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A Study Of The Impact Of Monetary Policy On Long-Term Interest Rates In New Zealand

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Abstract

This paper examines the impact of monetary policy on the daily long-term interest rate (the 10 year government bond rate) in New Zealand. An attempt is also made to compare the impact of international long-term interest rates (the 10 year bond rate) on domestic long-term rates. The Monetary Condition Index (MCI) and 90 day bill rates are used as proxies for the Reserve Bank's monetary stance over the period 3 October 1994 to 30 September 1997. In the empirical literature, it is common to use the benchmark short-term interest rate as the monetary policy proxy. However, this paper argues that using the MCI as the proxy is more appropriate, as it incorporates the effect of the exchange rate, and in part reflects the monetary policy stance of the Reserve Bank. The study finds that the impact of domestic monetary policy on daily long-term interest rates is limited compared to the impact of international interest rates on those same rates. New Zealand long-term interest rates seem not only to move with international rates, but seem to be largely driven by them.

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Chapter 1 Introduction

Since 1989, monetary policy in New Zealand has successfully achieved its primary goal of maintaining price stability, this goal having been instituted by the passing of the Reserve Bank Act in that same year. Consumer Price Index (CPI)-measured inflation has fallen from double digits in the late 1980s to under 2% in the early 1990s, where it has largely remained. The Reserve Bank Act had as its rationale the notion that the best contribution monetary policy can make to the economy is to create a low inflation environment, this in turn enabling people to make more informed and rational investment decisions, ensuring sustainable growth and a stronger economy.

Implementing monetary policy to achieve price stability inevitably affects other economic activities, though there is no universal agreement on precisely what variables money affects in the economy, how the effects are transmitted, the strength of the effects and the time lag of these effects (Gibson and Kaufman, 1971). Monetary authorities have imperfect information about the current condition of the economy, about the path it would follow if policy did not change, and about the effects a change in policy would have. These uncertainties should affect monetary policy (Romer, 1996). However, it is generally agreed (at least in the long run) that monetary policy cannot be used to control the rate of unemployment, the level of real national income, the real interest rate, the real quantity of money and the rate of growth of the real quantity of money, but it can have important effects on nominal variables (Friedman, 1968 and 1982). Changing the stance of monetary policy might have a temporary or short-run impact on real economic variables, but any lasting effect would be on nominal prices (Smithin, 1994). This paper focuses on what effects monetary policies have on daily long-term interest rates in New Zealand. It can be observed that as inflation has been brought down, long-term interest rates as measured by 10 year government bond rates have also been reduced from around an 18% peak in early 1986 to about 12% in 1990, and to under 9% during most of the 90s.

When studying the impact of monetary policy, often the focus is on how short-term interest rates, as a proxy for monetary policy, affect other variables. The well known term structure theory offers one explanation in terms of the relationship between short

and long-term interest rates. A simple version of this theory assumes that the relationship between long and short-term rates is dependent on the relationship between current short and expected future short-term interest rates plus a risk premium. The credibility of the Reserve Bank of New Zealand (RBNZ) in controlling inflation has increased while the expectation of high inflation has gradually reduced over time, which in turn lowers the inflation associated risk and therefore lowers the future spot short-term rates and risk premium.

However, monetary-induced change in short-term rates can be interpreted in different ways in regard to expected future inflation. For instance, an increase in short-term rates associated with a tighter monetary policy may, on the one hand, indicate that future inflation will be less, but on the other hand, this may be interpreted as fear of an increase in future inflation. Thus it is not clear which expectation in aggregate should be considered to influence future changes in short-term interest rates, or long-term rates.

Moreover, the determination of long-term bond rates itself, apart from monetary influences, depends on many factors, such as economic fundamentals, political risk and international rates. Among those, international rates are becoming one of the most important factors. A number of recent overseas studies, for example, Kneeshaw and Bergh (1985); Pigott (1993); Christiansen and Pigott (1997); Throop (1994) and Sutton (1997), suggest that international integration has contributed an important external factor in the determination of domestic bond rates. It is also evident that New Zealand long-term interest rates are driven significantly by international rates, in particular by US and Australian rates (Eckhold, 1998).

Does monetary policy impact on everyday long-term interest rates? Is this impact weakening, since domestic long-term rates are also influenced by foreign rates? Which of them is the dominant influence? This study examines whether monetary policy impacts on daily 10 year bond government rates in New Zealand. With respect to the importance of external effects, an attempt is also made to examine the impact of international rates on long-term interest rates.

The traditional approach of using benchmark short-term interest rates as the proxy for the monetary policy stance is used in this paper. The Monetary Conditions Index

(MCI), adopted by the RBNZ as an indication of its monetary stance in recent years, is also used. (The MCI is a combination of short-term interest rates and exchange rates describing overall monetary conditions. The MCI as a proxy of overall monetary stance is assumed to be a more comprehensive variable describing the overall monetary conditions than short-term interest rates. If the MCI indicated monetary conditions were not as desired by the RBNZ, the Bank would have to react to that and use its policy instruments to effect the desired change in the MCI, or indicate its displeasure and allow the market to set the appropriate rate.

There is strong evidence for the notion that the New Zealand daily 10 year bond rates are not co-integrated with the proxies of domestic monetary policy stance, but that they are with US and Australia's using the Engle and Granger (1987) cointegration test. In addition, when using the Granger (1969) causality test, the change in the New Zealand daily 10 year bond rates appears not to be caused by the proxies of domestic monetary policy stance, but by the US and Australian rates. This indicates that the impact of monetary policy on daily long-term interest rates is less than the impact of international rates on New Zealand long-term interest rates.

The paper is organised as follows: Chapter 2 introduces the background of New Zealand monetary policy and its monetary operation procedure. It also reviews the issue of international co-movements of long-term interest rates and the technique of cointegration. Chapter 3 describes the data collected by this paper. Chapter 4 presents the methodology and results of empirical testing. Chapter 5 presents conclusions and suggests areas of future research.

Chapter 2 Literature Review

2.1. Introduction

This chapter first introduces New Zealand monetary policy, how it works to affect the general price level, and its operation procedure. One distinguishing feature of New Zealand monetary policy is that the RBNZ has relatively more independence in operating monetary policy compared to other central banks. However, unlike those central banks that use an official interest rate to indicate their monetary policy stance, the RBNZ uses a number of different instruments. This chapter explains this and discusses why the common approach of using the short-term rate as the proxy of the official rate may be less ideal than in the New Zealand context. This study uses the MCI as an alternative proxy for New Zealand's monetary policy stance. The reasons why this is done is explained in this chapter.

This chapter also reviews the theory of the term structure of interest rates in order to understand how long-term interest rates are influenced by short-term interest rates. The theory, especially the expectation hypothesis, is important in understanding how monetary policy works to influence long-term interest rates. In this chapter, the empirical literature that exists on the topic of international co-movements of interest rates is also reviewed.

Finally, the chapter provides some background about cointegration analysis, including the Dickey and Fuller DF and ADF (1979, 1981) tests of stationarity, and the Engle and Granger (1987) approach to testing cointegration. The Granger (1969) causality test is also introduced in order to examine whether there are directional causal relationships existing between variables.

2.2. New Zealand Monetary Policy and Operational Procedures

2.2.1. Monetary Policy

In New Zealand, monetary policy's primary objective is maintaining price stability, which is unambiguously set out in section 8 of the Reserve Bank Act 1989. The Act was passed on the rationale that the best contribution monetary policy can make to the economy is to create a low inflation environment, this in turn encouraging people to make more informed and rational investment decisions, and so ensuring high rates of sustainable growth, and a stronger and more prosperous economy. Indeed, "not only among most academic economists but also among monetary practitioners, (it is agreed) that the long-run objective of monetary policy must be price stability, or, to put it more generally, control of the absolute level of price" (Friedman, 1982, p. 100). Aiming at price stability permits low long-term interest rates and helps provide a stable setting to foster investment and innovation by the private sector; these are essential to long-run economic growth (Greenspan, 1993).

The character of New Zealand's monetary policy and its operating procedures, are discussed in McCallum (1995), Walsh (1995), Dotsey (1991), Fisher (1993), Dawe (1993) and Grimes (1990). Two distinguishing characteristics should be pointed out in order to study the impact of monetary policy on inflation and other economic variables in New Zealand. First, the RBNZ, in contrast to most other central banks, can independently formulate and implement monetary policy. The RBNZ has been given a "greater independence from political influence" (Walsh, 1995, p. 1180). However, theory states that "the central banks should have independence only with regard to instrument settings, not objectives" (McCallum, 1995, p. 37).

Second, according to the Reserve Bank Act 1989, New Zealand monetary policy has as its sole objective the task of maintaining price stability. This is, in part, a response to the poor inflation performance of the 1980s (Walsh, 1995). In other countries monetary policy normally has multiple objectives, such as Australia, where the central bank must attempt to ensure currency stability, full employment, the welfare of its citizens and general economic prosperity (Holmes, 1994, p. 9). In the United States such objectives

include promoting full employment, stabilising prices, sustaining economic growth and maintaining equilibrium in the foreign exchange value of the dollar (Jones, 1986, p. 23).

Given these features of framework of New Zealand monetary policy, the objective has been easier to be achieved. CPI-measured inflation has fallen from double digits in the late 1980s to under 2% in the early 1990s and subsequently, meeting the target set in the Policy Target Agreements 1992 (it has been increased to 3% since the coalition government was formed in 1996). As the credibility of the RBNZ has been strengthened following its inflation performance and the earlier changes to the monetary policy framework, the expectation of future high inflation has been reduced, along with short and long-term interest rates.

2.2.2. Monetary Transmission Mechanisms

As the monetary authority has a legal monopoly with respect to the supply of money, it has the power to affect both real and nominal variables. Thus, it can influence the real short-term interest rate to effect desired changes in real variables such as unemployment or output, or nominal variables such as the price level. There are a number of variables through which the effects of monetary policy changes are transmitted to the wider economy. The main channels of monetary policy influences include the interest rate, the exchange rate, inflation expectations, and wealth and credit rationing effects (Pierce and Tysome, 1985; Lloyd, 1992). Beaumont and Reddell (1990) provide a good discussion of these from a New Zealand perspective and may be summarised as follows:

- interest rates

(Changing real short-term interest rates would be interpreted by market participants as a meaningful signal reflecting the stance of monetary policy against future inflation. There is a direct correlation between yields on longer maturity instruments and the expectation of the future path of short-term rates.) Because of this, the wholesale market rate would change correspondingly. (As wholesale market rates change the retail rate would also change, which in turn influences people's saving, investment and consumption decisions.) (For example, the rise in the short-

term interest rate would lead to an increase in the opportunity cost of holding cash, people would tend to increase savings and reduce consumption, in turn, leading to less inflationary pressure. An increase in the short-term interest rate would also increase the cost of borrowing, thus reducing investment and, in turn, reducing nominal expenditure and the price level.

- wealth and credit rationing

Increasing real short-term interest rates affects people's wealth if those same individuals are in debt, since the cost of servicing that debt becomes relatively more expensive. More generally, a rise in interest rates depresses asset values and, accordingly, wealth. Regardless of the way wealth is reduced, expenditure is also likely to fall.

Monetary policy-induced decreases in the monetary supply also restrict the supply of bank loans, so that households and businesses are unable to borrow as much as they desire, constraining their expenditures.

- exchange rates

Interest rate changes also affect exchange rates. In an open economy (like New Zealand's), international capital will flow into the country if there is a relatively high interest rate environment giving a high return to international investors, other things being equal. Higher capital inflows appreciate the domestic exchange rate, affecting import and export prices. For example, an appreciation of the local currency would cause the price of export goods to rise, and that of imported goods to fall, reducing aggregate demand as foreign goods are substituted for domestic goods, so reducing the general price level. Overall, empirical research undertaken by the RBNZ suggests that a 10 per cent appreciation in the exchange rate will directly lower the general price level by around 4 per cent¹.

- expectations

This is a very important channel of monetary transmission because expectations not only influence investment decisions and asset prices, but also wage bargaining in

¹ This finding may have changed since 1990, as the speed at which exchange rate effects pass into domestic prices may have increased (Beaumont & Reddell, 1990).

labour markets. As the credibility of the RBNZ is increasing over time, expected inflation and its associated risk has fallen, which in turn might encourage people to make more optimal investment decisions.

The increase in investments in long-term bonds both from home and overseas would push down the interest rate on those bonds. Foreign investors may be more likely to invest in New Zealand if they perceive a lower risk of devaluation of the New Zealand dollar. A stabilised price level would also reduce upward pressure on wages, since the real value of wages would be more secure.

However, people's expectations are often difficult to deduce; for example, monetary policy-induced increases in interest rates may, on the one hand, be interpreted as the RBNZ anxiety surrounding potential increases in future inflation, but on the other hand may be interpreted as reducing the potential for higher future inflation. Clearly, different expectations will have different effects on the expected future general level of prices and long-term interest rates.

2.2.3. Monetary Instruments

Using an interest rate as the indicator of the monetary policy stance is common in many countries; for example, in Australia, there is an Official Cash Rate set by the Reserve Bank of Australia, while in the United States the Federal Funds Rate is affected by the Federal Reserve. However, in New Zealand, no such rate is used as this indicator. As Peter Nicholl, former Deputy Governor of the RBNZ, explains, "We have used all these instruments (interest rates, reserve requirements, credit controls) in the past but we do not believe they are necessary or effective for implementing an anti-inflationary policy in a deregulated market and all were abolished in 1984 and 1985" (1994, p. 137).

Instead of using official short-term interest rates, the RBNZ has several 'technical' instruments available to use including the cash target, the discount margin, the supply of Reserve Bank Bills and interest rates paid on settlement account balances (Huxford and Reddell, 1996). The cash target is a supply side instrument, with the remaining

instruments being demand side controls. Appendix 1 lists these instruments and describes the way in which they effect changes in economic variables according to the wishes of the RBNZ, though these instruments are rarely used.

Another 'instrument', the one used most frequently by the RBNZ, is the so-called 'open mouth operation', incorporating the RBNZ's comments, speeches and publications with respect to its monetary policy stance. The RBNZ not only issues the Monetary Policy Statement (semi-annually) and Economic Projections (quarterly) to indicate its policy stance, but also often uses comments to influence monetary conditions. For example, after indicating that "it is too early for an easing" in the Economic Projections on 13 September 1996, David Archer, Chief Manager of the Reserve Bank's Financial Markets Department, on 16 October 1996, said that any further easing in monetary conditions would be inappropriate at that stage; on 24 October 1996, David Archer signalled again that monetary conditions had become a little firmer than needed for the task of keeping inflation inside the target range (Monetary Policy Statement, Dec 1996, p. 63-64).

The lack of an official interest rate as the guide to the monetary policy stance² in New Zealand makes it difficult to find a quantitative monetary variable useful for conducting the empirical tests relevant to this paper's research aims. It is not only hard to know what monetary stance each of the above instruments represents at any one time, but also, most of these instruments are used infrequently³. Although the Monetary Policy Statements and Economic Projections are issued regularly to present the monetary policy stance, it is not easy to quantitatively represent these statements or convert them to a numerically-based variable in the manner of an official interest rate. Moreover, it becomes even more difficult if all public comments, speeches and publications made by different representatives of the RBNZ, at different times, with respect to their policy stance, are to be incorporated into any such variable.

² Although the real-time gross settlement (RTGS) was proposed as a similar approach to the official rate (for those interested please see Reserve Bank Bulletin, June 1997), it was later dismissed by the RBNZ (see Reserve Bank Bulletin, Dec 1997).

³ The daily based Open Market Operation mainly used to smooth out the day-to-day flows across the settlement accounts (Huxford & Reddell, 1996).

Thus, even where the 90 day bill rate in New Zealand is not ideal as the proxy for the monetary policy stance, it is also difficult to effectively substitute for that variable any of the instruments listed above as being more representative of the Reserve Bank's policy stance. So it is then still necessary to use it as one proxy for that stance.

2.2.4. The MCI

In general, the approach of providing an official short-term interest rate gives a clear quantitative indication of what stance the monetary authority is taking against inflation. It is also far easier to conduct necessary empirical tests where this rate is available and meaningful. This can be done, and the exchange rate incorporated in the variable as suggested by Gerlach and Smets (1995), with the use of the MCI as an alternative proxy. The MCI may be a better approach to modelling a policy proxy for the reasons below.

1. By using only short-term interest rates, it is difficult to describe the overall monetary conditions, since the monetary conditions may be tightening or loosening without the change of interest rates. This is one reason why the RBNZ has used the MCI rather than the short-term interest rate as the indicator of monetary conditions in recent years.

In an open economy like New Zealand, monetary conditions cannot be described solely by interest rates, because monetary policy also affects the exchange rate directly, and the exchange rate affects prices (as discussed in Section 2.2.2). Other things being equal, capital will generally flow into a high interest rate environment for a higher return, and this movement would appreciate the exchange rate. The adjustment will continue until the foreign-domestic interest rate differential matched the expected rate of currency change. The monetary conditions can be changed without interest rates changes, and similarly, changes in interest rates do not necessarily mean that monetary conditions will change. For example, raising interest rates can be offset by some fall in exchange rates, leaving overall monetary conditions unchanged. In some circumstances, the monetary conditions can be

tightened (or loosened) with interest rates eases (or rises). An example of this is the monetary policy tightening prior to 1997 that resulted in the Trade Weighted Index (TWI) reaching a level above 68, but a fall in 90 day bill rates to a level below 7%, from round about 60 and 9% in 1995 respectively.

There is a ratio where both rates can just offset one another and this has been found to be 1:2 by the RBNZ. The details of this and how the MCI is constructed are described in Appendix 2. Whether the channel of interest or exchange rates is more efficient or effective in combating inflation is not important to the RBNZ, as long as the 'mixture' evident at any one time is optimal for the delivery of the desired rate of inflation.

Although the influence of the short-term interest rate is an essential part of monetary policy, it does not necessarily mean it is the only instrument available for central banks. If necessary, the RBNZ can intervene to peg the exchange rate, though this has little effect, and is often unsuccessful (Brash, 1997).

2. It is reasonable to assume that the effects of exchange rates are even more important for a small open economy like New Zealand. As a price taker, the effects of exchange rates for a small economy are greater than for relatively closed and large economies. This can be demonstrated easily in terms of the MCI ratio; the more the exchange rates affect the economy, the higher the ratio of the MCI. The ratio for New Zealand is 1:2; but for a relative large economy like Canada it is 1:3, and for the largest economy, that of the United States, it is 1:10 (Economics Department, the Reserve Bank of New Zealand, 1996, p. 227, footnote).
3. The MCIs are quantitative-based variables which are as useful as short-term interest rates in conducting empirical tests. The MCIs may be more ideal as proxies of the 'official' rates than the market-determined 90 day bill rates, since it has been 'officially' used as a guide to the policy stance of the RBNZ since June 1996⁴. It is generally expected that if the actual MCIs are not within a range of plus or minus 50 MCI points from the desired level, the RBNZ would have to react and more

⁴ The approach of using the MCI has been adopted by the RBNZ for a number of years.

forcefully influence monetary conditions rather than just relying on "open month" announcements.

However, there are some limitations to using the MCI, so its usefulness here should be qualified:

- Although this paper uses a fairly short sample period of three years, the MCIs may not be consistent over long periods. At different stages of the business cycle the chosen base of interest and exchange rates may be different. This is because at different cyclical positions the impact of these rates on inflation, and their lag effects, may be different.
- Generally speaking, the MCI base with different ratios of interest and exchange rates gives similar monetary conditions; for example, this is evident using ratios such as 1:1, 1:2 and 1:3 from 1985 to 1995 (Economics Department, the RBNZ, 1996, p. 226-227). However, it should be noted that using slightly different ratios of interest and exchange rates may give very different indications of the monetary policy stance. For example, with a simulated interest rate of 8% and a TWI of 68.5, the standard nominal MCI formula will give a nominal MCI equal to 1013; if the same numbers are used in the same formula but with a 1:3 ratio, the nominal MCI will equal 979. Clearly, the former appears to reflect a tighter policy stance but the latter appears to be a looser policy stance. The high sensitivity of this ratio needs to be allowed for when making comparisons across countries or at different stages of the business cycle.
- The MCI is only a proxy, not a strict rule, and does not give a perfect indication of monetary conditions. Much useful information is excluded from the MCI, such as business confidence and expectations. Moreover, when the MCI deviates from the RBNZ's desired level by up to plus or minus 50 points, in some situations the RBNZ may not react. For instance, the RBNZ may be tolerant of deviations temporarily in order to allow for shocks to the exchange rate, or at a time close to the next RBNZ economic projection.

2.3. The Term Structure of Interest Rates

The way in which monetary policy-induced changes in short-term interest rates affect long-term interest rates can be partly explained by the theory of term structure of interest rates. This theory seeks to explain the relationship between long and short-term interest rates. It basically consists of four parts: the pure expectation hypothesis, liquidity preference, the market segmentation and preferred habitat theory.

The pure expectation hypothesis, first developed by Fisher (1930), explains the relationship between long and short-term interest rates as the relationship between current short-term rates and expected future short-term interest rates. It assumes that investors maximise wealth regardless of the term premium. For example, if the return from one year plus the roll over for another year is equal to two year's return straightaway, investors are indifferent despite the fact that the first option has monetary availability at the end of first year. Since investors are only concerned about expected returns and trade when they expect future rates to change, long-term rates would be simply a geometric average of expected future short-term interest rates. If not, opportunities would exist to shift investment to the one with the maturity with the higher returns.

The liquidity preference hypothesis asserts the yield on longer term investment is equal to the averages of current and expected future short-term yields plus a risk premium. It assumes that the bond market is dominated by investors with short investment horizons, and investors will demand compensation for the risk of liquidity premium for longer bonds. Because longer term bonds are viewed as having more risk than shorter term, the expected return from holding longer term bonds must be higher than from holding shorter term bonds. For example, if investors expect rates to remain unchanged in the future, longer term bond yields must be higher than shorter term in order to be compensated for the longer term investment. The rate of return increases with the term to maturity of the bond, since the length of maturity must add a positive liquidity or term premium.

The market segmentation theory argues long-term investment is segmented into separate markets with different maturities (Culberson, 1957). It assumes that investors are divided into different groups, and each group of investors will only invest in securities that match their investment horizons. Since investors are concerned only with minimising risk, they are interested only in a particular maturity structure regardless of the expected returns on alternative maturities. Thus the market is segmented, with long-term investors investing in long-term bonds and short-term investors investing in short-term bonds.

Similar to the market segmentation theory, the preferred habitat theory argues that each investor has their preferred maturity and that they purchase securities outside their maturity range only if they are compensated with a higher expected return.

There is little empirical evidence to support the theories of market segmentation and preferred habitat. The expectation hypothesis appears to have considerable more economic content, according to Campbell and Shiller (1987). Compared to the expectations hypothesis, the liquidity preference hypothesis is in some sense more general since it incorporates expectations and risk premiums, though it is not conclusive whether one dominates the other (Dotsey and Otrok, 1995).

In New Zealand, some evidence for the rational expectations hypothesis holding is presented by Wai and Rose (1996). The difference between the rational expectations hypothesis and the general terms of expectations hypothesis is that the former assumes that market participants use all current available information to form their future expectations of the short-term interest rate, whilst the latter does not.

Reddell (1988) summarises the implications of these theories for monetary policy in New Zealand. If the pure expectation hypothesis is right, monetary policy should aim to effectively change expected inflation and/or expected real short-term interest rates in order to alter the long-term interest rates. The attempt of using a quantitative control such as buying or selling short or long-term bonds would be fruitless as there would be no changes in expectations. Monetary policy operation under the market segmentation theory would be effective through the discouraging or promoting of investment in a particular long or short bond by altering its supply. The preference liquidity theory,

though, is regarded as an advanced pure expectation theory, and has not reached obvious conclusions. However, despite the criticisms, the basic expectations approach provides the most useful starting point for analysis. Monetary policy-induced short-term interest rates impacting on long-term interest rates can be explained as being largely determined by financial market expectations of the future path of short-term rates, although such simple one-to-one relationships in New Zealand is dismissed by Reddell (1988).

2.4. The Co-movement of International Long Term Interest Rates

Recent global economic integration, and in particular international financial integration, contributes a significant factor causing interest rates to move together across countries. Although domestic monetary policy-induced changes in short-term interest rates still have an important impact on long-term interest rates, this influence may be declining in light of the global financial integration that has seen international co-movements in long-term rates, and even convergence worldwide.

Kneeshaw and Bergh (1985), Akhtar and Weiller (1987), Throop (1994) and Sutton (1997) suggest that since deregulation in the 1980s, technological advances, and the development of interest rate and currency swaps, are major factors contributing toward to international integration and, in particular, to financial market integration. It tends to reduce divergence between interest rates at home and abroad, and increases the degree to which yields in different countries move together over time. The convergence of interest rates across countries is occurring at an even faster speed, as evidenced by Mishin (1984), Gagnon and Unferth (1995) and Pigott (1997).

Christiansen and Pigott (1997) summarise a 'common benchmark' view explaining the impact of international integration on long-term interest rates, under a floating exchange system:

- both nominal and real term interest rates can differ or be imperfectly synchronised across countries, thus reflecting an individual country's currency risk and exchange rate expectations;
- long-term interest rates in individual countries are mainly determined by domestic economic conditions, in particular, expected inflation, the stance of monetary policy and domestic borrowing and savings;
- if long-term interest rates do move synchronously, this is due largely to similar movements in their fundamentals across countries, and vice versa;
- monetary authorities still retain the ability to influence long-term interest rates.

However, Christiansen and Pigott (1997) further suggest this common benchmark view may be oversimplified in the sense that real interest rates can also be affected by factors apart from those above, for example, the 'world' level of real interest rates. Bond traders adopting international diversified portfolio strategies react to rate movements in major markets rather than to fundamentals, thus any changes in 'world' rates would consequently affect domestic risk premia.

Sutton (1997) supports Christiansen and Pigott's (1977) study and finds that long bond term premia are positively correlated across markets, suggesting that the factors responsible for time variation in term premia have an international component. Interest rates can be different across countries because of the result of risk adjustments made for different countries' currencies. If a country's currency is rising or is expected to rise, the capital will flow in, which in turn will drive the country's interest rate down; similarly, a downturn in a country's currency will cause the capital to flow out and cause interest rates to rise. The opportunity to gain a higher return will exist until the interest rates differential is offset by the expected future currency changes.

The empirical studies of international rates affecting domestic rates are mainly based on United States, Japan, Germany and some other OECD countries. In recent years, only a few tests have been done in New Zealand regarding this issue. These tests mainly focus on what determines New Zealand bond yields, and include the international variables. This might reflect the fact that, as a 'price taker', New Zealand is too small to be regarded as having any influence on the world economy and/or its trading partners. Therefore the tests are inevitably one-sided findings regarding which interest rates from which country are most influential in determining New Zealand rates, or how New Zealand rates react to international rates; the findings do not show how New Zealand rates might impact on others. This one-sidedness may make less sense when trying to understand the behaviour of co-movements; however, they at least provide some evidence for external factors having an important role in determining domestic interest rates.

Eckhold (1998) suggests that international integration has increased in New Zealand because there is increased co-movement between international and New Zealand interest rates, and there is increased foreign ownership of New Zealand bonds. He

points out that "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". He further states, "a steady upward trend emerges which is consistent with the idea of increased market integration over time" (p. 33). His evidence shows that New Zealand bond yields are determined by both external factors and domestic factors. The external factors include the United States and Australian bond rates, while the domestic factors include the expected 90 day bill rates, currency expectations and political risk.

Eckhold (1998) also provides additional evidence to support his study⁵:

- Dyer (1994) develops a model using New Zealand 10 year bond yields as a function of world bond yields and includes other factors such as local monetary policy and currency expectations. Dyer indicates both United States and Australian rates and domestic monetary policy are relevant in determining the real New Zealand 10 year yields.
- Grimes (1994) gives similar results to Dyer. Grimes adds the component of 5 year yields and concludes that in the long run New Zealand 5 year yields are determined by the United States' and Australia's at equal proportions. However, Grimes concludes that Australian 10 year yields seem to be relatively more important in influencing New Zealand yields.
- Rae (1995) updates Grimes' work by adding 3 year yields. Rae indicates that both United States and Australian 10 year yields are determinants of New Zealand's; in the case of 5 and 3 year yields, the United States' rates seem to be more important.
- O'Donovan, Orr and Rae (1996) extend the 'external factors' to 16 OECD countries and find that Australian yields are the most important ones for New Zealand.

The evidence overall indicates that US and Australian 10 year bond rates are the best proxies of international long-term rates for studies of the movement of New Zealand

⁵ Note, these studies are cited in the Eckhold (1998) paper.

long-term rates. Whether daily US and Australian 10 year bond rates affect New Zealand daily 10 year bond rates is, once again, tested by this thesis, although the primary concern of this thesis is to examine whether domestic monetary policies impact on daily 10 year bond rates.

The empirical tests are conducted to discover (1) whether New Zealand 10 year bond rates are co-moved with the proxies of monetary policy and/or whether they are co-moved with international rates using cointegration techniques under the following hypotheses:

Hypothesis I - whether 10 year bond rates are co-moved with the proxies of monetary policy stance in New Zealand.

- the null hypothesis - 10 year bond rates are co-moved with the monetary proxies in New Zealand;
- against the alternative - 10 year bond rates are not co-moved with the monetary proxies in New Zealand.

Hypothesis II - New Zealand 10 year bond rates are co-moved with international rates.

- the null hypothesis - New Zealand 10 year bond rates are co-moved with international rates;
- against the alternative - New Zealand 10 year bond rates are not co-moved with international rates.

(2) whether New Zealand 10 year bond rates are caused by the domestic monetary policy and/or by external factors, using the Granger (1969) causality test under the following hypotheses:

Hypothesis III - whether the change in 10 year bond rates is caused by the proxies of monetary policy stance in New Zealand.

- the null hypothesis - the monetary proxies cause the change in 10 year bond rates in New Zealand;
- against the alternative - the monetary proxies do not cause the change in 10 year bond rates in New Zealand.

Hypothesis IV - whether the change in New Zealand 10 year bond rates is caused by international rates.

- the null hypothesis - international 10 year bond rates cause the change in New Zealand 10 year bond rates;
- against the alternative - international rates 10 year bond rates do not cause the change in New Zealand 10 year bond rates.

2.5. Cointegration

Cointegration is a statistical technique analysing the long-run relationship between sets of time series data⁶. It has received a lot of attention in the econometric literature since the concept was formally developed and introduced by Granger (1981, 1983). Cointegration deals with the linear combination of two or more individual non-stationary time series. It is well known that most macroeconomic data are found to be non-stationary, and when the long-run relationship between these type of variables is examined, the stationary and non-stationary data must be distinguished in order to apply the ordinary least squares (OLS). Broadly speaking, a stochastic process $\{Y_t\}$, is said to be stationary if its mean, variance and auto-covariance are constant over time⁷.

$$E(Y_t) = \text{constant} = \mu$$

$$\text{Var} (Y_t - \mu)^2 = \text{constant} = \sigma^2$$

$$\text{Cov} (Y_t - \mu)(Y_{t+k} - \mu)^2 = \gamma_k$$

Since there are no time factors included in any of these calculations it indicates that their means, variances and auto-covariances are independent of time. Note, auto-covariance between any two periods depends on the gap (k) between the periods but not the actual time at which this covariance is considered.

A stochastic process is said to be non-stationary when any of these conditions are not fulfilled. In other words their means, variance or covariance vary over time. For example, a simple random walk $Y_t = Y_{t-1} + \varepsilon_t$ is a non-stationary process since its means (variances and auto-variances) change with time. To see this, assuming $Y_1 = 0$, then:

$$Y_2 = \varepsilon_1$$

$$Y_3 = \varepsilon_1 + \varepsilon_2$$

⁶ A time series is a sequence of numerical data in which each item is associated with a particular instant in time (Kalirajan, 1995, p. 129).

⁷ This is also known as a weakly stationarity.

$$Y_4 = \varepsilon_1 + \varepsilon_2 + \varepsilon_3$$

-

-

$$Y_t = \sum_{j=1}^t \varepsilon_j$$

$$\therefore E(Y_t) = t\mu$$

Clearly, since the time factor t has been included in the calculation of its means, there is a violation of the condition of stationarity.

The test of stationarity is important because failure to do can lead to the problem of spurious regressions. Spurious regressions occur when a high degree of correlation is found between variables, but where this correlation does not automatically imply the existence of a causal relationship, and is more likely to be mathematical. Using OLS with non-stationary variables is more likely to produce spurious results, this being first discovered by Granger and Newbold (1974) in Monte Carlo experimentation and later explained theoretically by Phillips (1986, 1987). This has several implications. If the means, variances and auto-variances of the non-stationary variables change over time, all the computed statistics in the regression model which use these means, variances and auto-variances will be time dependent and will fail to converge to their true values as the sample size increases. Moreover, the conventional statistics such as the t test, the R^2 statistic and the Durbin-Watson (DW) statistic are inaccurate, and even misleading, as their distributions cease to be asymptotic. Ignoring non-stationarity could induce a serious bias towards the rejecting of the null hypothesis of no relationship between variables when it should not be rejected.

Non-stationarity can be generally removed by differencing data. If the data are differenced once (ΔY_t) to become stationary, it is then integrated to the order one, or $I(1)$. Similarly, if differenced twice to become stationary ($\Delta\Delta Y_t$), the series is $I(2)$, and so on to d times, or $I(d)$, where d is the amount of times the series must be differenced in order to induce stationarity. However, the process of differencing data could induce the loss of potentially valuable long-run information. Fortunately, cointegration deals with non-stationary variables. It has been found when two non-stationary variables are

combined in a regression it results in a stationary error term if those series are cointegrated. Then, the method of OLS can be applied without the problem of producing spurious results.

Holden and Thompson (1992) provide a simple and comprehensive discussion of the nature of cointegration based on Granger's works:

- If two variables are both non-stationary, e.g. $I(1)$, a linear combination of the two variables, normally, is also non-stationary $I(1)$.
- If the result of a linear combination of two $I(1)$ becomes $I(0)$, these two variables are said to be co-integrated.
- In general, if a linear combination of two $I(d)$ results in a variable which has a lower order of integration $I(d-b)$ ($d < b$) than its level, they are said to be co-integrated.

The implications of cointegration are important for economic analysis. If two non-stationary variables are co-integrated, they tend to move closely and the differences between them will be stable or stationary over time. Therefore, the test for cointegration is eventually testing for a long-run relationship between a set of variables.

The implications of cointegration in analysing the relationship between interest rates are also meaningful. If two set of interest rates are move together and not drift away over time, the cointegration should be found out to be existed between them. Throop (1994) suggests that if interest rates at home and abroad are cointegrated, it makes sense that they do not tend to drift apart over time and statistically, this means that a linear combination of the two interest rates would be stationary. The hypotheses I and II formed in this paper are problems of the cointegration type which are tested in Chapter 4.

To examine whether changes of NZ 10 year bond rates are induced by changes of domestic monetary policy or international rates, the Granger causality tests (Granger, 1969)⁸ are conducted.

The simple version of Granger causality may be explained in this way: considering two variables X and Y , if present Y can be predicted with better accuracy by using past values of X rather than by not doing so, other information being identical, X is said to Granger cause Y (or denoted as $x \rightarrow y$) (Charemza and Deadman, 1997, p. 164). However, the possible causalities may exist in reverse, for example, Y causes X ($y \rightarrow x$); or in a more complex case there is feedback, for example, Y causes X but X also causes Y . The hypotheses III and IV are problems of the Granger causality which are also tested in Chapter 4.

⁸ Or the Wiener-Granger causality test, since it was earlier suggested by Wiener, Wiener, N. (1956). "The theory of prediction", in E. F. Beckenback, ed., *Modern mathematics for engineers*, p.165-190. New York: McGraw-Hill.

Chapter 3 Data

3.1. 90 Day Bank Bill Rates

It is common to use short-term interest rates as the proxies of monetary stance since short-term interest rates are generally the indicator of central bank monetary policy stances. Gerlach and Smets (1995) suggest that, conceptually, the ideal rate to use as measure of monetary stance would be the official interest rate. However, since there is no such official interest rate used by the RBNZ to delivery its monetary policy, it is more difficult adopting this 'traditional' approach in New Zealand.

Another problem associated with using the short-term interest rate is it cannot describe overall monetary conditions. As discussed in Section 2.2.4, monetary conditions can be tightened or loosened without the change in interest rates, because of the extra exchange rate effect. Moreover, the effects of the exchange rate for a smaller open economy like New Zealand are greater than for a relatively large closed economy. Therefore, using only short-term interest rates may be not comprehensive enough for this thesis's purpose, highlighting the usefulness of the MCI.

Nevertheless, using short-term interest rates as the benchmark is still the most common way to measure the stance of monetary policy in New Zealand. The variation in the short-term interest rate is still an important part of monetary policy. Empirical studies such as those by Dyer (1994), Grimes (1994), Rae (1995) O'Donovan, Orr and Rae (1996) cited and also used in Eckhold's study (1998), all use this rate as the indicator of the Reserve Bank's policy stance. These studies find that New Zealand long-term bond rates are not only determined by external factors, such as US and Australian long-term bond rates, but also by domestic factors, such as the 90 day bill rate which represents the monetary policy stance. Generally, the 90 day bank bill rate is used as the benchmark short-term interest rate in New Zealand.

3.2. The MCI

The MCI is also used as an alternative proxy for the New Zealand monetary policy stance in this thesis. Although no formal empirical studies have been found that this variable represents the stance of monetary policy, this thesis makes an attempt to do so. As discussed in Section 2.2.4, the MCI is a more comprehensive variable than the 90 day bill rate in terms of describing monetary conditions, and has been officially used by the RBNZ as an indication of their desired monetary conditions since the middle of 1996. Eckhold (1998) indicates that: "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". The reasons Eckhold further explains "the finding of significant TWI (the Tread Weighted Index) 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 (Uncovered Interest Parity)⁹ as such" (p. 3).

Using short-term interest rates as the proxy stance of monetary policy may even be appropriate for a relatively closed and large economy. Based on the study of monetary transmission mechanism in the G-7 countries, Gerlach and Smets (1995) suggest that using short-term interest rates has limitations: first, there is little consensus among economists regarding the exact effects of monetary policy, and central banks may alter the stance of policy without changing official interest rates; for instance, by varying the availability of credit at the official rates. Second, there are channels of monetary policy transmission extra to that inherent in the short term interest rate. Third, central banks typically provide a number of different interest rates and this makes it difficult to choose the appropriate rate. Clearly, the MCI approach is superior than that approach that uses the short-term interest rate, since the former includes the effects of exchange rates.

⁹ It assumes that bonds in different currencies are at least partially substitutable so that market participants set bond yields such that risk-adjusted returns are equalised across countries.

3.3. 10 Year Bond Rates

The rates of 10 year government bonds from New Zealand, Australia and United States are used because they have similar risk characteristics in terms of the free assets in each country. Concerning the time difference across counties, the rates from US are shifted one day forward in order to see whether New Zealand rates are co-moved with this rate. Choosing the rates of Australia and US as representative of international rates for New Zealand are based on the Dyer (1994), Grimes (1994), Rae (1995) O'Donovan, Orr and Rae (1996) and Eckhold (1998) studies. They show that Australian interest rates are one of the most important rates in determining New Zealand rates. It is suggested that Australia is the most important trading partner for New Zealand, and its interest rates have a pervasive influence on New Zealand rates, since international investors typically put these two market into similar 'buckets' or groups as a result of the similarity in the two economies.

It is also evident that US 10 year bond rates are another important rate determining New Zealand 10 year bond rates. The US economy has the most influence on the world economy, with the change in US interest rates influencing to a great extent 'world' interest rates change. If Australian 10 year interest rates move with US rates, then it may be reasonable to assume that the impacts of Australian 10 year bond rates on New Zealand are eventually the impacts of the US 10 year bond rates on New Zealand, although this is not the focus of this paper.

3.4. The Data

All data are collected from Datastream International (except the MCI, which is taken from the RBNZ through the Department of Finance and Property Studies, Massey University).

The data are collected at daily intervals, with the sample period being from October 3 1994 to September 30 1997 (ending before the Asian equity market turbulence in October 1997). All data are in nominal terms. Generally speaking, the real term of the data can be transferred from the nominal term after adjusting for the inflation rate. However, the official announcement of the inflation rate is normally on a quarterly basis; thus it is difficult to adjust the nominal daily based data for inflation. For example, the real MCI can be calculated every quarter but not on a daily basis, as there is no daily inflation rate that can be used for the calculation.

Figure 1 (next page) plots 10 year bond rates and the proxies of monetary policy stance (the MCI and 90 day bill rates). From Figure 1, there appear to be no clear co-movements between NZ 10 year bond rates and the proxies of monetary stance, the MCI and 90 day bill rates. The upward trend of the MCI prior to the end of 1996 reflects the tightening of monetary policy at that time.

Figure 2 presents the plot of New Zealand, US and Australian 10 year bond rates. Three 10 year bond rates appear to move fairly closely over the sample period in Figure 2. The lowest US bond rates are obviously reflecting their lower currency risks. New Zealand 10 year bond rates are initially lower than Australian rates prior to 1996, and since then have increased and matched very closely the Australian rates. This probably reflects the adjustment of the inflation risk associated with New Zealand bond rates during the MMP election. The expected inflation target was expected to be lifted after the election, and was increased from 2% to 3% with the formation of the new coalition government. The close movement of New Zealand and Australian rates occurred mainly because international investors often put the two countries into the same 'bucket'.

Figure 1. The plot of the MCI, 90 day bill and NZ 10 year bond rates

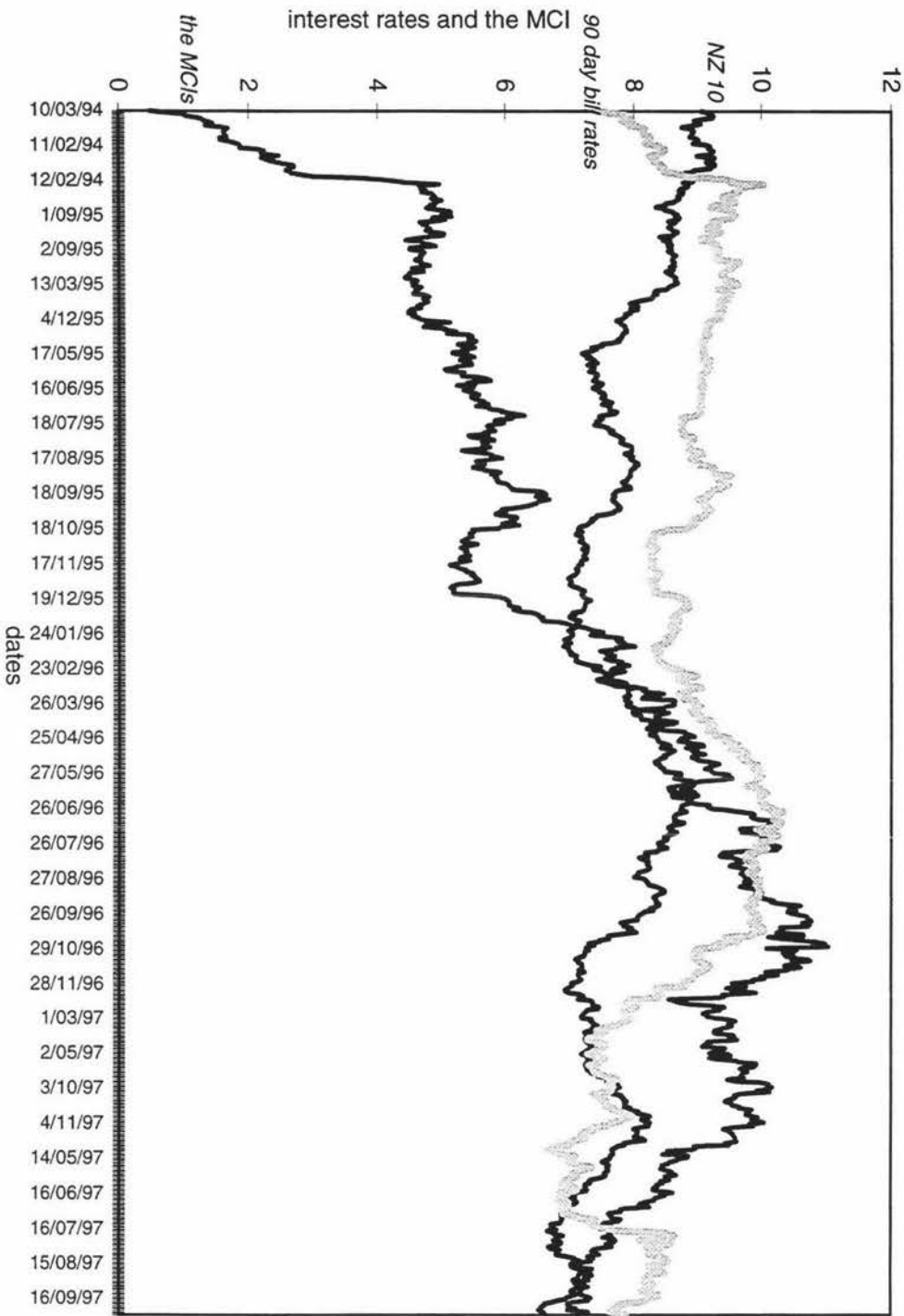


Figure 1 is the plot of 90 day rates, NZ 10 year rates and the MCIs from 3 October 1994 to 30 September 1997. Note, the MCIs here are divided by 100 in order to fit in the graph.

Figure 2. The plot of NZ 10, AUS 10 and US 10 year bond rates

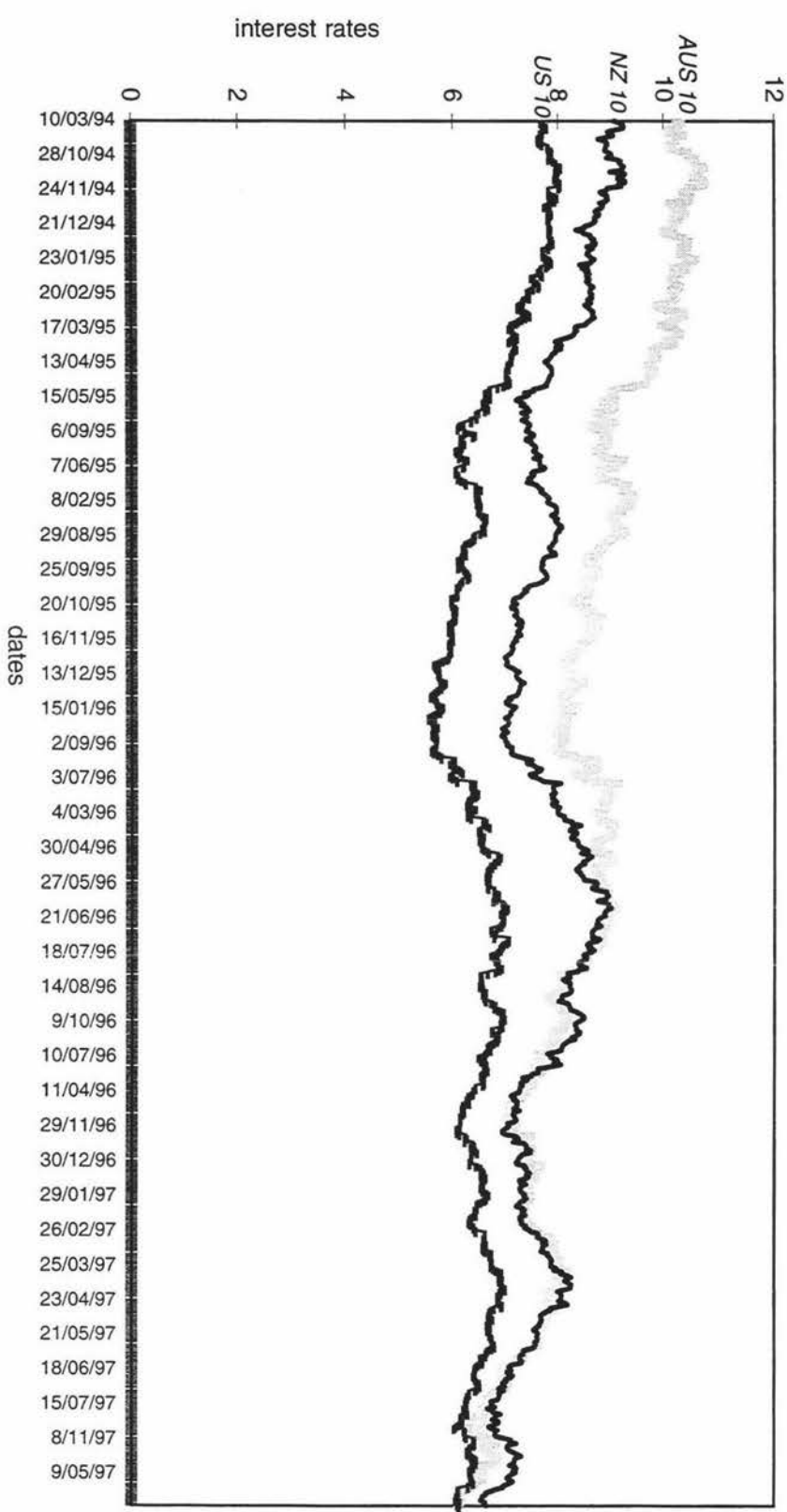


Figure 2 is the plot of NZ, US and AUS 10 year bond rates from 3 October 1994 to 30 September 1997. The graph shows that NZ 10 year bond rates move relatively close in line with US and AUS 10 year bond rates.

Chapter 4 Methodology and Results

4.1. Testing Stationarity

4.1.1. Background

There are several methods available to test stationarity, for example, the Sargan and Bharava (1983) CRDW-test; the Phillips and Perron (1988) non-parameter test and the Correlogram test. The Dickey-Fuller (1979) approach, also well known as the DF and ADF (Augmented -DF, 1981) test, is the most popular, and is applied by this paper. The tests seek to determine whether variables have unit roots.

Consider a first order auto-regression process:

$$Y_t = \rho Y_{t-1} + \varepsilon_t \quad (1)$$

Its difference can be written as:

$$\Delta Y_t = Y_t - Y_{t-1} \quad (2)$$

or

$$\begin{aligned} \Delta Y_t &= (\rho - 1)Y_{t-1} + \varepsilon_t \\ \{ \text{where } \varepsilon_t &\sim \text{IID}(0, \sigma^2) \} \end{aligned} \quad (3)$$

If ρ equals to 1 in equation (1), it is a random walk, or a non-stationary process. Since only when ρ is less than 1 is it stationary, the statistical hypotheses for testing ρ are:

null hypotheses: $H_0: \rho = 1$

against alternative: $H_a: \rho < 1$

Because problems associated with spurious regressions may occur if variables are non-stationary, the standard t -distribution cannot be used. Dickey and Fuller compute the τ value using Monte Carlo techniques, and this should be used instead. In practice, if the calculated sample value τ is greater than the Dickey-Fuller's critical value in absolute terms, the null hypotheses is rejected, and the data is deemed stationary. On the other hand, if it is less than the critical value, the data can said to be non-stationary.

In general, using lag operator L the process can be written as:

$$LY_t = Y_{t-1}$$

$$L^2 Y_t = Y_{t-2}$$

-

-

$$L^n Y_t = Y_{t-n}$$

so that now equation (1) can be rewritten as:

$$Y_t = \rho LY_{t-1} + \varepsilon_t \quad (1)'$$

or $\varepsilon_t = (1 - \rho L)Y_t$

Thus p th order auto-regressive (AR) process can be written as:

$$Y_t = \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \dots + \phi_n Y_{t-p} + \varepsilon_t \quad (4)$$

or

$$Y_t - (\phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \dots + \phi_n Y_{t-p}) = \varepsilon_t \quad (5)$$

It is convenient to collect all the left-hand side of equation (5) as $\phi(L)Y_t$ using the lag operator, so equation (5) can be rewritten as:

$$\phi(L)Y_t = \varepsilon_t \quad (6)$$

{ where $\phi(L)$ is the polynomial lag operator $1 - \phi_1 L - \phi_2 L^2 - \dots - \phi_p L^p$ }

It can be proved mathematically when the roots of the polynomial in equation (6) are greater than unity in absolute value, Y_t is stationary¹⁰, and therefore it is called the unit root test.

Equation (3) is often expressed in an alternative form such as:

$$\begin{aligned} \Delta Y_t &= \delta Y_{t-1} + \varepsilon_t \\ (\text{where } \delta &= \rho - 1) \end{aligned} \quad (7)$$

if adding the constant term into equation (7) it becomes:

$$\Delta Y_t = \beta_1 + \delta Y_{t-1} + \varepsilon_t \quad (8)$$

and if adding the time trend into equation (8) it becomes:

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \varepsilon_t \quad (9)$$

Clearly, the null hypotheses of testing $\rho=1$ in each case is eventually the testing $\delta = 0$, since $\delta = \rho - 1$, their critical values has been calculated by Dickey and Fuller.

The ADF test allows more lagged variables to be included in the model, and also tests whether serial correlation exists.

¹⁰ For example, in the simple AR (1) when its $L = 1/\phi_1$, if $\phi_1 = 1$, it becomes a random walk.

Assuming the error term ε_t is auto-correlated, equation (9) can be modified as:

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \alpha_i \sum_{i=1}^m \Delta Y_{t-i} + \varepsilon_t \quad (10)$$

(where m are the number of lagged terms, and

$\Delta Y_{t-1} = Y_{t-1} - Y_{t-2}$ and $\Delta Y_{t-2} = Y_{t-2} - Y_{t-3}$ and so on.)

The ADF test is comparable to the simple DF test, however, it involves adding an unknown number of lagged first differences of the dependent variables to capture auto-correlated omitted variables. Deciding how many lags should be used in the ADF test is difficult, but important, since too few lags may result in rejecting the null too often, while having too many lags reduces the power of the test. However, there is no clear indication in the literature as to how many lags should be included; for example, Said and Dickey (1984) suggest using longer lags where the sample is larger, but it should be less than $T^{1/3}$. While Schwert (1989) advocates using $l12 = \text{int}\{12(T/100)^{1/4}\}$ ¹¹.

4.1.2. Result

This study uses PcGive 9.0, a computer econometric time series analysis package, to conduct the empirical tests.

First, all variables are tested for stationarity applying the DF and ADF tests. The results using equation (7) and (10) are presented in Table 1. Since the null hypothesis of stationarity is rejected at both the 5% and 1% level, all series are deemed to be non-stationary.

¹¹ This study uses 10 lags; however, the results are similar when using 5 lags.

Table 1. Tests for stationarity in levels

Variables in levels	DF	ADF(10)
the MCIs	DF = 0.4716	ADF = -1.13
90 day bill rates	DF = -0.003458	ADF = -2.433
NZ 10 year bond rates	DF = -1.353	ADF = -1.948
AUS 10 year bond rates	DF = -1.762	ADF = -2.058
US 10 year bond rates	DF = -1.118	ADF = -1.668

*Note: * indicates 5% level of significance,
** indicates 1% level of significance.*

*Critical values given by PcGive 9.0
DF test: 5%=-1.94 1%=-2.568,
ADF test:5%=-3.418 1%=-3.975.*

To test whether these series are of a higher order of integration than I(1), the first differences of these series are tested. Table 2 presents the results of DF and ADF tests using first differences.

Table 2. Tests for stationarity in first differences

Variables in first differences	DF	ADF(10)
DMCI	DF = -29.25**	ADF= -8.133**
D90 day bill rate	DF = -27.88**	ADF = -7.426**
DNZ 10 year bond rates	DF = -29.03**	ADF = -6.903**
DAUS 10 year bond rates	DF = -29.24**	ADF = -8.966**
DUS 10 year bond rates	DF = -25.2**	ADF = -8.62**

Note: * indicates 5% level of significance,

** indicates 1% level of significance.

Critical values given by PcGive 9.0

DF test: 5%=-1.94 1%=-2.568,

ADF test: 5%=-3.418 1%=-3.975.

The results show that the null hypothesis of stationarity cannot be rejected at both 1% and 5% level on the first differences. It indicates that all variables are I(1) and no further tests need be conducted on higher order differences.

4.2. Testing Cointegration

4.2.1. Background

There are several methods available to test cointegration as well. The approach developed by Engle and Granger (1987) is popular and widely used for two-variable model regression. For the multivariate framework the Johansen (1988) method has recently become very popular. Others, for example, developed by Stock and Watson (1988), Kremers, Ericson and Dolado (1992), Phillips and Quliaris (1990) are also applied in many other studies. Note that, since cointegration deals with non-stationary data, there is an overlap between testing for a unit root and testing for cointegration, because both involve a test of stationarity. For examples, the approaches developed by Sargan and Bhargava (1983), Dickey and Fuller (1979, 1981) and Phillips and Perron (1988) can be used for such tests.

Engle and Granger's two step procedure is easy to use, intuitively clear, and applied by this paper. The first step is to test whether the residuals from the cointegration linear regression model, that includes the relevant non-stationary variables, are stationary. When the residual is stationary, the variables can be said to be cointegrated in levels.

Consider two non-stationary series Y_t and X_t where both are $I(d)$, their linear combination can be written as:

$$Y_t = \beta X_t + \varepsilon_t \quad (11)$$

or as:

$$\varepsilon_t = Y_t - \beta X_t \quad (12)$$

Testing whether ε_t are $I(d)$ or $I(I-b)$ (where $I > b$) is done according to the simple DF and ADF test methodologies.

Note, the ADF test for the residual are essentially specified by Engle and Granger as follows:

$$\Delta \varepsilon_t = \delta \varepsilon_{t-1} + \sum_{i=1}^m \alpha_i \Delta \varepsilon_{t-i} + v_t \quad (13)$$

Note, using equation (13) instead of equation (10) here, because there is no need to include an intercept and time trend in equation (13)¹². The ε_t can be interpreted as the deviations of Y_t from its long run path, and therefore is assumed to have a zero mean and no deterministic trend.

The coefficients $(1, \beta)$ of Y and X in equation (12) are the cointegrating vectors, and the second step of the Engle and Granger approach involves estimating this cointegrating vector. However, it is mainly used for the purpose of forecasting, so that when considering whether cointegration exists between variables, only the first step needs to be applied.

The major problem of the Engle and Granger test is when there are more than two variables involved, it is very difficult to apply. For example, if there are three variables in equation (12), such as:

$$\varepsilon_t = Y_t - \beta_1 X_t - \beta_2 Z_t \quad (14)$$

Then, the possible cointegrating relationship in equation (14) may exist between Y and X , X and Z , or Y and Z . The Engle and Granger approach is not very useful under these circumstances because the cointegrating vector $(1, \beta_1, \beta_2)$ is difficult to estimate, and the Johansen approach may be applied as an alternative.

This paper concerns the two-variable relationship. The primary concern is to examine whether domestic monetary variables are cointegrated with long-term interest rates, and to examine whether domestic rates are cointegrated with international rates. So, there

¹² Hansen (1992) shows that including a time trend in (13) could result in under-rejecting the null of no cointegration when it is false. See Hansen, B.E. (1992). Efficient estimation and testing of cointegrating vectors in the presence of deterministic trends. *Journal of Econometrics*, 63, 153-81.

are two separate cointegration regressions requiring testing - that between long-term interest rates and proxies of domestic monetary policy stance in New Zealand, and that between New Zealand long-term interest rates and international rates. Hence, the relationship between the proxy of New Zealand monetary stance and long-term international interest rates is not examined here.

Another problem associated with the Engle and Granger approach is that the test is sensitive to which variable is designated as the dependent variable in the equation. Dickey, Jansen and Thornton (1991) found out the result of the test could be different depending on which variable is chosen to be the dependent variable¹³. Also, some econometricians argue that the null hypothesis of the test of no cointegration may only make sense when the variables are cointegrated. Engle (1987) indicates that such a test would be far more useful than that incorporating the natural null of non-cointegration.

4.2.2. Result

Since all variables are found to be $I(1)$ in Section 4.1.2, testing whether the cointegrating relationship exists between variables is essentially a test of whether the residual from the result of their linear combination is $I(0)$. Hypotheses I and II of this thesis can now be tested applying equation (12)¹⁴. It has two aspects - whether the proxies of monetary stance are cointegrated with 10 year bond rates in New Zealand, and whether New Zealand 10 year bond rates are cointegrated with international rates. Table 3 presents the result for the former, using the MCI and 90 day bill rates as the proxies of monetary policy. Note, whether the MCI and 90 day bill rates are cointegrated is not examined in this paper.

¹³ The results are similar when monetary proxies are put into the left of the regression equation later.

¹⁴ One problem associated with the Engle and Granger approach is that the test is sensitive to which variable is designated as the dependent variable in the equation. Dickey, Jansen and Thornton (1991) found out the result of the test could be different depending on which variable is chosen to be the dependent variable. However, the results for all cointegration on which variables is chosen to be the dependent variable are similar when left-hand side variables are interchanged with right-hand variables later.

Table 3. Tests whether 10 year bond rates are cointegrated with the MCI and 90 day bill rates in New Zealand

Residuals in level	DF	ADF(10)
NZ 10 & MCI	DF = -1.267	ADF = -1.43
NZ 10 & 90 day	DF = -1.84	ADF = -1.583

*Note: * indicates 5% level of significance,
 ** indicates 1% level of significance.*

Critical values given by PcGive 9.0

DF & ADF test: 5%=-1.94 and 1%=-2.568.

It appears that 10 year bond rates are not cointegrated with the monetary proxies, the MCI and 90 day bill rates in New Zealand. The results seem to suggest that monetary policies have no significant impacts to drive the daily long-term interest rates. Holden, Peel and Thompson (1990) suggest that non-cointegration "implies that the theoretical model is incorrect and in particular, important variables have been omitted" (p. 79). One of the obvious omitted variables here are international rates.

Hypothesis II tests whether NZ 10 years bond rates are cointegrated with US and Australian rates. Note once again, whether Australian 10 years bond rates are cointegrated with US rates is not examined in this paper. Table 4 presents the results of the tests.

Table 4. Tests whether NZ 10 year bond rates are cointegrated with US and Australian 10 year bond rates

Residuals in level	DF	ADF(10)
NZ 10 & AUS 10	DF = -2.81**	ADF = -1.958*
NZ 10 & US 10	DF = -3.12**	ADF = -1.963*

Note: * indicates 5% level of significance,
 ** indicates 1% level of significance.

Critical values given by PcGive 9.0

DF & ADF test: 5%=-1.94 1%=-2.568

The results show that the DF tests are significant at both 1% and 5% for both cases. However, the ADF tests are only significant at 5% for both cases. This indicates that NZ 10 year bond rates seems to be cointegrated with US and Australian rates, although the findings are not robust. Overall, the evidence indicates that daily 10 year bond rates seem to move with external impacts rather than domestic monetary aspects.

4.3. Testing the Granger Causality

4.3.1. Background

The Granger (1969) causality test¹⁵ deals with stationary data and involves the following regressions:

$$Y_t = \sum_{i=1}^n \alpha_i X_{t-i} + \sum_{j=1}^n \beta_j Y_{t-j} + U_{1t} \quad (15)$$

$$X_t = \sum_{i=1}^m \gamma_i Y_{t-i} + \sum_{j=1}^m \delta_j X_{t-j} + U_{2t} \quad (16)$$

(where U_{1t} and U_{2t} are uncorrelated)

Equations (15) and (16) show that current dependent variables are related to past values of dependent variables themselves as well as of the explanatory variables. Clearly, if the estimated coefficient on the lagged Y in equation (15) is statistically different from zero as a group, such as $\sum \alpha_i \neq 0$ and the estimated coefficient on the lagged Y in equation (16) is not statistically different from zero, such as $\sum \delta_j = 0$ there is an unidirectional Granger causality from X to Y . Conversely, if $\sum \alpha_i = 0$ in equation (15) and $\sum \delta_j \neq 0$ in equation (16), and there is a unidirectional Granger causality from Y to X .

Granger suggests when the sets of coefficients of Y and X are statistically significantly different from zero, there is a feedback or bilateral causality, and if they are not statistically significantly different from zero in both regressions, independence exists (Gujarati, 1995). In practice, equation (15) or (16) can be estimated as the general regression, and coefficients of Y and X then can be omitted and specified as the restriction. A straightforward test for testing the restriction would be an F test or the Lagrange Multiplier (LM) test.

¹⁵ The Sims-GMD test are also known as an alternative. See Sims, C. (1972). Monetary, income, and causality. *American Economic Review*, 62, 540-552.

For example, in equation (15),
the null hypothesis is $\Sigma\alpha_i = 0$;
against the alternative $\Sigma\alpha_i \neq 0$.

If the computed F value exceeds the critical F value at the chosen level of significance, the null hypothesis is rejected, in which case it can be said that X causes Y.

4.3.2. Result

The results of the tests of Hypotheses III and IV are presented in Table 3 using equations (15) and (16). It is clear that the US and Australian rates cause the rates of New Zealand, but the converse does not exist. This is consistent with the primary belief that, as a price taker, New Zealand is too small to have any significant effects on its trading partners or the world. The results also show that the change in the MCI and 90 day bill rates does not induce the change in 10 year bond rates; nor is the converse true.

Table 5. Granger causality tests

Direction	The Wald Test --F value & P value of F
DMCI → DNZ10	1.4265 [0.2124]
D90day → DNZ10	1.0939 [0.3624]
DAUS10 → DNZ10	3.5445 [0.0036] **
DUS10 → DNZ10	50.86 [0.0000] **
DNZ10 → DMCI	1.1729 [0.3208]
DNZ10 → D90day	1.794 [0.1119]
DNZ10 → DUS10	0.89528 [0.4836]
DNZ10 → DAUS10	1.8143 [0.1077]

Note: F values and P values here are given by PcGive9.0.

* indicates 5% level of significance,

** indicates 1% level of significance.

Chapter 5 Conclusion

This thesis sought to determine what relationship exists between monetary policy and long-term interest rates (10 year bond rates) in New Zealand. This involved, in part, finding an adequate proxy for New Zealand monetary policy. Reviewing New Zealand monetary policy and its operational procedure this thesis found that the common approach of using short-term interest rates (90 day bill rates) as monetary policy stance was not ideal, since the RBNZ does not use this rate to deliver its monetary policy. The MCI was then studied and used as an alternative of this proxy, given that this variable was identified as being more representative of the monetary policy stance in New Zealand. This is an important contribution made by this thesis, in that this variable has rarely been used in similar studies.

No cointegrating relationship was found between daily 10 year bond rates and the proxies of monetary policy stance such as 90 day bill rates and the MCI. In addition, it was found that changes in 90 day bill rates and the MCI do not Granger cause the changes in 10 year bond rates. These two tests indicate that the daily impacts of the domestic monetary policies on 10 year bond rates are very limited.

However, a cointegrating relationship has been found between New Zealand 10 year bond rates and its corresponding international rates, the US and Australian rates in particular. Moreover, both US and Australian 10 year bond rates have been found to Granger cause the change in New Zealand 10 year bond rates, but the converse is not true. These two tests indicate that New Zealand 10 year bond rates not only move with international rates, but are largely driven by international rates on a daily basis. These results are also consistent with the literature on international long-term interest rates that generally supports the view that those rates are cointegrated across countries.

The result that New Zealand 10 year bond rates are driven by US and Australian 10 year bond rates is consistent with the Eckhold (1998) study; however, the result that the domestic monetary policy has very limited impacts on New Zealand 10 year bond rates is not. In Eckhold's study, New Zealand 10 year bond rates are determined by both external factors and domestic factors, such as monetary policies and political risks. The

results from this thesis do not suggest that domestic monetary policies have no impact on long-term bond rates in New Zealand. Indeed, inflation and expected inflation has been reduced significantly by the RBNZ since the early 1990s, which lowered long-term interest rates (through the Fisher effect). However, these impacts may not be testable using daily variables as monetary policies were often not implemented on the same basis.

Nevertheless, the results do suggest that the impact of domestic monetary policies is very weak compared to the impact of international rates on daily NZ 10 year bond rates. Watching the performance of the international bond market may be helpful to predict the movement of local bond rates, although this could also be a simplification. Economic fundamentals, expected inflation, and currency risks can all affect the change in long-term international rates.

This thesis also raises other issues worthy of investigation. First, the degree to which the effects of domestic monetary policy is weakening could be tested, and also to what variables or rates the long-term interest rate is converging in New Zealand. Second, the nature of the MCI could be further studied, especially with respect to the extent to which it actually reflects the monetary policy stance of the RBNZ. Third, the relationship between the monetary policy stance of the RBNZ and international long-term interest rates could also be looked at more closely, to determine if, and to what extent, any such relationship exists. Discovering that monetary policy in New Zealand reacts to international rates, whether systematically or not, would be a significant finding.

Appendix 1 The New Zealand Monetary Instruments

The instruments of New Zealand monetary operations include:

- cash target ---how much settlement cash is supplied by the RBNZ. If the cash target is increased, financial institutions tend to not compete aggressively as there is a lower probability of them having to discount RBNZ Bills (a 91 day non-risk instrument which is issued on a twice weekly basis by the RBNZ, and can be discounted if it has 28 days or less to maturity). Decreased demand for settlement cash and RBNZ Bills therefore leads to easier monetary conditions and lower interest rates, everything else being equal.
- discount margin ---if it is left higher by the RBNZ it means the penalty cost of obtaining additional settlement cash via the discounting process will increase. Monetary conditions are tightened and interest rates will rise.
- supply of RBNZ Bills ---as a potential substitute for settlement cash, the increase in the supply of these bills means easier monetary conditions, so that interest rates will become lower if all other things remain equal.
- interest rate paid on settlement account balances ---if the margin below market interest rates paid on settlement cash increases, banks are discouraged from holding excess settlement cash balances. Easier monetary conditions will result and interest rates will fall.

Appendix 2 The Construction of the MCI

Depending on the real or nominal term of interest rates and the TWI, the MCI can be further divided into a nominal and a real MCI. A nominal MCI is constructed by using a combination of a nominal interest rate and exchange rate while a real MCI uses the real rates. The key distinguishing feature between them is that a nominal MCI can be calculated at any desired frequency such as, for instance a daily basis; but a real MCI is restricted according to the frequency of the official inflation figure (reported on a quarterly basis in New Zealand). Generally speaking, the nominal and real MCI will not diverge unless the inflation between New Zealand and its trading partners becomes significantly different; the nominal MCI tended to drift down when New Zealand's inflation rate was above that of its trading partners in most of the 1980s.

The New Zealand interest and exchange rates used as the benchmarks by the RBNZ are the 90-day bill rate and the Trade Weighted Index (TWI); and the base period is December 1996. The RBNZ has constructed both the nominal and real indices using an arbitrary fixed base of 1000 for the December 1996 quarter.

The formula for the nominal MCI is:

$$\{(90\text{-day rate} - 8.9) + (1/2) * [\log_n(\text{TWI}) - \log_n(67.1)] * 100\} * 100 + 1000$$

The first part of equation is the difference in the nominal 90-day rate, the second part shows the percentage change in the TWI. The figure 8.9 and 67.1 are the average rates of the 90-day bill and TWI respectively in the December 1996 quarter. The weight of 1/2 on TWI reflected an estimated 2:1 relative impact of interest rates and exchange rates on New Zealand economic activity. The impact of the exchange rate is relatively bigger for a small open economy such as New Zealand, while its impact will be relatively smaller for a larger and relatively closed economies, such as USA. Therefore the MCI ratios tend to be smaller for New Zealand (2:1) and tend to be greater for USA (10:1) (Monetary Policy Statement, vol 59, p227, footnote 8).

For the real MCI :

$$\{(90\text{-day rate} - 6.5) + (1/2) * [\log_n(\text{TWI}) - \log_n(1)] * 100\} * 100 + 1000$$

The real 90-day bill rate of 6.5 is calculated using the nominal rate minus that quarter's inflation rate of the CPI of 2.4 (excluding Credit Services). The real base level of TWI has been normalised to 1 for the December 1996 quarter. In practice, the real TWI can be calculated as the normal TWI multiplied by New Zealand's GDP deflator (interpolated from annual data) and divided by the trade-weighted average of GDP deflators of New Zealand's main trading partners.

Note, the ratio of 1:2 should not applied as a strict rule. Because such a ratio is only a 'rule of thumb' which could vary over a long period time. The RBNZ has their desired MCI range set out quarterly since June 1996, which is aiming to provide a more comprehensive indicator for the public. However the usefulness of this indicator should be qualified, as the RBNZ can tolerate a deviation from their desired range under a number of circumstances. For example, if there is a short-term adjustments after some shocks, or at a time close to their next economic projection.

Appendix 3 How to interpret the MCI

The ratio of 2:1 indicates that a 1 percent increase in the 90-day rate can be roughly offset by a 2 percent fall in the TWI, such changes leaving monetary conditions in terms of the medium-term inflation target unchanged. It should be noted here that such a ratio is only an approximate estimation, and should not be applied as a strict mechanism. If the TWI is held constant, a rise in the 90-day rate will increase the MCI, or tighten monetary conditions; similarly a fall in the 90-day bill rate would loosen monetary conditions. If the 90-day rate is unchanged, the rise in the TWI results in a tightening of monetary conditions, and vice versa.

One obvious advantage of adopting the MCI approach is that when the situation of one rate rising and another falling occurs, the MCI can still indicate overall monetary conditions in terms of loosening or tightening. For example, a rise in the interest rate coupled with a fall in the exchange rate will make the determination of the likely overall monetary conditions difficult, if looking at the two rates separately.

If the MCI is greater than base level 1000, it means the overall monetary conditions are relatively tight; if the MCI is less than 1000 it means overall monetary conditions are relatively loose.

The MCI can be negative if both interest and exchange rates are significantly less than their benchmark rates. Why? This can be easily explained by a mathematical demonstration. For example, in the nominal MCI equation, if the first part

$$((\{ (90\text{-day rate} - 8.9) + (1/2) * [\log_n(\text{TWI}) - \log_n(67.1)] * 100 \} * 100)$$

is negative and greater than the second part (1000), the result will be negative. An example of a negative MCI could be found during 1992-1994, when the 90-day bill rate fell below 6 percent, and the TWI below 55.

There is a special case when the MCI equals 1000 or zero, as here the monetary conditions under such circumstances can be interpreted as being at an unchanged stance

with respect to the chosen period. This is denoted as neutral monetary conditions, and this will only be the case if the inflation outlook is unchanged.

References

- Banerjee, A., Dolado, J., Galbraith, J., & Hendry, D. (1993). Co-integration, error correction, and the econometric analysis of non-stationary data. New York: Oxford University Press.
- Bank for International Settlements. (1989). International interest rate linkages and monetary policy. Spring Economists' Meeting (March).
- Beaumont, C., & Reddell, M. (1990). How monetary policy influences inflation. Reserve Bank Bulletin, 53(4), 358-378.
- Benzie, R. (1992). The development of the international bond market. BIS Economic Papers, No. 32.
- Brash, D. (1997). Exchange rates, export prices, and the Reserve Bank's Monetary Conditions Index. Reserve Bank Bulletin, 60(3), 209-214.
- Campbell, J., & Shiller, R. (1987). Cointegration and tests of present value models. Journal of Political Economy, 95(5), 1062-1088.
- Charemza, W., & Deadman, D. (1997). New directions in econometric practice (2nd ed.). Cheltenham: Edward Elgar.
- Christiansen, H., & Pigott, C. (1997). Long-term interest rates in globalised markets. OECD Working Papers, No. 36.
- Cuberston, J. M. (1957). The term structure of interest rates. Quarterly Journal of Economics, 71, 485-517.
- Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. Journal of the American Statistical Association, 84, 427-431.

Dickey, D. A., & Fuller, W. A. (1981). Likelihood ratio estimates for autoregressive times series with a unit root. Econometrica, 49(99), 1057-1072.

Dotsey, M. (1991). Monetary policy and operating procedures in New Zealand. Discussion Paper G91/1, Federal Reserve Bank of Richmond.

Dotsey, M., Otrok, C. (1995). The rational expectations hypothesis of the term structure, monetary policy, and time-varying term premia. Economic Quarterly, 81(1), 65-81.

Doornik, J., & Hendry, D. (1996). GiveWin: An interface to empirical modelling. London: International Thomson Business Press.

Eckhold, E. (1998). Determinants of New Zealand bond yields. Discussion Papers G98/1, Reserve Bank of New Zealand.

Economic Department, Reserve Bank of New Zealand. (1996). Summary indicators of monetary conditions. Reserve Bank Bulletin, 59(3), 223-228.

Elliott, G., & Bewley, R. (1994). The transmission of monetary policy: The relationship between overnight cash rates. The Economic Record, 70 (208), 19-25.

Engle, R., & Granger, W. J. (1987). Co-integration and error correction: representation, estimation, and testing. Econometrica, 55(2), 251-276.

Financial Market Department, Reserve Bank of New Zealand. (1997). Monetary policy implementation and signalling: The review and the decision. Reserve Bank Bulletin, 60(3), 215-217.

Fisher, I. (1930). The theory of interest. New York: MacMillan.

Friedman, M. (1968). The role of monetary policy. The American Economic Review, 58(1), 1-17.

Friedman, M. (1982). Monetary policy: Theory and practice. Journal of Money, Credit, and Banking, 14 (1), 98-118.

Fung, A., & Hansen, E. (1993). Bank credit and monetary policy. Reserve Bank Bulletin, 56(1), 32-47.

Gerlach, S., & Smets, F. (1995). The monetary transmission mechanism: Evidence from the G-7 countries. BIS Working Papers, No. 26.

Geske, R., & Roll, R. (1983). The fiscal and monetary linkage between stock returns and inflation. The Journal of Financial, XXXVIII(1), 1-33.

Gibson, W., & Kaufman, G. (1971). Monetary economics: readings on current issues. New York: McGraw-Hill Book Company.

Granger, C. W. J. (1969). Investigating causal relations by econometric models and cross-spectral methods. Econometrica, 37, 424-438.

Granger, C. W. J., & Newbold, P. (1974). Spurious regressions in econometrics. Journal of Econometrics, 35, 143-159.

Granger, C. W. J., & Newbold, P. (1986). Forecasting economic time series (2nd ed.). London: Academic Press, Inc.

Greenspan, A. (1993). The Fed aims for price stability. Challenge, September-October, 4-10.

Grimes, A. (1990). The theoretical basis for monetary policy. Reserve Bank Bulletin, 53(2), 118-125.

Gujarati, D. (1995). Basic Econometrics (3rd). New York: McGraw-Hill, Inc.

Hamilton, J. (1994). Time series analysis. Princeton: Princeton University Press.

Hardouvelis, G. (1994). The term structure spread and future changes in long and short-term interest rates in the G7 countries: Is there a puzzle? Journal of Monetary Economics, 33, 255-283.

Harris, R. (1995). Using cointegration analysis in econometric modelling. London: Prentice Hall/Harvester Wheatsheaf.

Hendry, D., & Doornik, J. (1996). Empirical econometric modelling: Using PcGive 9.0 for Windows. London: International Thomson Business Press.

Holden, K., & Thompson, J. (1992). Co-integration: An introductory survey. British Review of Economic Issues, 14(33), 1-55.

Holden, K., Peel, D., & Thompson, J. (1990). Economic forecasting: An introduction. Cambridge: Cambridge University Press.

Homes, F. (1994). A new approach to central banking: The New Zealand experiment and comparisons with Australia. Wellington: The Printing Press.

Huxford, J., & Reddell, M. (1996). Implementing monetary policy in New Zealand. Reserve Bank Bulletin, 59(4), 309-322.

Johansen, S. (1988). Statistical analysis of cointegration vectors. Journal of Economic Dynamics and Control, 12, 231-254.

Jones, D. (1986). Fed watching and interest rate projections. New York: New York Institute of Finance.

Kneeshaw, J., & Bergh, P. (1985). International interest rate relationships: Policy choices and constraints. BIS Economic Papers No. 13.

Lloyd, K. (1991). Exchange rate regimes and monetary policy. Reserve Bank Bulletin, 54(4), 312-329.

McCallum, B. (1995). New Zealand's monetary policy arrangements: Some critical issues. Discussion Papers G95/4, Reserve Bank of New Zealand.

Mishkin, F. (1984). The real interest rate: A multi-country empirical study. Canadian Journal of economics, 17(2), 283-311.

Mishkin, F. (1993). Money, interest rates and inflation. England: Edward Elgar.

Nicholl, P. (1994). Intervention techniques under a deregulated financial environment. Reserve Bank Bulletin, 57(2), 130-143.

Phillips, P. C. B. (1986). Understanding spurious regressions in econometrics. Journal of Econometrics, 33, 311-340.

Phillips, P. C. B. (1987). Time series regression with a unit root. Econometrica, 55, 227-301.

Phillips, P. C. B., & Perron, P. (1988). Testing for a unit root in time series regression. Biometrika, 75, 335-36.

Phillips, P. C. B., & Quliaris, S. (1990). Testing for cointegration using principal components methods. Journal of Economic Dynamics and Control, 12, 205-230.

Pierce, D., & Tysome, P. (1985). Monetary economics: theory, evidence and policy (2nd ed.). London: Butterworths.

Pigott, C. (1993). International interest rate convergence: A survey of this issue and evidence. Federal Reserve Bank of New York Quarterly Review, 18(4), 24-37.

Quigley, N. (1992). Monetary policy and the New Zealand system: An historical perspective. Discussion Papers G92/1. Reserve Bank of New Zealand.

Reddell, M. (1988). The yield curve and monetary policy. Reserve Bank Bulletin, 51(2), 85-89.

Reserve Bank of New Zealand. (1992). Monetary policy and the New Zealand financial system (3rd ed.). Wellington: Hutheson Bowman & Stewart.

Reserve Bank of New Zealand. (Dec 1996). Monetary Policy Statement.

Romer, D. (1996). Advanced macroeconomics. New York: McGraw-Hill.

Said, S., & Dickey, D. (1984). Testing for unit roots in autoregressive moving average models of unknown order. Biometrika, 71, 599-607.

Sargan, J., & Bhargava, A. (1983). Testing residuals from least squares regression for being generated by the gaussian random walk. Econometrica, 51, 153-174.

Shiller, R. (1979). The volatility of long-term interest rates and expectations models of the term structure. Journal of political economy, 87, 1190-1219.

Simone, F., Dennis, R., & Redward, P. (1996). A monetary conditions index for New Zealand. Discussion Papers G96/2, Reserve Bank of New Zealand.

Smithin, J. (1994). Controversies in monetary economics: Ideas, issues and policy. England: Edward Elgar.

Spencer, G. (1990). Monetary policy: the New Zealand experience 1985-1990. Reserve Bank Bulletin, 53(3), 252-269.

Stock, H., & Watson, M. (1988). Testing for common trends. Journal of American Statistical Association, 83, 1097-1107.

Sutton, G. (1997). Is there excess comovement of bond yields between countries? BIS Working Papers No. 44.

Throop, A. (1994). International financial market integration and linkages of national interest rates. Federal Reserve Bank of San Francisco Economic Review, 3, 3-18.

Toma, M. (1992). Why not a contestable market for the RBNZ? Discussion Papers G92/6, Economic Department, Reserve Bank of New Zealand and Department of Economics, University of Kentucky.

Wai, M. (1995). Testing rational expectations: a cointegration analysis on New Zealand's term structure of interest rates. Master's thesis, Massey University, Palmerston North.

Wai, M., & Rose, L. (1996). Testing the rational expectations hypothesis in a small cap market: The case of New Zealand's term structure of interest rates. Departmental Working Paper Series WP 96.1, Department of Finance, Massey University.

Walsh, C. (1995). Is New Zealand's Reserve Bank Act of 1989 an optimal central bank contract? Journal of Money, Credit, and Banking, 27(4), 1179-1191.

Wong, J. K. (1993). Testing and estimating cointegrating relationships: A survey. Discussion Papers G93/1, Reserve Bank of New Zealand.