

The Yield Curve As An Indicator Of Monetary Conditions

This article, prepared by Andrew Fung and Bryan Chapple, discusses the links from the yield curve to inflation and output.

Executive Summary

The yield curve, a monetary conditions indicator, can be linked to output and inflation.

The yield curve is one of the Reserve Bank's indicators of monetary conditions. There are several reasons why the yield curve might be linked to output and inflation. If the real rate of interest is constant, and inflation expectations are formed rationally, then the expectations theory of interest rates implies that the yield curve slope can help forecast inflation. Theories linking the yield curve to output are less clear, although there are a number of reasons why the structure of interest rates may indicate trends in growth.

Overseas studies confirm a link.

Overseas empirical studies have found that the yield curve does contain information useful for predicting inflation. But, these results are not constant across different countries. The yield gap also has predictive power for output, and has been found to be a useful addition to a leading index of output in some studies. Again, the results differ between countries.

There may be a link in New Zealand.

Simple graphical analysis using New Zealand data shows that there is some link between the yield gap and inflation, with the relationship to output less clear. With only limited post-deregulation interest rate data available, it is difficult to carry out detailed empirical research in New Zealand. Despite the data problems, both theory and overseas evidence suggest that some empirical research on the yield gap be useful. The results could help quantify the link between the yield gap and inflation and output.

One of the variables in the Reserve Bank's checklist of monetary indicators is the structure of interest rates (or the yield curve). The structure of interest rates may provide information about monetary conditions over and above that of the general level of interest rates. In particular, some studies have found that the yield curve may help forecast future interest rates, inflation and output. The success of these efforts has been varied - and the results appear to differ between countries. Still, the results have been sufficiently positive to encourage continuing work. The Reserve Bank monitors these studies as part of its ongoing research into monetary indicators. Given the relatively recent deregulation of New Zealand's financial system, there has been little scope so far to undertake empirical studies into these relationships.

This article surveys the type of information which the yield curve may contain, as a precursor to further, empirical, research. The first section defines the yield curve, and discusses why the curve's shape may change. Second, theories showing why the difference between short-term and long-term interest rates might be of use are explained - showing possible links from the yield curve to output and inflation. The emphasis is on providing intuitive explanations. The findings of some overseas studies as to the usefulness of the yield curve as an indicator of inflation and growth are covered in the third section. The paper concludes with a brief graphical analysis of the links between the yield curve and New Zealand's inflation and growth rates, and points to areas where empirical research may be carried out in the future.

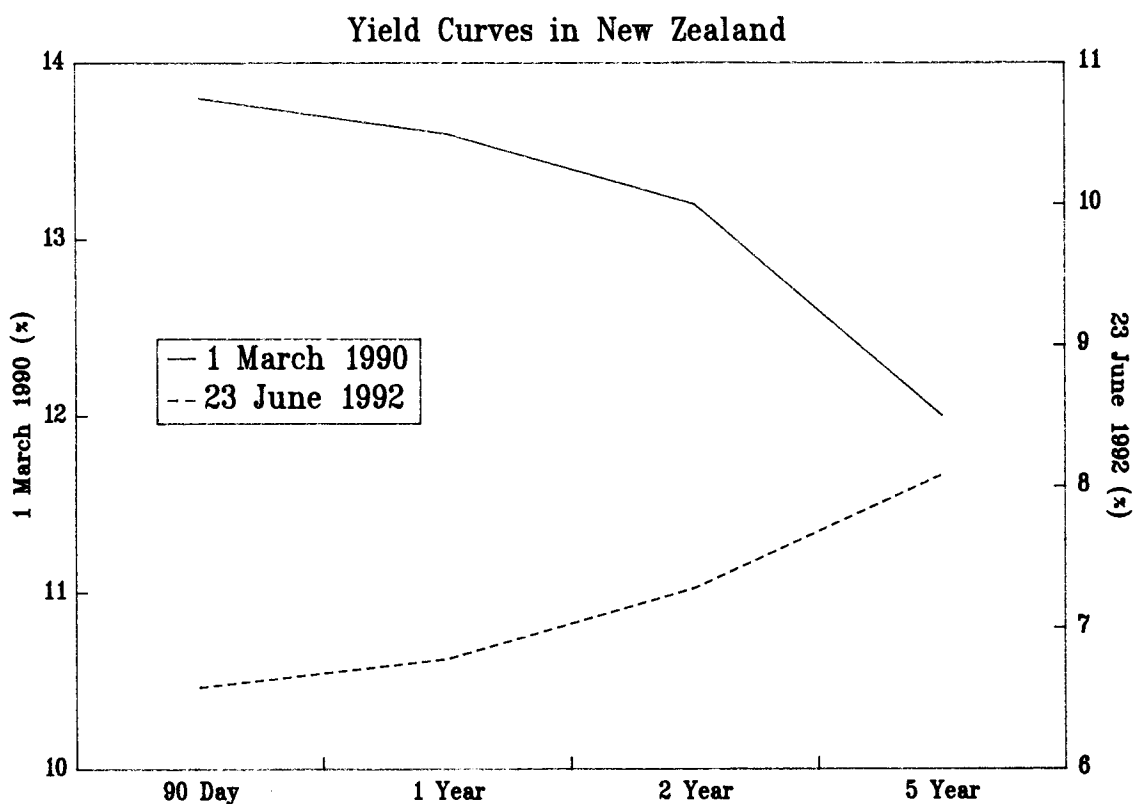
What is the Yield Curve?

The yield curve describes the relationship between interest rates on securities (such as government bonds) with different maturities. And the difference between two such interest rates at a point in time is often referred to as the yield gap. In New Zealand, the yield gap is generally taken as referring to the difference between the yields on 90-day bills and 5-year government stock, although a yield gap exists between instruments of any maturity. The term structure of interest rates, or the term spread, are other terms often used to describe the relationship. As interest rates change frequently, the yield curve or gap refers to the structure of interest rates at a particular point in time. Ideally, only assets with the same risk of default are compared, ensuring that changing risk assessments do not distort the relationships observed. Interest rates on assets issued by the government are normally used when deriving a yield curve in New Zealand.

The interest rates on instruments with different maturities can be graphed for any particular date. Depending on the structure of interest rates at that time, the shape of the curve will differ. If shorter-term interest rates are below those for longer periods, the yield curve is often referred to as 'positive'. In contrast, when short-term interest rates are above long-term rates, the curve is described as 'negatively' sloped, or inverted.¹ The associated yield gaps will be positive and negative respectively. Figure 1 shows the yield curve in New Zealand for 1 March 1990 and 23 June 1992. The graph illustrates how the yield curve changed from a negative slope to a positive slope between those dates, and also how the whole level of interest rates fell (note the different scales used for the interest rates for those two dates).

¹ There are other possibilities. The curve may be 'humped' - that is, as the time to maturity increases, interest rates first rise, then decline (or decrease initially and then increase).

Figure 1



The expectations theory of the yield curve.

Three main theories have been advanced to explain how the shape of the yield curve is determined. The first is that expectations of future interest rates are taken into account in determining the term structure — known as the *expectations* theory of interest rates. This theory assumes that investors expect to get the same return from investing in a succession of short-term bonds as they would from holding a long-term asset to maturity. Long-term interest rates are an average of current and expected future short-term interest rates. As an example, assume that someone wishes to invest funds for two years. They can choose between holding a two year bond until maturity, or buying a one year bond and reinvesting the proceeds of the maturing bond in another one year bond. Under the expectations theory, the expected return is the same for either strategy. (Alternatively, the expected return would be the same for holding a one year bond to maturity, as it would be for holding a longer-term bond for only one year, and then selling it.)

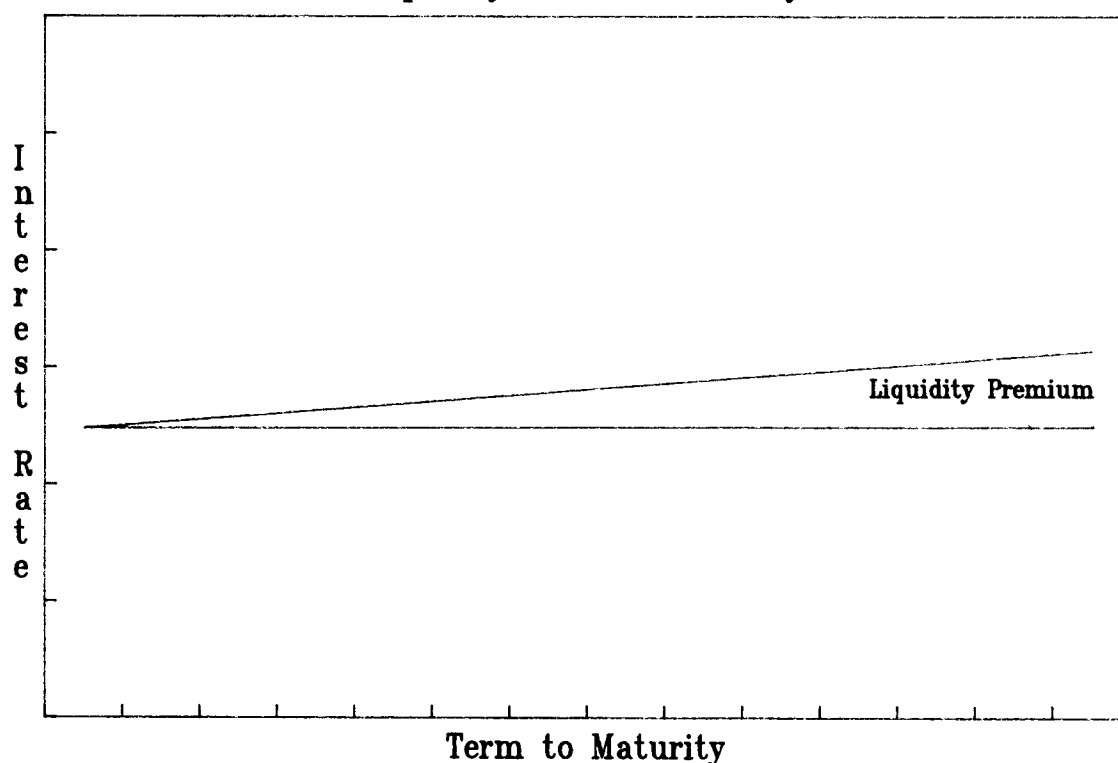
An implication of the theory is that when long-term interest rates are above short rates (a positively sloped yield curve), interest rates are expected to increase. Conversely, a negative yield curve slope implies that interest rates are expected to fall. Such movements in future interest rates are required to ensure that the expected returns from different investment patterns are the same. When the yield curve is positively sloped, an expected increase in rates at the short end will increase the yield available when the funds invested in short bonds are reinvested. An expectation of an increase in rates at the long end of the curve produces an expected capital loss on those bonds, again helping to equalise expected returns. This explanation of the determination of yield curves is the foundation for the link between the shape of the yield curve and inflation expectations, which will be discussed in more detail below.

The expectations theory was discussed in an article in the *Reserve Bank Bulletin*, December 1993: 'Expectations and the Term Structure of Interest Rates'. That article suggested that the expectations theory is questionable in empirical terms. Most studies have found that positively sloped yield curves are associated with falling interest rates. This suggests that long-term interest rates are not unbiased forecasts of future short-term rates. The exception noted was a study using New Zealand data which supported the expectations theory.

The liquidity preference theory of the yield curve.

The expectations theory, in its simplest form, ignores the risks associated with holding bonds over a longer period of time. When there is uncertainty, investors may prefer to buy bonds which will mature in the short-term, lowering the risk of suffering a capital loss. The *liquidity preference* theory of the yield curve incorporates this idea of risk aversion as an addition to the expectations theory. While expectations are important in influencing the yield curve, the liquidity preference theory suggests that individuals generally prefer to invest in short-term assets. Consequently, a premium is necessary to induce investors to hold longer-term bonds. This risk premium will result in the yield curve sloping upward unless a fall in interest rates large enough to offset this is expected. Figure 2 shows the impact of the risk premium on a hypothetical yield curve (where inflation is expected to remain unchanged in the future). The risk premium causes the yield curve to pivot upward.

Figure 2
Liquidity Preference Theory



The segmented market theory of the yield curve.

An alternative theory of the term structure is the so-called *segmented market* or *preferred habitat* theory. This theory assumes that financial market participants are risk-averse, and prefer to match investment and spending decisions closely, rather than necessarily seek the highest return. For example, those saving for retirement may prefer to invest

in long-term assets, while those saving for next month's tax bill favour investing in short-term assets. In the extreme, the theory implies that the market for assets for each maturity is independent of that for other maturities. Shifts in interest rates in one segment of the market would have no impact on any other portion of the market. In this case, the shape of the yield curve would be unlikely to contain much useful information regarding expectations of future output or inflation developments.

In practice, the yield curve we observe is likely to be explained by some combination of all three theories described above, with each of the factors varying in importance through time. It is difficult to verify from data which theory is more accurate, as empirical tests are often unable to clearly distinguish between competing explanations for observed behaviour. In a recent Bulletin article (referred to above) the evidence in support of the expectations theory was discussed. That article concluded that there was only limited empirical support for the theory, but that the reasons for this finding were not clear. Interested readers are referred there for a more detailed discussion of the issues surrounding the expectations theory.

What can the Yield Curve tell us?

The expectations theory of the yield curve can be used to link the yield curve to inflation expectations. In addition, a number of theories, and some empirical evidence, suggest that the yield curve can be a useful indicator of real economic activity. This section discusses these theories, with an emphasis on explaining intuitively why the yield gap may be able to help predict inflation or real activity.

The yield curve and inflation.

The expectations theory of the term structure provides a theoretical link between interest rates on bonds with differing maturities. In addition, interest rates can be seen as providing both compensation for the loss of purchasing power due to inflation, and a 'real' rate of return. The concept can be illustrated with a simple equation - a variant of the Fisher equation²:

$$i_t = p_t + r_t \quad (1)$$

where: i_t is the nominal interest rate in the money market;

p_t is the expected rate of inflation; and

r_t is the expected real rate of interest.

The nominal interest rate on a one year bond, for example, can be decomposed into expected inflation over that period and the expected real interest rate. When interest rates of different maturities are related in the way the theory suggests, the equation can be used to generate a link to inflation. If the real interest rate is assumed to be constant, then

² Strictly, the Fisher equation is given by $(1 + i_t) = (1 + p_t)(1 + r_t)$, but may be approximated by Equation (1) when interest rates and expected inflation rates are low.

differences in nominal interest rates between maturities will reflect market participants' expectations of the evolution of inflation. The difference in interest rates on one year and five year government stock, for example, will reflect expectations of the change in inflation in the intervening period. If inflation is forecast rationally (that is, all available information is used, and errors are not systematic), and the real rate of interest is constant, then the expectations theory suggests that the yield curve slope can forecast inflation.

The theory has some intuitive appeal, and appears plausible. Consider the situation when inflation is steady, and expected to remain unchanged. A change in policy to reduce inflation is then announced, and monetary policy tightened. Generally, monetary policy actions occur in the short-term money market, and hence have their largest impact there. A tightening in policy would tend to increase short-term interest rates. A credible policy action will result in expectations of lower future inflation and, with constant real interest rates, this implies lower long-term interest rates. The yield curve therefore becomes downward sloping, at least until short-term interest rates decline. In this scenario the negative yield gap will be associated with falling inflation. As short-term interest rates decline with inflation, the yield curve would flatten. A monetary policy easing, leading to the expectation that inflation will increase, produces a positive yield curve in a similar way. Hence, changes in the yield curve are likely to contain information about changes in expectations regarding the future course of inflation. And, if expectations are unbiased, then changes in the yield curve will provide leading information on actual changes in inflation.

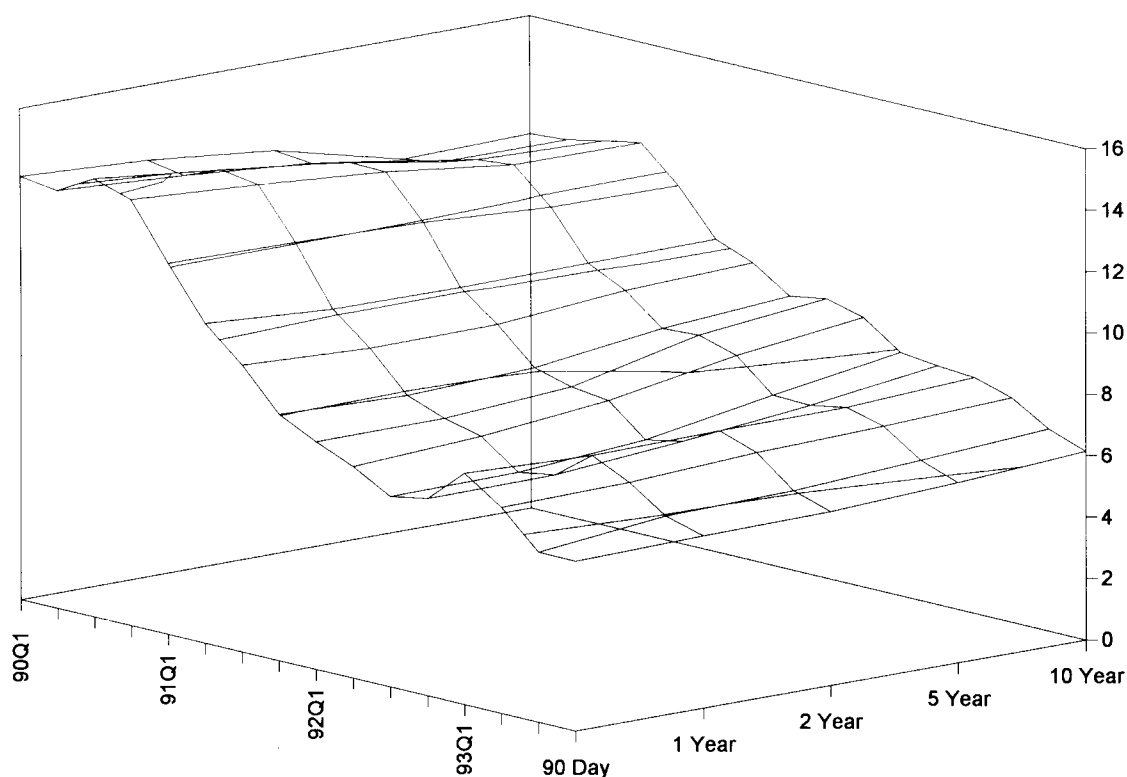
The yield curve and inflation in New Zealand.

For much of the period of New Zealand's recent disinflation, the yield gap (calculated as the difference between 5-year government stock and 90-day bank bills) was negative. This was consistent with the view that inflation was expected to fall, and that monetary policy pressure was being brought to bear on inflation. In that sense, the yield gap served to indicate information to the Bank about expectations of future inflation, and acted as something of a measure of the credibility of policy. Interest rates have declined considerably in recent years as inflation has fallen and the yield gap is now positive - with long-term interest rates slightly above short-term rates. Rather than suggesting that inflation is expected to increase, this may be explained by some other theory of the term structure - such as the liquidity preference theory - and, therefore, may be quite consistent with expectations of no change in future inflation. Figure 3 shows the term structure of interest rates in New Zealand over recent years. The change in the shape of the yield curve and the general fall in interest rates can be seen in the graph.

The yield curve and output.

Theories relating the yield curve to output are more varied than those linking the spread to inflation. One of the theoretical problems is explaining why the slope of the yield curve is better able to predict output than the general level of interest rates — particularly short rates. Despite the difficulties, a number of linkages have been proposed to explain the relationship observed in some countries.

Figure 3
Interest Rate Surface in New Zealand



One of the theories is based on the premise that the real interest rate may move over time. If the real rate is the more important determinant of output, it would be difficult to assess the impact of changes in nominal rates on output. When the long-term interest rate is used as a proxy for the real interest rate, the difference between short- and long-term interest rates may be a better guide to monetary tightness than any single interest rate. Intuitively, a tightening in monetary policy, reflected in an increase in short-term interest rates, will tend to produce a negative yield gap. The negative yield gap will be associated with slower growth during the transition to lower inflation.

A further channel for the yield curve to explain output movements may be through determining the timing of spending decisions. A positive yield curve slope, with short rates below long rates, may indicate to those about to undertake investment that interest rates are likely to increase. This could increase the likelihood that investment is carried out sooner rather than later, and boost output.

The theories suggest that the yield curve can help interpret the output implications of interest rate changes. The yield curve slope may be especially useful as an indicator for particular components of spending such as durable consumer goods (housing, cars and so forth) and investment spending by businesses which are particularly sensitive to interest rates. And the theories imply that the yield curve has information additional to that of short-term interest rates in explaining output movements. This would justify using changes in the yield gap, in addition to movements in the level of interest rates, as an indicator of output.

The Results of Overseas Studies

A large number of studies have been carried out on the term structure of interest rates, using a variety of methods. The different approaches to empirical work make it hard to summarise concisely the results of the studies. This article discusses a few studies to provide an indication of the type of results contained in the literature.

Considering first studies on the yield gap-inflation relationship, some fairly promising results have been found. A common method used has been to estimate an equation where the change in the average inflation rate between two periods is explained by the gap between interest rates on bonds with those maturities. As an example, the difference between the inflation rate over the next year, and the *average* inflation rate over the next two years, could be predicted by the difference in current nominal interest rates on one year and on two year stock. The following equation is often estimated to test the relationship:

$$\text{inf}_{t,m} - \text{inf}_{t,n} = a + \beta(i_{t,m} - i_{t,n}) \quad (2)$$

where: $\text{inf}_{t,m}$ is the average inflation rate expected over the period from t to m ; and

$i_{t,m}$ is the nominal interest rate at time t on a bond maturing in period m .

Equation 2 follows directly from the theoretical discussion above. If expectations are formed rationally, and the real interest rate is unchanged, then the equation can be tested on data by comparing the yield gap with subsequent inflation out-turns. Yield spreads are tested against the change in inflation over those same periods. An alternative approach is to vary the gap length or the period over which the change in inflation is measured (or both), in an effort to extract the most useful information about inflation from the yield gap, even if the periods do not match.

Browne and Manasse (1990) examined the term structure of interest rates in the G7 major industrial economies³ other than Japan, with a view to assessing its usefulness for forecasting inflation. The authors tried a variety of different time periods and, in general, found that the yield gap contained useful information about inflation, particularly over shorter periods. However, for the United Kingdom the yield gap had no detectable forecasting power for inflation. Jorion and Mishkin (1991) also conducted a cross-country study.⁴ Their results were similar to those of Browne and Manasse - shorter yield gaps predicted inflation better in the United States, and the results for the United Kingdom were not statistically significant. Both studies found that a longer yield gap performed better than a short gap in Germany, in contrast to the conclusion for the United States.

3 The United States, Japan, Germany, France, the United Kingdom, Italy and Canada.

4 Covering the United States, the United Kingdom, Germany and Switzerland.

Both studies indicated that the predictive power of the yield gap varies across countries, and that the most informative length of the spread also varies from country to country. Yet a clear finding is that for some countries, the difference between short and long term interest rates has helped predict inflation. This result helps explain why many central banks monitor the yield curve, and why research continues on the topic.

A similar diversity in results is found in studies which look for a link between the term structure of interest rates and real economic activity. Theory does not specify which particular yield gap will predict growth over a given period, although most research appears to focus on spreads over several years. Hu (1993) investigated the forecasting power of the yield curve in the G7 countries. The author found a positive relationship between the yield gap and future growth for all countries investigated. When short term interest rates were lower than long term rates, output growth tended to increase. However, there was considerable cross-country variation. The country with the strongest link was Canada.

Using US data, Estrella and Hardouvelis (1991) investigated the predictive power of the yield gap for output. They found that the spread had extra predictive power for real activity over and above that of an index of leading indicators, and also contained information additional to that of the level of short-term interest rates. Regarding the components of GDP, the yield gap had more predictive power for investment and durable consumption than for total consumption.

Figure 4

**Yield Gap and Change in CPI Inflation
(2 Year to 90 Day Spread)**

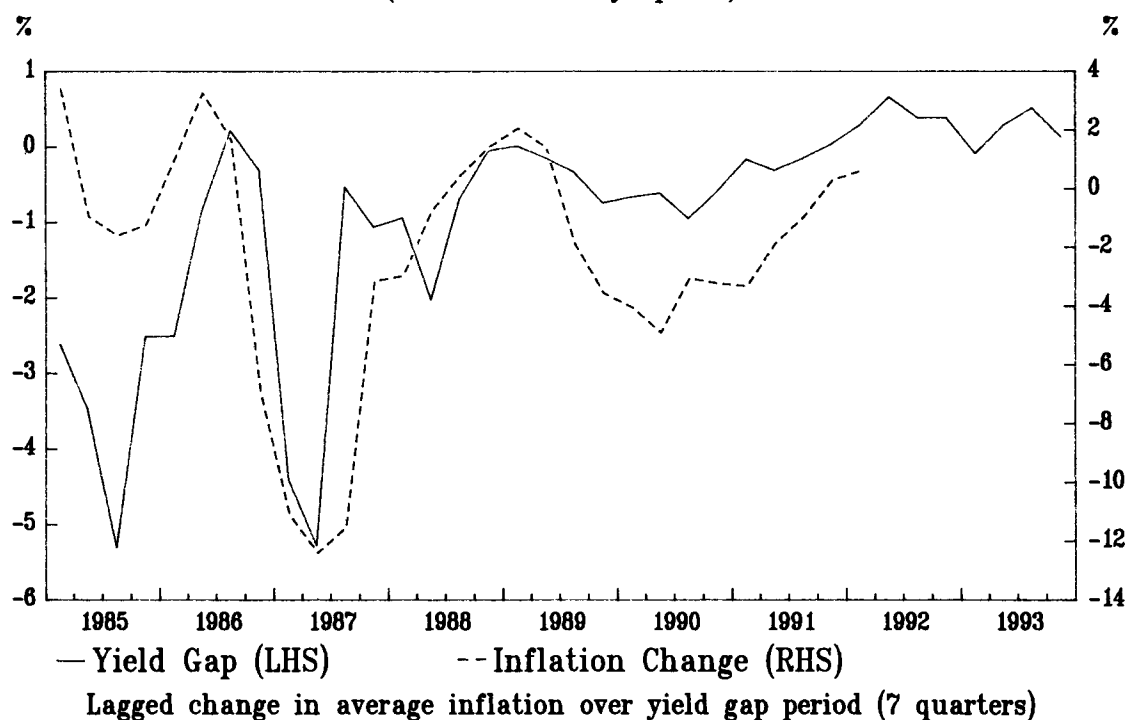
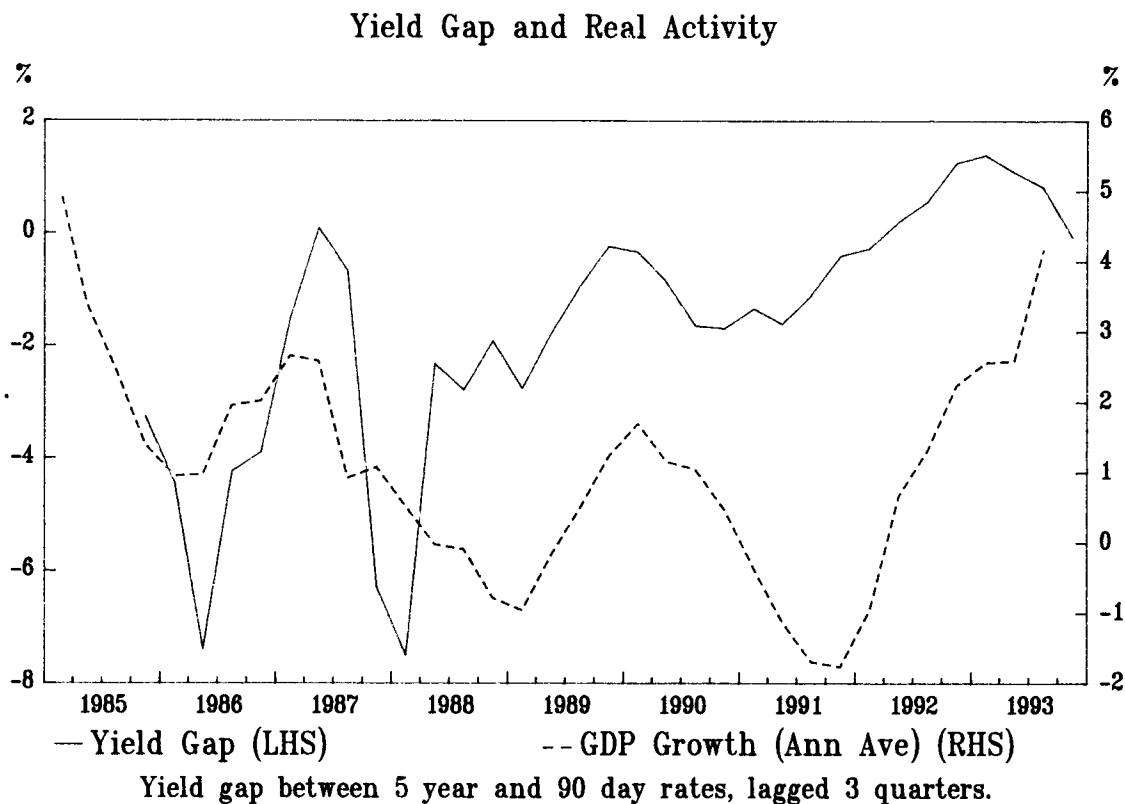


Figure 5



Possible New Zealand Research

The yield gap is currently one of the indicators in the Reserve Bank's checklist of monetary indicators. However, given the difficulties in determining a clear link between the yield gap and inflation, a low weight has been placed on the information provided in recent years. The discussion of theory and the results of some overseas studies presented above, show that in some countries the yield gap can help assess future inflation growth. This may be as a variable in a composite indicator series, or directly via an estimated relationship.

Graphical analysis shows some linkages to inflation.

To date, little formal work has been published in New Zealand on the information content of the yield gap. Some illustration of the potential strength of any relationships can be seen in Figures 4 and 5 which compare a measure of the yield gap with inflation and output respectively. Some link between the spread and inflation is apparent in Figure 4 (although much of the information may be due to movements in short-term interest rates, rather than in the yield curve itself). Any relationship with output is less obvious.

The graphs do suggest some potential for finding a useful measure of the relationship between the structure of interest rates and inflation, with the possibility of a link to output less likely. Ongoing research at the Reserve Bank is trying to quantify these relationships. However, data difficulties are a constraint. The theory underlying the work is based on the presumption that interest rates are essentially market-determined. In this

case, market expectations of inflation and real interest rates will be reflected in the term structure. If interest rates are largely government-determined, there will be little useful information in them. As interest rates were controlled to a varying extent prior to 1985, only subsequent data can be used. There are also only a limited number of maturities available in New Zealand for government stock. Both of these factors restrict the options available for experimenting with different length spreads — particularly at the longer end of the yield curve. Still, some useful information may be found at the short end of the curve — and any empirical relationships would better inform our use of the yield curve.

References

Browne, F. and P. Manse (1990). 'The Information Content of the Term Structure of Interest Rates: Theory and Evidence', *OECD Economic Studies*, No. 14.

Estrella, A. and G.A. Hardouvelis (1991). 'The Term Structure as a Predictor of Real Economic Activity', *Journal of Finance*, Vol XLVI, No. 2.

Hu, Z. (1993). 'The Yield Curve and Real Activity', *IMF Working Paper WP/93/19*.

Jorion, P. and F. Mishkin (1991). 'A multicountry comparison of term-structure forecasts at long horizons', *Journal of Financial Economics*, 29.

Reserve Bank of New Zealand (1993). 'Expectation and the Term Structure of Interest Rates', *Reserve Bank Bulletin*, Vol 56, No. 4.