreciation term which drops by 2/3 and becomes insignificant. Despite this, the two tests of model stability reported show the model to be stable at standard significance levels.

Notwithstanding the statistical evidence of the stability of the model presented above the model shows a tendency to over-predict rates from the second half of 1996. The graph of actual versus long-run predicted shows why this occurs. Since the second half of 1996 real 3 year yields have been below their long-run level. The size of this deviation is large relative to that seen in the past.

Actual vs Long Run Predicted Real 3 Year Yields



1996 was an exceptional year for the domestic bond market in that it signalled a resurgence in the issuance of Euro-kiwi bonds in amounts not seen since the 1980s. The graph below shows the monthly issuance levels of Eurobonds over 1996. A total of $5,537 m of bonds were issued – primarily with maturities of one to three years.[7] This activity represented a huge boost to foreign investment in the short-end of the New Zealand bond curve which at times created some problems. In particular, demand for New Zealand government 3 year bonds (required by issuers to convert fixed into floating rate funding) was so high that those yields were pushed down relative to those on other bonds on the yield curve. Much of this activity occurred from the middle of 1996 onward and explains why real 3 year yields appear to be low over the second half of 1996 as compared to predicted levels.

The graph below shows the relationship between Eurobond issuance and the difference between the actual 3 year (ie, the July 1998 maturity) and the interpolated 3 year rate. This shows the extent to which the 3 year rates was pushed down relative to the surrounding maturities. This pressure also pushed 3 year yields down relative to foreign yields, resulting in the model prediction errors noted above.

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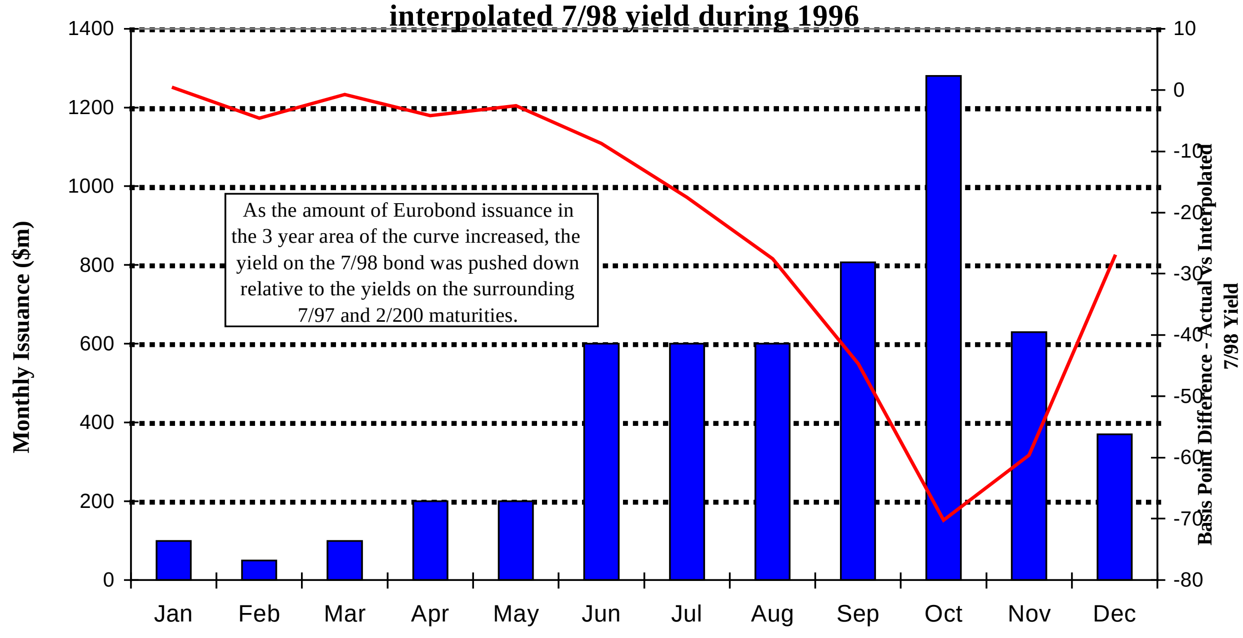
7 In addition, approximately $3,087m of Samurai bonds were issued in 1996.

Eurobond Issuance versus the gap between the actual and interpolated 7/98 yield during 1996



5.3 5 year bond yields

The table below reports the results of estimating the 5 year model using the full sample available.

5 Year Bond Yields - Full Sample Estimation

	Full-Sample Coefficient	**In-Sample Coefficient**
$NZ5YR_{-1}$	- 0.044	- 0.041
$AU5YR_{-1}$	0.033	0.031
$NZ90DFR_{-1}$	0.018	0.016
$AU90DFR_{-1}$	- 0.011	- 0.011
$\Delta NZ90DFR$	0.527	0.528
$\Delta NZ5YR_{-1}$	0.140	0.143
$\Delta AU5YR$	0.091	0.086
$\Delta AU5YR_{-1}$	0.071	0.075
$\Delta LNZTWI$	- 1.543	- 1.45
Constant	0.019	0.017
R^2	0.56	0.55
σ	0.096	0.096

Parameter Stability Tests*

Residual Variance Stability Test x^2 (50) = 42.35 (0.77)

Chow Test of Parameter Stability F(50,419) = 0.84 (0.77)

* Note that p-values are reported in parentheses.

The results in the table confirm that the structure of the model has not been greatly affected by the addition of the extra year of data. Parameter stability tests indicate no evidence of stability at conventional significance levels. There seems little evidence of biased predictions. The model suggests that real 5 year rates were initially above long-run levels in the first half of last year and then below long-run levels from the second half of 1996. The deviations are relatively small relative to historical occurrences. The predictions of the model suggests that the impact of the Euro activity in 1996 was less pronounced on the 5 year bond than the 3 year maturity. This is expected given that the bulk of the issuance occurred in the shorter maturities in 1996.

5.4 10 year bond yields

The table below presents the result of re-estimating the 10 year specification using the full data set available.

10 Year Bond Yields - Full Sample Estimation

	Full-Sample Coefficient	**In-Sample Coefficient**
$NZ10YR_{-1}$	- 0.044	- 0.047
$AU10YR_{-1}$	0.032	0.037
$NZ90DFR_{-1}$	0.014	0.014
$AU90DFR_{-1}$	- 0.007	- 0.010
◑$NZINFU_{-1}$	0.013	0.022
◑NZ90DFR	0.370	0.380
◑LNZTWI	- 1.814	- 1.526
◑$NZ10YR_{-1}$	0.194	0.204
◑US10YR	0.171	0.131
◑AU10YR	0.197	0.194
Constant	- 0.044	- 0.087
R^2	0.53	0.52
☞	0.089	0.089

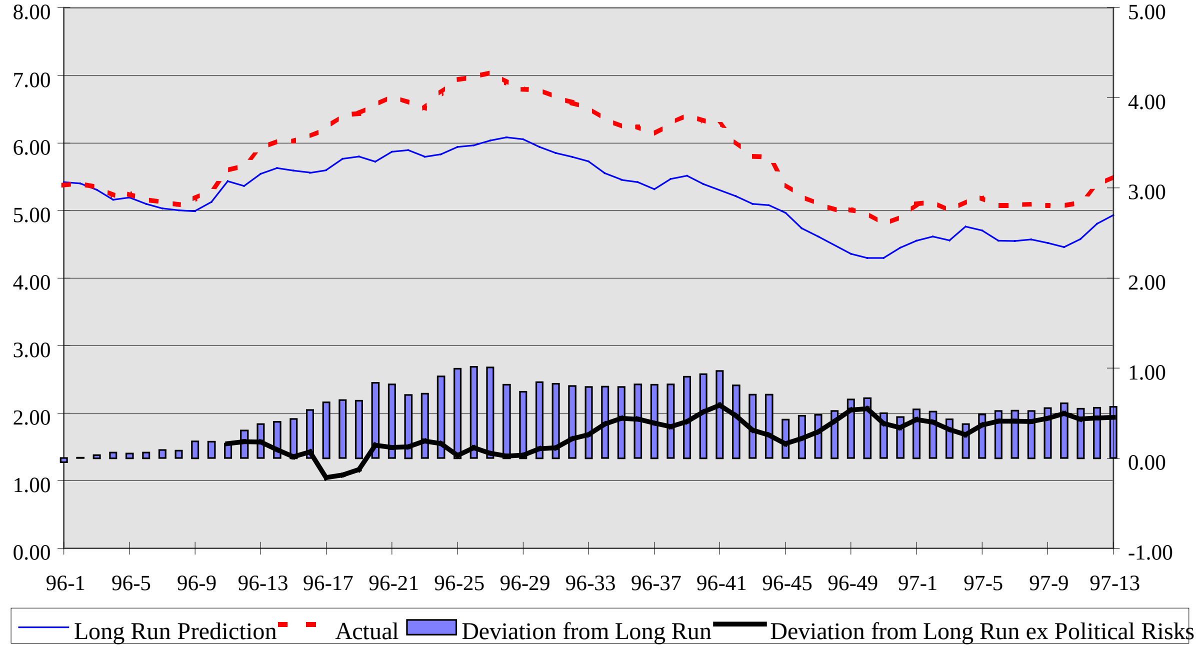
<u>Parameter Stability Tests*</u>

Residual Variance Stability Tests	x^2 (49)	=	54.11	(0.29)
Chow Test of Parameter Stability	F(49,419)	=	1.00	(0.48)

* Note that p values are reported in parentheses

The table above shows that the 10 year model performed reasonably well over the forecast period. Tests for parameter and residual variance stability reject the hypothesis of forecast instability. There is some evidence that the model under-predicts changes in bond rates over the forecast period. An examination of the chart below reveals why. From early 1996, a wedge has opened up between long run predicted and actual real 10 year bond yields.

10 Year Model - Actual vs Long-run Predicted during 1996-97



1996 was a turbulent year for the long end of the New Zealand yield curve. A key factor behind this turbulence was the shifting perceptions of investors as regards the impact of the country's first MMP election in October on the political landscape and government policy. The 10 year model unfortunately includes no proxies to account for shifting assessments of political risks as such proxies are difficult to find. However, it is possible to construct one using data from New Zealand's fledgling indexed bond market. A new tranche of inflation indexed bonds were issued in November 1995. These were the first indexed bonds issued in New Zealand since 1985 and represented an attempt by the government to foster a liquid indexed bond market. Whilst amounts issued and trading volumes were thin early in 1996, both increased steadily over the year. To some extent one can use the spread between indexed and nominal bonds as a guide to shifts in inflation expectations and uncertainty. The spread between nominal and indexed bond yields is determined primarily by two factors, inflation expectations and the inflation uncertainty premium.

$$R_{NZ} - r_{NZ} = \pi + IU_{NZ} \qquad (19)$$

where R_{NZ} = nominal bond yield
r_{NZ} = indexed bond yield
π = inflation expectations
IU_{NZ} = inflation uncertainty premium

The inflation uncertainty premium is the premium included in nominal bond yields that compensates the investor in nominal bonds for the risk of a change in the volatility of inflation outcomes. This is distinct from that compensation for the expected level of inflation outcomes which is given by the π term. Factors that affect the level of IU_{NZ} include political risks. For example, the risk that an election outcome might generate a set of macroeconomic policies that change the inflation process would increase the inflation uncertainty premium relative to the case where no election exists at all.

This type of scenario emerged over the first half of 1996 in New Zealand. Over this period, investors became increasingly agitated over the prospects for quite different macro policy scenarios after the election. At the same time, inflation expectations surveys showed little change in actual inflation expectations. Thus investors seemed to increase their assessment of the potential variability of inflation outcomes after the election, but left their assessment of the average level of inflation unchanged. This equated to an increase in the inflation uncertainty premium which was reflected in the spread between nominal and indexed bond yields over the first half of 1996. That spread widened from around 220 points in February to around 295 points in late May/early June. After June, these fears eased somewhat, mainly reflecting the optimism of offshore investors who bought New Zealand bonds in large quantities over the second half of the year. By the October election, all of the widening of the nominal-indexed spread had reversed. The graph above shows the deviation from long run predicted levels once the impact of the movements in the nominal-indexed bond yield spread have been stripped out. This line shows that much of the deviation up to the middle of 1996 is explained by this effect. The result leaves domestic real yields above their long-run predicted levels for the second half of 1996 and into 1997. But the size of that deviation is not large by historical standards.

6. Conclusions and summary

This study has examined the determinants of New Zealand bond rates since 1988. The behaviour of these rates has been successfully modelled in an augmented Uncovered Interest Parity (UIP) framework. This allows for both short and long-run influences on bond yields and also allows domestic macroeconomic factors to play a role in determining the medium term trends in bond rates relative to offshore factors. The main results show that bond rates in the US and Australia have important influences on domestic yields. US rates are more important for short bond yields while Australian rates are more useful in determining the trends in long rates. The expected relative stance of monetary policy plays a crucial role in determining the spread between New Zealand and offshore yields with this effect getting stronger as the maturity of the bond shortens. Currency expectations are relevant in the determination of short bond yields but are less important for long bond rates. Long bond yields are affected by New Zealand's historical inflation performance in that a premium exists to account for the fact that New Zealand has a history of high inflation, even though it is lower now. The evidence suggests that this premium will decrease over time if the current relatively low levels of inflation are maintained.

An examination of the trends in domestic bond yields over 1996 shows that there were significant effects on short and medium term bond yields related to the high levels of Eurobond activity in the second half of the year. Also there is evidence to suggest that the political risk premium on domestic long bond yields rose significantly through the first half of 1996 before dissipating over the second half of the year.

Finally there is some evidence of increasing integration between the domestic and foreign bond markets in recent years. This is consistent with the ongoing maturation of the domestic markets after liberalisation in the mid 1980s and the steady up-trend in foreign ownership of domestic bonds in recent years.

Further research needs to further tease out the interactions between the major bond markets and the Australasian markets. Although the results here show a strong correlation between the trends in Australian and New Zealand bond rates, they tell us little about what drives the Australasian markets overall. As noted earlier, an examination of the trends in real bond yields within a systems framework may help shed some light on the ultimate impact of developments in the major offshore markets on New Zealand rates.

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