ARTICLES

Making sense of international interest rate movements

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In this article, we describe a framework for analysing movements in government bond interest rates and present some results from applying this approach. Our framework disaggregates movements in nominal rates into estimated changes in real interest rates and inflation expectations. In addition, we discuss a measure of interest rate uncertainty, a factor which will often influence movements in these components. Since any long-term bond can be thought of as equivalent to a sequence of shorter-term bonds, we also calculate implied forward measures of each of these factors to better understand not only which factors are driving movements in nominal interest rates but also over which periods of time (i.e., current, future or some combination of the two) these factors are having an effect. We use the method to analyse movements in term interest rates in the US and the UK, two major markets with good data, since the global financial crisis intensified in 2008. It appears that the global financial crisis has had a largely temporary impact on longer-term measures of interest rate components: looking ahead, markets appear not to expect longer-term interest rates to be much different than they were prior to 2008. There are limits to our ability to apply these techniques directly to New Zealand markets, but the Reserve Bank of New Zealand uses them to help make sense of what is going on in international bond markets which in turn directly affect longer-term interest rates in New Zealand.

1 Introduction

Interest rates in New Zealand are affected by many things. Short-term market interest rates are influenced primarily by actual and expected near-term Reserve Bank policy rates, but also by factors such as banks’ funding needs. The level of longer-term rates tends to be more influenced by factors such as inflation expectations and expected future economic growth.1 Movements in global interest rates, especially in the major world economies, often have a significant impact on New Zealand longer-term interest rates. They can also provide insights into the nature of the shocks hitting those economies. In this article, we examine the relationship between New Zealand interest rates and overseas interest rates and examine how separating nominal interest rates into their components can provide insights into the shocks or disturbances affecting an economy.

We focus in particular on the period since the collapse of Lehman Brothers in September 2008 and the onset of the most intense phase of the global financial crisis. Over that period, there have been large changes in international interest rates as the global economy went through a deep recession and, in response, policy-makers implemented large amounts of monetary and fiscal stimulus. Throughout the crisis and in the more recent period of relative stabilisation, there has been significant debate about the nature of what is going on in interest rate markets. In this article, we illustrate some of the techniques used at the Reserve Bank to explore these issues, as part of our analysis of the international economy and the influences on the New Zealand economy and New Zealand interest rates.

The article proceeds as follows. Section 2 establishes the relationship between New Zealand and offshore interest rates. Section 3 details the methodology and describes the data. Section 4 looks at some recent results. Section 5 concludes.

2 The relationship between overseas and New Zealand interest rates

As a small open economy, New Zealand is sensitive to disturbances hitting major world economies, and those of our main trading partners. These shocks can affect New Zealand’s economy both through trade channels and through financial market channels. Changes in longer-
term international interest rates are one important financial markets channel, and those changes often affect New Zealand almost instantaneously. That makes it important to understand what is affecting international rates. Interest rates on government bonds can vary widely between countries. However, shorter-term changes in New Zealand government bond rates are often closely linked to bond rate changes in other countries.²

Figure 1 plots the correlation of daily changes in New Zealand ten-year government bond yields with changes in government bond yields in some other countries. Several features are apparent. First, the closest correlation is between New Zealand and Australian bond rates. This is not surprising, since the economic cycles in the two countries have historically often been highly synchronised and markets have historically treated them that way. Second, the correlation between New Zealand yields and foreign yields is much higher than it used to be.³ The increasing integration of financial markets across the world has made it easier for investors to identify and exploit profitable opportunities and thereby equalise expected returns across countries. Third, despite the general upward trend, the closeness of the relationship between New Zealand and foreign yields has varied over time. For example, since 2006, the correlation between New Zealand and foreign interest rates has reduced significantly.

That fall probably reflects the changing nature of the shocks hitting the global economy. Some shocks affect all countries simultaneously. For example, the decline in long-term interest rates during the early-mid-2000s as part of the ‘search for yield’ as investors’ appetite for risky assets increased was seen in many countries, generating very similar moves in interest rates across countries. Conversely, other shocks may affect only individual countries or affect a range of countries in different ways. For example, the recent global financial crisis affected different countries to varying degrees: neither New Zealand nor Australia experienced a banking crisis in the way that the US and the UK did; and the New Zealand economy experienced a more severe recession than the Australian downturn.

Therefore, when we monitor developments in the economies and markets that matter most to us, identifying the factors and shocks influencing foreign bond rates helps us to better understand what is driving those economies and to better understand the implications for New Zealand.

3 Methodology and data

When we analyse movements in international interest rates, we typically follow two broad steps. In the first stage, we aim to identify separately the impact of real factors and inflationary factors on interest rates. In the second stage, we examine the importance of these factors at different time horizons. We describe these two steps in more detail below.

Real rates, inflation and uncertainty

Conceptually, the nominal interest rate on a financial asset can be divided into three components: a real interest rate (r), expected inflation over the term of the asset (π) and a risk premium (ε). As a result, we can express nominal interest rates (i) as:⁴

\[
\hat{i} = r + \pi + \epsilon
\]

While this provides a useful conceptual representation of a nominal interest rate, in practice it is not possible to clearly

² For further details of the relationship between New Zealand and overseas interest rates, see Schmidt-Hebbel (2006).
³ This result is not unique to New Zealand yields. The correlation between yields on US government bonds and bond yields in other countries also demonstrates a gradual upward drift.
⁴ This relationship is known as the ‘Fisher Hypothesis’.

Reserve Bank of New Zealand: Bulletin, Vol. 74, No. 1, March 2011
separate each component. For example, measures of both the real interest rate and inflation expectation components will include various types of risk premia, ($\epsilon_r$ and $\epsilon_\pi$) which can be affected by, among other things, the degree of uncertainty around future economic outcomes. Accordingly, it is useful to think of our analysis as separating a nominal interest rate into the following components:

$$i = (r + \epsilon_r) + (\pi + \epsilon_\pi)$$

When trying to interpret financial market developments, and especially in trying to give developments economic meaning, we usually only have proxies for what we really want to know. There is no such thing as “the” real interest rate, even in the inflation-indexed debt market. Rather, there is an observed yield on specific instruments, which can be affected by all sorts of changeable credit and liquidity effects, especially in troubled periods when it is most important to try to make sense of the data. For example, government bond yields were typically treated as a proxy for (credit) risk-free interest rates – but in the latest recession and crisis, pervasive sovereign credit concerns have suddenly become a lot more prominent. The same caveats apply to almost all the data we are interested in. The limitations do not mean that the analysis is not useful, only that it is one part of a comprehensive study of the data and requires considerable judgement. A good analyst has to assess what emerges from these data in the light of every other bit of information, formal or informal, to hand. That is, in part, why central banks employ teams of analysts to make sense of what is going on in markets.

In a closed economy (that is, one that doesn’t trade with the rest of the world), the (term structure of) real interest rates would adjust to equate the country’s level of saving to its level of investment. In a stylised world of perfectly open economies, in which all goods and factors of production flow effortlessly between countries, real interest rates would be determined by the global balance of supply and demand for real funds. Global real interest rates would be affected by all sorts of changeable credit and liquidity effects, especially in troubled periods when it is most important to try to make sense of the data. For example, government bond yields were typically treated as a proxy for (credit) risk-free interest rates – but in the latest recession and crisis, pervasive sovereign credit concerns have suddenly become a lot more prominent. The same caveats apply to almost all the data we are interested in. The limitations do not mean that the analysis is not useful, only that it is one part of a comprehensive study of the data and requires considerable judgement. A good analyst has to assess what emerges from these data in the light of every other bit of information, formal or informal, to hand. That is, in part, why central banks employ teams of analysts to make sense of what is going on in markets.

We can obtain an indicative measure of real interest rates from inflation-indexed government bonds, which are issued in many countries. These bonds pay a fixed interest rate plus a component tied to realised inflation, so that the fixed component is a proxy for a real interest rate. In the US, inflation-indexed bonds issued by the Federal government are called TIPS (Treasury Inflation Protected Securities). Both the US and UK governments issue indexed bonds at a wide range of maturities. In other countries, the inflation-indexed government bond market is less well developed. For example, bonds indexed to the Euro area harmonised index of consumer prices, excluding tobacco (HICP\(x\)), have only been issued by the French, Greek, Italian and German governments. In New Zealand, there is currently only one inflation-indexed government bond on issue, which matures in 2016. However, the New Zealand Debt Management Office has announced plans to issue additional indexed bonds in the future, when market conditions are appropriate.

We can estimate the expected inflation component of nominal interest rates by calculating the ‘break-even inflation rates’, which are the difference between the nominal yield on a conventional government bond and the real yield on an inflation-indexed bond of the same maturity. Break-even inflation rates are not ‘clean’ measures
of inflation expectations, as they also implicitly include an inflation risk premium, i.e., the value market participants place on removing uncertainty about the future inflation rate, as distinct from simply their mean expectation of future inflation. They can also be affected by differences in liquidity conditions in the markets for conventional and inflation-indexed bonds. As a result, it is useful to compare breakeven inflation rates with survey-based measures of inflation expectations. Surveys have their own weaknesses however. They may provide a more accurate measure of expected inflation among those surveyed, but are generally only available on a monthly or even quarterly basis. In addition, surveys do not require anyone to back their view by putting money on the line in the way that estimates derived from financial market prices do.

Finally, a proxy for uncertainty around future nominal interest rates can be obtained from the implied volatility on ‘swaptions’. Implied volatility is a forward-looking measure of the degree of volatility expected in the price of the underlying instrument that people buying/selling are allowing for and the value they place on eliminating that uncertainty. Implied volatilities are derived from the prices of options on the underlying instrument. Swaptions are options on interest rate swaps, i.e. contracts that give the buyer the right, but not the obligation, to enter into an interest rate swap at a specified date in the future for a specified term. We use swaptions because they are generally more highly traded and standardised than other interest rate options and therefore provide a better measure of implied volatility through time. During normal times, the volatility in swap rates will move almost one for one with volatility in the underlying risk-free or government bond rate. Consequently, there is usually a high degree of correlation between implied volatilities derived from non-government and government interest rate options. However, in times of market stress there may be some divergence. In those periods, analysts need to cross-check the insights on uncertainty from the swaptions market with whatever other information they can obtain, including that on the less-liquid government bond options markets.

### Calculating forward rates

In addition to the decomposition of nominal interest rates described above, we can also decompose term interest rates into a series of shorter spot and implied forward interest rates. Given, say, information on today’s two-year bond rate and today’s one-year bond rate it is a simple matter to derive an implied forward one-year rate one-year hence. The implied forward rate is, in essence, simply the rate that means a holder or borrower would be indifferent between issuing/holding a two-year bond now, or issuing/holding a one-year bond now and then rolling it over into another one-year bond in a year’s time. The relationship can be expressed more formally as:

\[(1 + i_t) = (1 + i_s)(1 + f_s)\]

Where \(f_s\) is the ‘forward’ short rate that equalises the return from investing in the long bond with the expected return from investing in the short-term bond and then rolling the investment over when it matures. If this relationship did not hold, then there would be opportunities for traders and investors to profit from the difference between the long-term interest rate and the short-term interest rate. A term structure of spot interest rates and their component forward interest rates contain the same information, but expressing rates in forward terms provides a clearer view of the impact of different factors at different horizons.

We can calculate forward interest rates in more general cases using a simple formula:

\[f_{l-s} = \frac{i_l - i_s}{l - s}\]

Where \(f_{l-s}\) is the forward rate over the period \(l-s\) and \(i_l\) is the interest rate for a particular maturity \(l\), and \(i_s\) is the interest rate for maturity \(s\).

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9 More complicated methods would allow us to split the uncertainty in real rates and inflation into separate components. See, for example, Haubrich (2009).


11 See Hull (2009) for more details. The calculation as expressed assumes continuously compounding zero-coupon interest rates, whereas we use coupon-bearing data on a semi-annual basis. The differences, in levels and changes, are not material in the context of our analysis.
rate for a shorter maturity. This formula can be used to calculate implied forward rates for nominal and real interest rates, and break-even inflation rates. The formula for calculating forward implied volatility on swaptions is similar, but uses volatilities on long and short options as inputs.

Forward real interest rates are driven by different factors depending on their term to maturity. Changes in shorter-term real interest rates will often be heavily influenced by expected changes in monetary policy. Longer-term forward real interest rates will more often reflect factors such as productivity shocks, and households’ and firms’ desire to spend or save. In practice, there is no hard and fast boundary, and we typically observe changes in expected short-term interest rates also having a material, but muted, influence on longer term spot and implied forward rates.

The implied volatilities on swaptions also tend to be driven by different factors depending on the expiry date of the option. Implied volatility in short-term swaptions will often reflect uncertainty around the expected stance of monetary policy and the cyclical path of economic growth. Implied volatility in longer term swaptions will more often reflect uncertainty around future inflation outcomes and the determinants of long term interest rates, e.g. the expected real return on capital. In addition, changes in actual experienced volatility in the underlying asset also tend to spill over into higher future implied volatility for a period.

All these market price measures can also be affected by technical market factors, such as the degree of liquidity in particular sections of the market. For example, increased demand from UK pension funds for long-dated inflation linked bonds has forced the price of these bonds higher from around 2005 – driving down the yield. UK pension funds have increasingly sought to match their liability cash flows (i.e. ‘defined benefit’ pension payments) with their asset cash flows (through long-dated inflation-linked government bonds) and the fall in yields was exacerbated by relatively limited supply of long-dated inflation linked bonds. In the case of swaption implied volatilities, US swaption markets can be temporarily affected by fluctuations in the activity financial institutions need to undertake to hedge their exposure to mortgage pre-payment risk. In periods of crisis, factors driving each of the components can be particularly challenging to disentangle as the willingness or capacity of market participants to take on additional risk dries up.

4 Analysing movements in US and UK interest rates

In this section, we use the framework to analyse movements in government bond yields in the US and the UK over the last few years. We chose these countries partly because of their importance as major economies and financial markets and partly because they have the widest range of inflation-indexed bonds. The US remains by far the most important international market. Comparing and contrasting the results across the US and UK provides insights into how the events of the last few years have affected different countries in different ways.

Figures 2 and 3 below and overleaf show nominal government bond yields of varying maturities for the US and UK. During 2008, nominal yields fell sharply at all maturities in both countries, although the falls occurred much earlier in the US, which faced financial crisis pressures and recession risks earlier in the year. More recently, yields have rebounded across all maturities in both countries. We can use our framework to help analyse the factors driving these movements in interest rates.

Figure 2
Nominal US government bond yields
First, we examine movements in real yields of the same maturity over the same period. Figures 4 and 5 show the large changes in implied real yields during the financial crisis. Real yields in the US fell sharply during the early stages of the financial crisis from late 2007 with five-year real yields even turning briefly negative in early 2008 as nominal interest rates fell below the rate of expected inflation. At this stage of the crisis, there was a very strong differentiation between government securities – still generally seen as credit risk-free in major economies – and any sort of financial sector-related debt. The combination of the ‘flight to quality’ and the unexpectedly deep recession helped drive real interest rates down. Real yields in both the US and UK then surged higher through late 2008, following the announcement of significant additional fiscal and monetary policy stimulus measures, which probably both allayed some extreme aversion to risk and, at least temporarily, restored confidence in the economic outlook. From there, real yields fell steadily in both countries during 2009-early 2010, but longer-term US real yields have increased sharply in recent months. In contrast, UK real yields have remained low. This is consistent with the recent divergence in economic outlooks for the UK and the US economies, with UK economic data continuing to indicate fairly soft growth, while in the US there have been continuing signs of improvement in economic conditions, especially after the second round of quantitative easing was announced by the Federal Reserve. It may also be consistent with the more aggressive approach to fiscal consolidation that has been pursued in the UK.

Taking this one step further, we can determine the periods for which real yields have moved the most by calculating implied forward real interest rates. Figures 6 and 7 below show that forward real interest rates at 0-5 years ahead remain well below pre-crisis levels, consistent with the current level of nominal policy rates, but rates at longer horizons are little changed. In other words, longer-term interest rates are lower than they were prior to the recession largely because of falls in short-term interest rates. This may suggest that interest rate markets have not priced in a significant impact from the financial crisis on long-run potential growth rates in the US and the UK.\(^{13}\)

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\(^{12}\) Note that over some periods data is missing, as there was not a government bond available with an appropriate maturity.

\(^{13}\) However, some other analysis suggests the level of potential output may have been lowered by the crisis.
Alternatively, it is possible that the longer-term implied forward rates might reflect some combination of a lower risk-free rate and a higher premium for sovereign credit risk. As the fiscal situation has deteriorated in many countries, sovereign credit risk in advanced countries has come into focus. Spreads on credit default swaps represent a proxy, although not hugely liquid, for the sovereign credit risk premium, as they capture the cost of insuring against the risk of a debt issuer, in this case a sovereign, defaulting on their repayment obligations. Although sovereign credit default swaps for the US and UK have remained fairly static over the last year, even for those countries the spreads are materially higher than they were three years ago (see figure 8 below).

Inflation expectations
As noted above, to give us some insight on the extent to which increases in inflation expectations have driven the recent movements in US and UK nominal bond yields, we examine the break-even rate of inflation. Figures 9 and 10 below plot break-even inflation rates for the US and UK across a variety of maturities. At the peak of the crisis, break-even inflation rates in both the US and UK fell away very sharply, and short-term break-even rates even became negative. While this may partly have reflected concern about an increased risk of deflation occurring, it is also likely to have been due partly to heightened uncertainty more generally and poor liquidity conditions in the inflation-indexed bond market. More recently, shorter-term break-even inflation rates have increased significantly. While US break-even rates have returned to pre-crisis levels except at short-term horizons, UK break-even rates appear to have mostly settled at the persistently higher levels they had reached by mid-2008. This is consistent with growing concern about rising inflationary pressures in the UK.

Looking at which future periods investors expect this inflation to occur in, figures 11 and 12 plot forward break-
even inflation rates for the US and UK. Consistent with unease about possible risks of deflation at the height of the crisis, short-term US and UK break-even inflation rates became negative in late 2008. More recently, near-term inflation expectations have returned to pre-crisis levels in the UK, while US near-term inflation expectations have remained relatively subdued. This is consistent with the pricing in short-term interest rate markets, where an increase in the Bank of England policy rate is expected shortly, while a rate rise from the US Federal Reserve is not expected until some time in 2012.

**Uncertainty**

Finally, it is useful to establish the extent to which changes in investor uncertainty may have played a part in the recent fluctuations in US and UK yields. Figures 13 and 14 below plot the implied volatilities from UK and US options of varying maturities on a one-year interest rate swap. While implied volatility in both markets has ticked up recently, it is still well below the levels seen during the global financial crisis and, more recently, the Euro zone debt turmoil over 2010.

**Figure 13**

Implied volatility from US options on a 1-year swap

Looking at which future periods investors are most uncertain about, figures 15 and 16 below show that it is near-term volatility that is the highest for both the UK and the US. This probably reflects the extent to which official interest rates in those countries are perceived to be exceptionally low. In

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For example, a two-year option on a one-year swap gives the option holder the right but not the obligation to receive a one-year swap at a rate defined at the outset of the contract. Expectations of volatility, or implied volatility, are a crucial determinant of the price of the option, so markets tend to quote implied volatility directly rather than outright prices.
times such as these, financial market participants face not only the standard uncertainties but also uncertainty around how quickly interest rates will return to more ‘normal’ levels. Near-term volatility in the UK has increased markedly in recent months, perhaps reflecting the recent uncertainty around how monetary policy will respond to higher inflation out-turns in the face of a decidedly weak domestic economy. Longer-term implied volatility is also higher than pre-crisis levels in both the US and UK. That may suggest uncertainty around future inflation outcomes and the extent to which long-term inflation expectations are anchored, but it may also reflect greater uncertainty more generally following the financial crisis.

**Figure 15**
*Forward implied volatility from US options on a 1-year swap*

**Figure 16**
*Forward implied volatility from UK options on a 1-year swap*

### Conclusion
As a small open economy, New Zealand is sensitive to disturbances hitting major world economies, and especially those of our main trading partners. These shocks can affect New Zealand’s economy both through trade channels and through financial market channels. There is typically a high degree of correlation between New Zealand and global interest rates – although this relationship has weakened somewhat in the wake of the financial crisis and the global recession.

This article has outlined a framework to disaggregate movements in global bond yields and help make sense, on a timely basis, of the shocks hitting major countries’ economies, as reflected in financial market prices. Of particular interest from this standpoint is that it appears that, after all the turmoil and uncertainty of the last few years, and the big overhang of future fiscal adjustment many countries still face, markets are not expecting the future to look so very different from the past.

Currently, there is only one inflation-indexed bond on issue in New Zealand and trading in New Zealand inflation swaps is very limited, so it is not possible to apply this framework formally to the domestic markets. However, we have alternative sources of this information in well-established survey measures of inflation expectations and actual and forward measures of New Zealand nominal government bond rates (see figures 17 and 18 below). Figure 18 also includes forward nominal rates for the US and UK. In so far as we can tell, the New Zealand picture is not so different from that in other countries. On survey measures, medium-term inflation expectations have not changed much, and despite a protracted period of a very low OCR implied forward government bond rates in New Zealand look quite similar, if a little higher than, they were five years ago. The New Zealand Debt Management Office has announced plans to issue additional indexed bonds in the future, when market conditions are appropriate. Therefore, at some point, we may be able to extend the more formal analysis of the New Zealand markets using this sort of framework.
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