A STUDY INTO THE CONSEQUENCES OF USING THE MONETARY CONDITIONS INDEX AS AN OPERATIONAL TARGET FOR MONETARY POLICY IN NEW ZEALAND

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Applied Economics at Massey University New Zealand

Robin Andrew Loomes

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This thesis is dedicated to the memory of

Dr Claudio Michelini

ABSTRACT

The Reserve Bank of New Zealand (RBNZ) used a Monetary Conditions Index (MCI) as an operational guide for monetary policy from 30 June 1997 until 16 March 1999. This thesis uses four different methodologies to determine how this affected the implementation of monetary policy. The first is a survey that investigates the impact of the MCI regime on the way financial market participants viewed the RBNZ's policy stance. The second methodology consists of a series of rolling 10-week regressions that examines the relationship between short-term interest rates and the exchange rate. The third methodology is the autoregressive-distributed lag procedure, which explores the links between the RBNZ's policy actions, the MCI and its components, and external influences as represented by the United States 90-day bank bill rate. Finally, additional information about these relationships is obtained from block Granger causality tests, forecast error variance decompositions and impulse-response functions derived from a VAR framework. This study draws two major conclusions from the results. First, the MCI regime was responsible for an inverse relationship, which developed between the two components of the MCI and lasted from June 1997 until November 1998. This deepened the recession in 1998 by raising short-term interest rates when the currency depreciated after mid-1997. Second, the MCI regime did not significantly change the way the RBNZ's policy instruments impacted on the MCI or its components.

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TABLE OF CONTENTS

ABBREVIATIONS

A90	Australian 90-day Bank Bill Rate
ADF	Augmented Dicky-Fuller
AIC	Akaike Information Criterion
AR- λ^2	Lagrange multiplier version of Godfrey's test for residual correlation
AR-F	F-version of Godfrey's test for residual correlation
ARDL	Autoregressive Distributed Lag
BC	Bank of Canada
CBI	Central Bank Independence
CPI	Consumer Price Inflation
DF	Dicky Fuller
DVM	Dummy variable for model with MCI as dependent variable
DVN	Dummy variable for model with NZ90 as dependent variable
DVX	Dummy variable for model with FX as dependent variable
EC	Error Correction
ECA	Employment Contracts Act
ECB	European Central Bank
EMU	European Monetary Union
ESF	Exchange Settlement Funds
FEV	Forecast Error Variance
FPS	Forecasting and Policy System
FX	Value of the New Zealand dollar in American cents
GDP	Gross Domestic Product
GST	Goods and Services Tax
H- λ^2	Lagrange multiplier test for heteroscedasticity
H-F	F-test for heteroscedasticity
HQC	Hannan-Quinn Criterion
IMF	International Monetary Fund
IR	Impulse-Response
ISC	Interest Rate on Settlement Cash
LFV	Liquidity Forecast Variation
LM	Lagrange Multiplier

LO	Liquidity Operations
LR	Log-Likelihood Ratio
MCI	Monetary Conditions Index
MPS	Monetary Policy Statement
NZ	New Zealand
NZ90	New Zealand 90-day Bank Bill Rate
OCR	Official Cash Rate
ODM	Overnight Discount Margin
ODMG	Overnight Discount Margin (using government securities as collateral)
ODMP	Overnight Discount Margin (using private paper as collateral)
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary Least Squares
OMO	Open Market Operation
PTA	Policy Targets Agreement
RBB	Reserve Bank Bill
RBA	Reserve Bank of Australia
RBNZ	Reserve Bank of New Zealand
RBNZA-64	Reserve Bank of New Zealand Act 1964
RBNZA-89	Reserve Bank of New Zealand Act 1989
RESET- λ^2	Lagrange multiplier version of Ramsey's test for functional mis-specification
RESET-F	F-version of Ramsey's test for functional mis-specification
RSS	Residual Sum of Squares
SER	Standard Error of Regression
SBC	Schwarz Bayesian Criterion
TB	Treasury Bill
TBS	Treasury Bill Sales
TWI	Trade Weighted Index
US	United States
US90	United States 90-day bank bill rate
VAR	Vector Autoregression

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

The Treasury (1984) argued that inappropriate government interventions were largely responsible for problems besetting the New Zealand economy after the mid-seventies. External developments such as the oil price shocks of the 1970s merely exposed long-standing structural problems that made it hard for the economy to adjust to changing economic realities. Many interventions had limited success because they were poorly designed and their objectives conflicted. For example, the wage and price freeze, which ended in 1984, reduced inflationary expectations and increased the profitability of businesses by reducing real wages but was not supported by appropriate monetary, fiscal and exchange rate policies. Government expenditure did not fall in line with tax cuts made at its introduction and this caused the nominal money supply to grow throughout the freeze and the budget deficit to rise to 9-percent of gross domestic product (GDP).

Many policymakers came to believe that a new style of economic management was required. These people gained the ascendancy in government after the foreign exchange crisis of July 1984 and introduced a series of far reaching macroeconomic and financial reforms that continued until 1 July 1994 when the Fiscal Responsibility Act came into force. Dalziel and Lattimore (1999) describe this programme, which included the deregulation of financial markets, floating of the New Zealand dollar, privatisation, corporatisation of government trading departments, removal of producer subsidies, and deregulation of the labour market under the Employment Contracts Act (ECA). These were radical changes and it often took many years before their benefits became apparent. For example, economic growth, which reached 7-percent in 1984, remained below 2-percent for almost the entire period from December 1985 to June 1993, while unemployment rose to nearly 10-percent over the same interval (ibid., pp. 96-97).

The reform of monetary policy was critical to the success of this programme and was given a legislative basis by The Reserve Bank of New Zealand Act 1989 (RBNZA-89). The RBNZA-89 put inflation-targeting theory into practice by making price stability the sole objective of monetary policy and giving the Reserve Bank of New Zealand (RBNZ) autonomy in choosing the best means of achieving and maintaining it. In a broader context, the RBNZA-89 was part of a move by many western governments away from demand management policies and towards a more hands-off style of economic management. The influence of the natural-rate hypothesis advanced by Friedman (1968) and Phelps (1968) can be seen behind this process and hence behind the RBNZA-89. Friedman and Phelps argued that nominal variables, such as the money supply, have no permanent effect on real variables and so there is no long-run trade-off between unemployment and inflation. This implies that every economy has its own long-run equilibrium, which is largely insensitive to monetary policy induced shifts in aggregate demand.

The RBNZA-89 required monetary policy to be conducted transparently in order to increase credibility and reduce risk premiums. In line with this, the RBNZ used a Monetary Conditions Index (MCI) as an operational guide from 30 June 1997 until 16 March 1999 in an effort to improve the communication of its monetary policy stance to financial markets. The RBNZ thus became one of only four central banks to publish an MCI. The Bank of Canada (BC) used its MCI as an operational target in a similar manner to the RBNZ, whereas the central banks of Norway and Sweden used their MCIs only as indicators of monetary conditions when formulating policy.

The New Zealand MCI is calculated as the weighted sum of the 90-day bank bill rate (NZ90) and the Trade Weighted Index (TWI), and so can be used as a rough measure of the overall ease or tightness of monetary conditions. The MCI regime had many critics who claimed that it not only failed in its objectives but may also have exacerbated the very problems it was meant to solve (Bennett, 1999; Edlin, 1997; Grimmond, 1998).

This thesis used four methodologies to investigate the impact of the MCI regime on the effectiveness of monetary policy. The first was a survey, which was given to the chief economists of six New Zealand banks in order to find out how the MCI regime affected their perceptions of the RBNZ's monetary policy stance. The second methodology consisted of a series of rolling 10-week regressions. It was used to determine if an inverse relationship existed between changes in the NZ90 and the value of the New Zealand dollar in American cents (FX) on a regular basis or was confined to periods associated with readily identifiable portfolio shocks. A systematic negative relationship would suggest that the MCI hindered policy implementation[1]. An identical study was conducted with Australian data in order to provide a comparative analysis. The third methodology was the autoregressive-distributed lag (ARDL) technique. It was used to obtain information about how the MCI and its two components were affected by RBNZ policy actions and external influences as represented by the United States 90-day bank bill rate (US90). Finally, block Granger causality tests, impulse-response (IR) functions and forecast error variance (FEV) decompositions were obtained from a vector autoregression (VAR) framework. They yielded additional information about how the RBNZ's policy instruments influenced the NZ90 and FX.

Results obtained from these methodologies suggest that the MCI regime failed to improve the implementation of monetary policy and caused a systematic inverse relationship to develop between short-term interest rates and the exchange rate. This deepened the recession in 1998 by raising interest rates when the exchange rate depreciated after mid-1997. The study also finds that the MCI regime did not significantly change the way the RBNZ's policy instruments affected the MCI or its components. The RBNZ was unable to set the desired value of the MCI on a daily basis and its policy instruments had no significant long-term influence on interest rates or the exchange rate, in fact they appear to have been more useful in smoothing out daily fluctuations in money markets.

The balance of this thesis is organised as follows. Chapter two reviews the theoretical basis and empirical development of the MCI, and summarises its use by central banks and financial institutions around the world. Chapter three describes the recent history of monetary policy in New Zealand with special emphasis on the MCI regime. Chapter four describes the methodologies and data used in this study. Chapter five presents the empirical results and chapter six summarises the main conclusions of this thesis. Five appendices and a list of references follow. Appendices 1 and 2 contain those sections of The Reserve Bank of New Zealand Act 1964 (RBNZA-64) and the RBNZA-89 that relate to the conduct of monetary policy. Appendix 3 contains a copy of the survey used in this study. Appendix 4 describes the operation of monetary policy in Australia and Appendix 5 describes the dummy variables used in the ARDL analysis.

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[1] This inverse relationship is explained in greater detail in section 4.2.

2 MONETARY POLICY AND THE MONETARY CONDITIONS INDEX

2.0 Introduction

This chapter reviews the theoretical and empirical background of the MCI. Section 2.1 looks at the literature on the rules versus discretion debate. The problem of dynamic inconsistency is described and the main approaches to dealing with it are outlined. Section 2.2 describes the monetary policy framework within which the discussion of the MCI occurs. It is based on a series of instruments, targets and indicators. Section 2.3 examines the effect of uncertainty on the transmission of monetary policy. The need to reduce uncertainty was a principal motivation for developing the MCI concept. Section 2.4 defines the MCI and explains its construction. Section 2.5 considers the choice of weights and variables used to calculate an MCI and the econometric assumptions of the underlying empirical model. As will be seen, the usefulness of a calculated MCI is questionable if these issues are not properly resolved. There are two important situations where an MCI might have practical uses and these are described in section 2.6. Section 2.7 looks at caveats on the use of MCIs as operational targets. Section 2.8 looks briefly at the Norwegian and Swedish MCIs before focussing on the Canadian experience. It also looks at efforts to compute an MCI ratio for the Euro group countries. Section 2.9 ends the chapter with some concluding comments.

2.1 The Rules versus Discretion Debate

The 'rules versus discretion' debate is related to the issue of central bank credibility. Monetary policy may be conducted either on the basis of rules or according to the discretion of the policymaker. Policy is rules-based if the policymaker applies a rule in each period (or in each case) that is designed to apply to all periods (or cases). Policy is discretionary if decisions are made on a period-by-period (or case-by-case) basis without reference to a general rule or formula. No country has a purely rules-based policy although New Zealand is the closest to that extreme (Bernanke and Mishkin, 1997, p. 106).

2.1.1 Dynamic inconsistency

High inflation in the developed countries during the 1970s prompted research into the possibility that the dynamic inconsistency of low inflation monetary policy might create an inflationary bias. Under this scenario, inflation can occur after a monetary authority makes a public commitment to a low inflation policy if the rational[2] public interprets such commitments in a particular way.

Kydland and Prescott (1977) were the first to analyze this issue. Their model showed how a time inconsistency problem might cause discretionary policy to increase inflation without a compensating increase in output. The rational public knows that policymakers have an incentive to let inflation rise above its optimal low level once public expectations have been formed. Short-run output and employment considerations become more compelling the tighter policy gets, especially as the benefits of low inflation occur in the long-term. Moreover, the marginal cost of additional inflation is likely to be low if expected inflation is low. This makes monetary policy easier to implement the looser it is and gives policymakers unbalanced incentives that make them susceptible to an inflation bias. If the public knows that an inflation bias exists, their pricing decisions will reflect the rate of inflation it is believed policymakers will tolerate, rather than an announced inflation target. This increases the negative short-run output effect of policies trying to deliver long-term price stability. Kydland and Prescott (ibid.) argued that a central bank would have high policy credibility if it were required to keep the money supply growing at a low, constant rate because deviations are easily detected.

Barro and Gordon (1983a) suggested that policymakers could overcome dynamic inconsistency by using fixed rules that are known and understood by the public. They showed that systematic forecast errors of inflation are eliminated when rational expectations are based on current information and a universally known decision rule. They concluded that a rules based system has two advantages over discretionary policy. First, precisely defined rules deter policymakers from carrying out undesirable actions by making it easier to monitor their behaviour. Second, policy rules increase certainty by reducing the possibility of policy changes. Market participants can then enter into

[2] In the context of the Rational Expectations Hypothesis.

long-term contracts knowing that the likelihood of incurring a significant monetary loss has been minimized.

Fischer (1990) took an opposing view. He argued in favour of discretionary behaviour because it permitted flexibility in accommodating exogenous shocks and stabilizing output. He also pointed out that the rules-versus-discretion debate is largely irrelevant because monetary policy lies on a continuum marked by different degrees of discretion. Any particular rule will produce an undesirable economic outcome if it is applied inappropriately and so attention should focus on evaluating alternative monetary policies.

Some theorists have investigated the possibility of using a policy rule without having to rely on supporting legislation. Reputation and delegation are the two main approaches considered[3].

2.1.2 Reputation

Barro and Gordon (1983b) largely instigated the development of reputation models. They argued that a monetary authority should use contractionary policies to achieve price stability and establish a credible reputation that would allay market uncertainty in future periods when inflation is high. A central bank can increase output by creating unexpected money shocks that temporarily raise inflation. However, agents soon become familiar with the bank's policy rule and so do not systematically under-predict inflation. Policymakers should therefore follow predetermined rules to maintain their reputations even if there is no legislation requiring them to do so. Barro (1986) extended this analysis by assuming that the public eventually learns the policymaker's preferences. Thus uncertainty surrounding the policymakers' ability to commit to their objective is the important issue.

Backus and Driffill (1985) examined the effect of uncertainty about the central bank's preference between inflation and output. Their model took the form of a game between the public and a government that can either behave conservatively by targeting zero

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[3] There are two other possibilities. Barro and Gordon (1983b) and Rogoff (1987) discuss punishment equilibria. Persson and Tabellini (1993) and Walsh (1995a) discuss incentive contracts.

inflation or inflate the economy to promote growth. The public is initially unaware of the government's approach and so even a weak government can establish a reputation for itself by not inflating to begin with. Both players select the optimal course of action given their opponent's selected course, and while considering the effect of such actions on future reputation. Credibility is determined by the public and is represented in the model by the probability of the government being serious about its commitment to fighting inflation. The model indicated that policy credibility is best established when three conditions are met. They are the appointment of a conservative central banker known to be strongly averse to inflation, the central bank being free from government intervention when implementing monetary policy, and a legislative policy rule that pre-commits the central bank.

A monetary authority may adopt 'noisy' policy-making procedures to make the private sector uncertain about its preferences (Canzoneri, 1985). This enables policymakers to slow down the public's learning process of the central banker's preferences. They can then create surprise inflation when output gains are high and surprise deflation when they are low. However, Cukierman and Meltzer (1986) point out that the central bank ultimately suffers from such a policy because of the increase in inflation variance. Noisy monetary policy may also generate higher inflation and so would probably only benefit central banks faced with continually high levels of inflation (Canzoneri, 1985).

2.1.3 Delegation

Delegation involves transferring the control of monetary policy to people known to be inflation averse. Rogoff (1985) suggested that the appointment of a conservative central banker would reduce any inflationary bias. However, there must be an optimal level of conservatism because central bankers may not offset supply shocks appropriately when inflation and employment both comprise the social objective function.

Eijffinger and Hoeberichts (1996) suggested a trade-off against central bank independence when determining the optimal degree of conservatism. For example, if monetary policy is largely at the discretion of the government, the central bank should compensate by employing highly conservative central bankers. A more dependent central bank would be less committed to stabilizing inflation and so the desired level of conservatism increases as society's preference for stabilizing employment increases (ibid.). This makes intuitive sense for three reasons. First, inflation becomes increasingly biased upwards as agents focus on employment. The central bank must then strengthen its commitment to maintaining price stability in order to protect its credibility. Second, the optimal level of conservatism falls if there is a high variance of productivity shocks because the central banker has to be more flexible in achieving lower inflation. Third, the tendency for agents to generate inflation means that the desired level of conservatism has to be high when the output gains from allowing inflation are high.

Walsh (1995a) disagreed with these conclusions. He suggested that the growing popularity of "inflation contracts" made it less important to appoint a conservative central banker. Governments can sign contracts with central banks that specify inflation targets and give the central banker incentives to achieve the desired target and disincentives to cheat. The credibility-flexibility trade-off does not exist in such cases.

2.1.4 Central bank independence

Central bank independence (CBI) can be used to measure the extent by which policymaking is delegated to conservative policymakers. Investigations by Alesina (1988); Grilli *et al.* (1991) and Cukierman *et al.* (1992) show a strong negative correlation between CBI and inflation. At the same time, Alesina and Summers (1993) and Cukierman *et al.* (1993) have shown that there is no correlation between CBI and real variables such as average GDP growth. Such findings have encouraged central bank reforms around the world.

McCallum (1997) challenged these conclusions on two grounds. First, discretionary policy does not always generate high inflation. A central bank is likely to stop trying to exploit temporary expectations if it understands that to do so would see its objectives more fully achieved on average. Thus there is no necessary trade-off between flexibility and commitment as implied in the literature. Second, the contracting approach only relocates the motivation for dynamic inconsistency; it does not overcome it because the Government also has an incentive not to enforce the contract.

Hutchison and Walsh (1998) pointed out that much of the empirical literature is based on cross-sectional studies and little research has been done on the effects of institutional changes within countries. This is a serious deficiency because CBI may not be responsible for reduced inflation if it is endogenous (Posen, 1995). Hutchison and Walsh (ibid.) looked at the effects of the RBNZA-89 on the economy and concluded that it had increased the short-run output-inflation tradeoff. The Phillips Curve had become flatter and so less inflation was associated with a given expansion than before.

Razzak (1995) looked at the shape of the New Zealand Phillips curve by applying a simultaneous equation model to quarterly data from 1983Q2 to 1994Q4. His results revealed that a nonlinear, asymmetric relationship existed between inflation and the output gap. This implied that:

> ... a monetary authority with the objective of maintaining the inflation rate within a narrow band may need to act in an asymmetric fashion. In particular ... if policy does not respond to demand disturbances in an asymmetric manner, average inflation will tend to be above the centre of the target range, and output lower than would otherwise be possible.
>
> (Razzak, 1995, p. 1).

A second study by Razzak (1997) also found an asymmetry in the inflation-unemployment relationship. His investigation used the Generalized Method of Moments technique to apply a single equation expectation augmented Phillips curve to quarterly data from 1982Q3 to 1996Q1. Razzak used his estimate of the Phillips curve to construct a simulation model for a small-open economy where expectations are formed rationally, the central bank keeps inflation within a tight band, and the public has perfect information on the monetary rule employed by the central bank. He simulated a demand shock hitting the economy and considered the effects on output and inflation when the central bank reacted immediately to the demand shock and again when its reaction had a two period lag. Razzak concluded that:

> Delays in monetary policy responses to positive demand shocks lead to an increase in the inflation rate, and larger losses in bringing inflation down. This is attributable to the asymmetry of the Phillips curve, and the persistence of inflation, and occurs despite the fact that expectations are rational. A monetary authority with the objective of maintaining the inflation rate within a narrow band needs to react more promptly to positive demand than negative demand shocks. An alternative implication is that if policy does not respond to demand

> disturbances promptly, inflation and output variations can be higher than they would be in an economy with a linear Phillips curve.
>
> (Razzak, 1997, p.12).

These findings support arguments favouring greater CBI to the extent that it increases the responsiveness of monetary policy to demand shocks.

2.1.5 Inflation targeting

The reduction of inflationary expectations is the key to lowering inflation permanently (Bank for International Settlements, 1996; Brayton *et al.*, 1997). Since the mid-1980s, many countries have reformed central banks in ways designed to strengthen expectations of low inflation (Kirchner, 1997). These include changes to central bank charters, the adoption of price stability as the primary objective of monetary policy, and legislation to increase the independence and accountability of monetary authorities in pursuing that goal. At the same time, central banks have changed operating procedures to increase the transparency of policy and improve its communication to financial markets. The publication of regular inflation reports that explain the rationale of policy actions is one example of these changes. Amano et al. (1996) and the Bank for International Settlements (1996) found that such developments improved credibility, reduced market uncertainty and increased the predictability of market reactions to policy. In particular, they reduced political pressure to adopt inflationary policies that only achieve temporary gains in output.

"Inflation targeting" is a relatively new strategy whereby the government or central bank specifies the inflation target as a range. It is characterised by:

> ...the announcement of official target ranges for the inflation rate at one or more horizons, and by explicit acknowledgement that low and stable inflation is the overriding goal of monetary policy...increased communication with the public about the plans and objectives of the monetary policymakers, and...increased accountability of the central bank for attaining those objectives.
>
> (Bernanke and Mishkin, 1997, p. 97).

Different countries have used this approach to focus monetary policy on achieving price stability and improving policy credibility (Table 2.1). Inflation targeting has been an integral part of the central bank reforms implemented in New Zealand although it does not need to be coupled with greater CBI (Kirchner, 1997, p. 6).

Table 2.1 Inflation Targeting in Different Countries

Country (date of adoption)	*Target Series Definition*	*Target Level (percentage annual inflation)*	*Time Horizon*
Australia (1993)	Underlying CPI (excluding fruit and vegetables, petrol, interest costs, public sector prices and other volatile prices)	2–3	Ongoing
Canada (February 1991)	Core CPI (excluding food, energy and first-round effects of indirect taxes)	1–3	18 months
Finland (February 1993)	Underlying CPI (excluding government subsidies, indirect taxes, housing prices and mortgage interest payments)	about 2	Ongoing
Israel (December 1991)	CPI	8–11	1 year
New Zealand (March 1990)	Underlying CPI (excluding changes in indirect taxes or government changes, significant changes in import or export prices, interest costs and natural disasters)	0–2 (until November 1996; 0–3 thereafter)	1 year
Spain (January 1995)	CPI (excluding first-round effects of indirect tax changes)	below 3	Through 1997
Sweden (January 1993)	CPI	2 ± 1	Ongoing
United Kingdom (October 1992)	RPIX (RPI excluding mortgage interest payments)	lower half of 1–4 until spring 1997; 2.5 or less thereafter	Until the end of this Parliament

Source: Bernanke & Mishkin, 1997, p. 99.

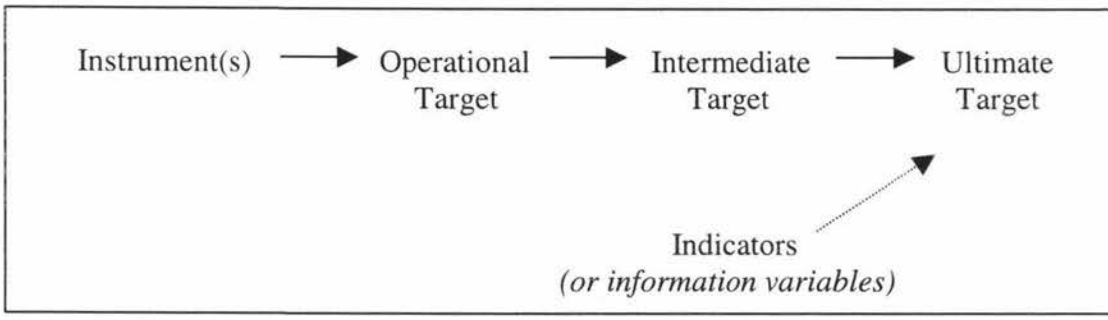
2.2 Monetary Targets and Instruments

When formulating and implementing monetary policy, policymakers focus on a series of variables, ranging from the policy instrument, at one end, to the ultimate target of policy at the other. Figure 2.1 represents an approach to monetary policy described by Freedman (1994) that shows how these variables fit together.

2.2.1 Instruments

Central banks implement monetary policy through instruments (Freedman, 1994). These vary between countries and depend on their institutional structures, political

Figure 2.1 Elements of Monetary Policy



Freedman, 1994, p. 67.

systems and stages of development. Most developed capitalist countries have traditionally used the bank rate, reserve ratios and open market operations (OMOs) to control the creation of deposits and set an upper limit to the money supply. Other instruments have targeted particular forms of credit rather than the money supply. Examples include the imposition of ceilings on mortgage credit and 'moral suasion' to persuade institutions to restrict their loans in general or certain types in particular. The relationship between instruments and the ultimate goal of monetary policy can be very indirect (Freedman, 1994). Also, long lags usually exist between them because many markets adjust slowly in response to new information. In this respect, New Zealand is no different to most developed countries, despite extensive deregulation and the promotion of competition in the goods and labour markets since 1984 (Beaumont and Reddell, 1992). Most central banks therefore focus on operational targets, intermediate targets and indicators when determining the appropriate monetary policy stance.

2.2.2 Operational targets

Many countries use an official short-term interest rate as a guide to monetary policy stance. For example, the Reserve Bank of Australia (RBA) uses an official cash rate (OCR) (Reserve Bank of Australia, 1999) while the United States Federal Reserve uses a federal funds rate (Board of Governors of the Federal Reserve System, 1994). Freedman (1994) argued that the MCI is more appropriate for small countries with a floating exchange rate because of the importance of the exchange rate channel. Support for this view came from the Bank for International Settlements (1989, 1996) which found that the development and globalization of financial markets had made the exchange rate a key element of the transmission mechanism in small and open economies. This had made prices react quicker to changes in monetary policy and had enhanced the role of expectations. De Kock and Deleire (1994) and Mauskopf (1990) observed a similar although weaker trend for larger economies, notably the United States. Also, the Organization for Economic Cooperation and Development (OECD) (1998) found that the link between monetary policy and exchange rates was important for efforts to lower inflation in many countries after the early 1980s.

2.2.3 Intermediate targets

An intermediate target must satisfy three requirements (Rowhani, 1994, p. 11). These are observability (it should be observable with a short lag); controllability (it should be controllable by the instrument variable); and predictability (it should have a predictable relationship with the ultimate objective, both in magnitude and timing). Intermediate targets enable central banks to adjust instrument settings quicker and more accurately in response to shocks than would be the case if the focus were solely on current values of the ultimate target. They differ from operational targets in that they are not affected as quickly by changes in instruments. For example, changes in the quantity of settlement cash affect short-term interest rates almost immediately whereas the effect on monetary aggregates may take weeks or months. Thus intermediate targets are typically nominal variables.

2.2.4 Ultimate targets

Multiple objectives have been a feature of monetary policy in most developed countries. For example, central banks in the United States (Jones, 1986, p. 23) and Australia (Holmes, 1994, p. 9) have used monetary policy to simultaneously promote any number of conflicting objectives, such as full employment, price stabilisation, economic growth and a stable exchange rate. However, the existence of multiple objectives tends to raise inflation expectations. This happens in three ways. First, market participants build risk premiums into prices in case the priority of objectives changes. Second, accountability is reduced because failure to achieve one objective can be explained by reference to others. Third, multiple objectives undermine CBI by requiring the Government to control the Bank in order to coordinate with other agencies pursuing similar macroeconomic objectives, either in full or in part. The Australian experience illustrates the consequences of having multiple objectives (Rowhani, 1994). The Bank of Australia adopted several different monetary policy approaches from 1983 until 1994 with the result that short-term exchange rate and growth objectives appeared to become more important than medium-term objectives such as reducing inflation. Hence there was no sustained reduction in inflation during much of that period.

Long-term price stability was raised to a paramount position among the macroeconomic objectives of central banks during the 1980s as policymakers came to realise that monetary policy had a dominant influence on the price level (Lindsey and Wallich, 1989).

2.2.5 Indicators

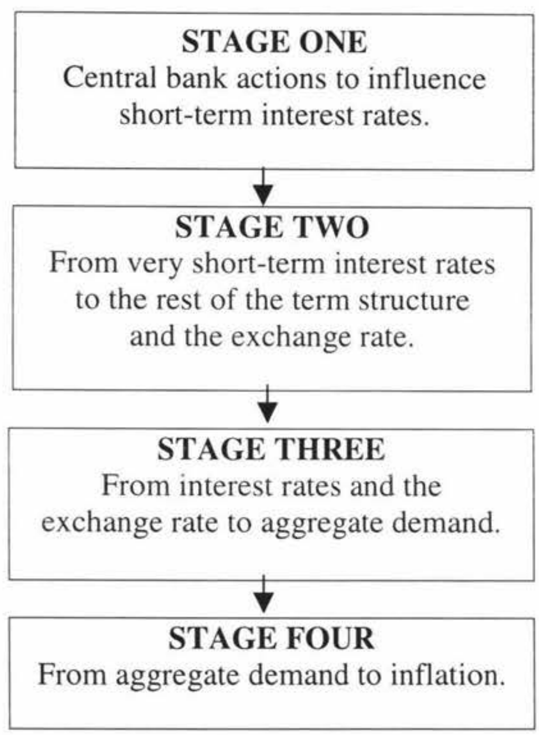
Indicators are variables from relevant markets that provide leading or contemporaneous information about potential movements in the ultimate target. The RBNZ uses several indicators because none by itself adequately summarizes monetary stance, and because each is influenced by factors aside from monetary policy (Beaumont and Reddell, 1992). The main indicators monitored by the RBNZ are the exchange rate, the yield curve, the level of interest rates relative to expected inflation, and the money and credit aggregate growth rates. Changes in these indicators are analyzed in conjunction with each other, and other relevant information including developments in the real sector and asset markets.

2.3 The Impact of Uncertainty on Monetary Policy

A central bank can influence real short-term interest rates to promote desired changes in real variables such as output, or nominal variables such as the price level. The effects of monetary policy changes are transmitted to the economy through interest rates, the exchange rate, inflation expectations, and wealth and credit rationing effects (Pierce and Tysome, 1985; Lloyd, 1991). However, uncertainty undermines the effectiveness of these channels if unexpected demand or exchange rate shocks hit the economy or if the market is unsure about the long-run objectives of economic policy (Thiessen, 1995, p. 43). These two types of uncertainty may interact. For example, markets might be unsure if the central bank's reaction to a demand shock constitutes a change in its long-run objectives. Alternately, the Bank might be unsure how financial markets would react to its statements and actions.

The model of the transmission mechanism described by Thiessen (1995, pp. 44-49) and illustrated in Figure 2.2 is a useful starting point for discussing the influence of uncertainty on the transmission channels of monetary policy.

Figure 2.2 The Monetary Policy Transmission Mechanism



Source: Thiessen, 1995, pp. 44-49.

2.3.1 Stage one

Adjustments to the supply of settlement cash aimed at influencing short-term interest rates comprise the first stage of the transmission mechanism. The monetary authorities cannot accurately predict the desired settlement balances of trading banks and other financial institutions and so there may be a lag of one or two days before the desired effect on very short-term rates is observed (ibid., 1995, p. 45).

2.3.2 *Stage two*

Financial markets typically regard changes in real short-term interest rates as an indication of the stance of monetary policy against future inflation. Hence market expectations about monetary policy help determine the impact of changes in the one-day rate on the term structure of interest rates and the exchange rate (Romer, 1996, pp. 395-398; Beaumont and Reddell, 1992, pp. 56-57). This might explain why empirical relations may account for only a fraction of the variation in long-term interest rates and why monetary policy factors are not the only explanatory variables (Akhtar, 1995). This view is consistent with recent studies indicating that the reaction of long-term interest rates to short-term rates depends upon past success in controlling inflation. Christiansen and Pigott (1997) found that any rise in long-term rates caused by increases in short-term rates tended to be smaller for countries with more favourable inflation records. The response declined for countries such as Italy and France as their inflation performances improved. Buttiglione *et al.* (1997) also found that increases in short-term rates lowered longer-term forward rates in countries with good inflation records and raised them for those with unfavourable records.

Interest rate changes also affect exchange rates because international investors looking for high returns are attracted to economies with relatively high interest rates. Higher capital flows appreciate the currency. However, exchange rates are also influenced by factors over which monetary policy has little control. These include the current account balance, external debt, shifts in productivity and political uncertainty. Frankel and Rose (1994) found it hard to identify stable relations to account for exchange rate movements. Also, Gruen (1996) found that real effective exchange rates have remained variable despite the achievement of low inflation and its convergence across countries.

2.3.3 *Stage three*

Changes in interest rates and the exchange rate typically have a significant impact on aggregate demand (Beaumont and Reddell, 1992). Consider the consequences of a reduction in the money supply. The reduced supply of bank loans means that households and businesses can no longer borrow as much as they desire. The accompanying rise in real short-term interest rates increases the opportunity cost of holding cash and so induces people to increase savings. It also reduces wealth by depressing asset values and increasing debt-servicing costs. Higher rates also appreciate the currency, changing the relative price of exports and imports in a way that causes foreign goods to be substituted for domestic goods. However, the timing of changes in consumption and investment are unpredictable because economic units change their spending patterns according to their expectations of the future, and expectations are hard to deduce (Thiessen, 1995, p. 49). For example, policy induced increases in interest rates could be interpreted as either RBNZ anxiety about potential increases in future inflation or as a precaution to reduce the potential for future inflation.

Expected inflation and its associated risks fall over time as the credibility of the central bank increases. Gagnon (1997) maintains that monetary policy must be credible if the full benefits of a low inflation environment are to be realized. Only then will participants in product and labour markets be sure that any period of low inflation is permanent and change their pricing strategies and contract durations accordingly.

2.3.4 Stage four

Uncertainty about the nature, size and duration of economic shocks makes it hard to predict changes in aggregate demand and their effect on the rate of inflation. Different expectations have different effects on the expected future general level of prices and long-term interest rates. The RBNZ has tried to minimise this problem by basing its views of the world economy on a consensus of market forecasters (Reserve Bank of New Zealand, 1998b, p. 5). Overseas forecasters are better informed about their respective economies and the average of a group of well-informed forecasters is likely to be more reliable than a single forecast. Nevertheless, such an average can be inaccurate as is indicated by the extent to which forecasters had to revise their estimates of Asian (GDP) growth following the onset of the Asian financial crisis in 1997 (ibid.).

2.4 Development of the MCI

2.4.1 Motivation

Many central banks reacted to the high inflation of the 1970s by adopting money and credit aggregates as intermediate targets (Shigehara, 1997; Friedman, 1992). These aggregates were less stable after the 1970s and almost all central banks abandoned their use as intermediate targets[4]. The focus of monetary policy then shifted to more final targets such as macroeconomic stability and growth (Leiderman and Svensson, 1995).

The evolution of monetary policy in Canada mirrored these developments. In 1975, the BC adopted a narrow aggregate called M1 as an operational target (OECD, 1976), but it failed to help control inflation during the late 1970s. This was partly because aggregate demand and inflation were not sensitive enough to changes in M1 and partly because extensive financial innovation made it difficult to interpret (OECD, 1983). Other aggregates were considered but their reliability was also questionable and so, in 1982, the BC replaced M1 with a short-term interest rate and began concentrating on ultimate goals. This changing focus increased interest in quantifying the effect of policy instruments on output and inflation, and in using such estimates to guide monetary policy. This, it was hoped, would reduce uncertainty and establish the credibility of the BC's inflation target by improving the link between monetary policy actions and inflation expectations (Zelmer, 1995). In line with this, the BC developed the MCI concept to measure the effects of real interest rates and the real exchange rate on economic activity and prices.

2.4.2 Construction of an MCI

Any variable influenced by monetary policy that reflects a different channel through to inflation can potentially be included in an MCI. Possible candidates include the yield gap, stock market indices and bank lending growth. However, many channels represented by these variables are either inadequately understood or are relatively minor (Freedman, 1994). Duguay (1994) showed that monetary policy is mainly transmitted through changes in short-term interest rates and the exchange rate and that strong linkages could be estimated from them to total spending and inflation. These links are important because central bank actions have a more direct influence on short-term interest rates and the exchange rate than on monetary and credit aggregates. Duguay

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[4] The German Bundesbank was the last major central bank to use monetary aggregates as intermediate targets (Rowhani, 1994, pp. 21-46). This policy inspired the European Central Bank (ECB) Governing Council to give the money stock a position of central importance in its present price stability strategy (Deutsche Bundesbank, 2000).

estimated that a percentage point increase in Canadian short-term rates had the same effect on spending over time as a 3-percent appreciation of the currency.

MCIs are typically developed as a linear combination of the weighted sum of changes in a summary measure of the exchange rate (e) and a benchmark interest rate (R) from their base year values ($t = 0$) (Reserve Bank of New Zealand, 1996, p. 225). The level of the MCI therefore has little meaning but the difference in its value between two points of time gives a measure of the degree of tightening or easing of monetary conditions. The RBNZ constructs both nominal and real indices using an arbitrary fixed base of 1000 for the December 1996 quarter (Reserve Bank of New Zealand, 1997b, pp. 25-27). Their formulae are:

$$\text{(2.1)} \quad \text{Nominal MCI} = \{(\text{90-day rate} - 8.9) + 0.5*[(\log_n \text{TWI}) - \log_n(67.1)]*100\}*100 + 1000$$

$$\text{(2.2)} \quad \text{Real MCI} = \{(\text{real 90-day rate} - 6.5) + 0.5*[\log_n(\text{real TWI}) - \log_n(1)]*100\}*100 + 1000$$

The first part of each equation is the difference in the NZ90; the second part is the percentage change in the TWI. The numbers 8.9 and 67.1 in equation 2.1 are average rates for the NZ90 and TWI, respectively, in the 1996 December quarter. In equation 2.2, the value of 6.5 for the NZ90 is calculated using the nominal rate minus that quarter's inflation rate as measured by the CPI of 2.4. The real base level of the TWI is normalised to one for the December 1996 quarter.

The impact of exchange rate movements on the economy increases as the proportion of economic activity accounted for by the foreign sector increases. Hence the MCI ratio tends to be smaller for large closed economies and larger for small open economies. The range of estimated weights for each country in Table 2.2 arises from the use of different models and different sample periods. A consensus in estimated weights across models is nothing more than that and may arise simply because the different models of a given economy used the same data. The weight of 2 given to New Zealand in Table 2.2 corresponds with the value of 0.5 for the TWI coefficient in equations (2.1) and (2.2). This reflects the estimated 2:1 relative impact of interest rates and the exchange rate on economic activity in New Zealand (Dennis, 1997a). It 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.

Table 2.2 Selected Alternative Relative Weights for MCIs*

Country	Source							
	Central Banks	IMF	OECD	Deutsche Bank	Goldman Sachs	JP Morgan	Merrill Lynch	Dornbusch et al.
Australia			2.3			4.3	4	
Austria				3.3				
Belgium						0.4		
Canada	2, 3	4, 3	2.3		4.3	2.7	3	
Denmark						1.9		
EMU								2.17
Finland						2.5		
France		3	4.0	3.4	2.1	3.5		2.10
Germany		2.5, 4	4.0	2.6	4.2	2.3	4	1.39
Italy		3	4.0	6.6	6.0	4.1		2.89
Japan		10	4.0		8.8	7.9	10	
Netherlands				3.7		0.8		
New Zealand	2							
Norway	3					1.4		
Spain			1.5	2.5		4.2		1.46
Sweden	3-4		1.5	0.5		2.1		8.13
Switzerland				6.4		1.7		
United Kingdom		3	4.0	14.4	5.0	2.9	3	
United States		10	9.0		39.0	10.1	10	

* Weights are those on interest rates relative to those on exchange rates.

Source: Ericsson, N.R. *et al.*, 1999, p. 36.

Real MCIs can only be calculated when inflation data is available to compute the real exchange rate whereas the nominal MCI can be calculated at any frequency. They are approximately equal in the short-term because inflation expectations and inflation differentials between economies change slowly. In the long-run, the difference between foreign and domestic inflation introduces a trend in the nominal exchange rate that causes them to diverge. The real MCI is therefore more appropriate for long-term issues whereas practicalities demand that the nominal MCI be applied to the analysis of short-term matters (Reserve Bank of New Zealand, 1997a, pp. 25-27).

2.5 Econometric Issues Underlying the MCI Concept

2.5.1 Assumptions of the underlying empirical model

The weights used in an MCI are not directly observable and must be derived from the estimated coefficients of an empirical economic model. Thus an MCI is only as good as the assumptions made in the construction of its underlying model. Eika *et al.* (1996) and Ericsson *et al.* (1999) identify and discuss six econometric issues that arise when developing and estimating an MCI.

Dynamics. Eika *et al.* (1996, pp. 770-771) claim that the time profile of aggregate demand may be influenced by interest and exchange rate changes that leave the MCI unaffected. This is because a series of different short-, medium- and long-term multipliers exist if lags in an economy's response to changes in the exchange rate and interest rates are different. This is consistent with simulation results obtained from macro-economic models showing that exchange rate changes affect real economic activity more rapidly than interest rate changes in open economies (Smets, 1995). Work by Stevens (1998, pp. 39-40) is also relevant. He used a model of the Australian economy developed by de Brouwer and O'Reagan (1997) to show how temporal properties affect the usefulness of an MCI. He concluded that a constant MCI might conceal important economic processes if it is used as a policy guide in one period when its weights have been derived from another.

Data Nonstationarity[5]. The use of non-stationary variables in a time-series regression may produce spurious results (Phillips, 1986). This arises because a variable's temporal properties affect the distribution of its error terms (Eika *et al.*, pp. 771-774). Charemza and Deadman (1997, pp. 92-96) illustrated this point by regressing a linear relationship on a quadratic trend. The resulting model had promising diagnostic test statistics and yet the regression analysis made no sense. Nonstationarity can be removed from a series by differencing.

Exogeneity. Exchange rates and interest rates are not exogenous if inflation feeds back on to them over the relevant time period. Endogeneity causes their weights to underestimate their impact on aggregate demand. It can be remedied if the feedback is

[5] Nonstationarity is described in greater detail in section 4.3.1

estimated and incorporated into the elasticities from which the MCI is derived (Eika *et al.*, pp. 774-776).

Omitted Variables. Short-term interest rates and exchange rates may not be the only important transmission channels through to aggregate demand. For example, Borio (1995) showed that lending at fixed long-term interest rates is more prevalent than adjustable-rate and short-term lending in most continental European countries. It may therefore be more appropriate to include a long- instead of a short-term interest rate in the MCIs of some countries. Other asset prices, such as stock prices, might also play an important role in the transmission mechanism through their wealth effects on aggregate demand (Smets, 1997). The omission of such variables can bias coefficient estimates of dynamic variables. Those biases are likely to change over time and induce parameter variance as data correlations change (Eika *et al.*, p. 777).

Parameter Constancy. Parameter invariance causes estimations of the weights to give different values over different sample periods and may be caused by any one or combination of the above four issues (ibid., pp. 776-777).

Estimation Uncertainty. An estimated weight may vary numerically even when statistically constant. This arises from coefficient uncertainty and is reflected in large standard errors (Ericsson *et al.,* 1999, pp. 41-44).

MCIs used by the central banks of Canada, Sweden and Norway were based on econometric models developed by Duguay (1994), Hansson (1993) and Jore (1994), respectively. Eika *et al.* (1996) analyzed the assumptions underlying these models using an analytical framework that related the exchange rate, e, an interest rate, R, and an exogenous variable, q, to real domestic output, y, and the price level, p. In equation form it is expressed as:

$$(2.3) \qquad y_t = \mu_1 + (\pi_{11} + 1)y_{t-1} + \pi_{12}p_{t-1} + \pi_{13}R_{t-1} + \pi_{14}e_{t-1} + \pi_{15}q_{t-1} + \varepsilon_{1t}$$

$$(2.4) \qquad p_t = \mu_1 + \pi_{21}y_{t-1} + (\pi_{22} + 1)p_{t-1} + \pi_{23}R_{t-1} + \pi_{24}e_{t-1} + \pi_{25}q_{t-1} + \varepsilon_{2t}$$

The variables y and p are in logarithms, π_{ij} is the coefficient on the jth variable of the ith equation, μ_1 and μ_2 are constants, and the two error terms, ε_1 and ε_2, are assumed to be serially uncorrelated.

Eika *et al.* (1996, pp. 778-785) found that all three models failed to satisfy the important econometric requirements discussed above and that the MCIs derived from them were unlikely to be useful operational policy tools. The Canadian model had "extensive albeit restrictive dynamics, possible cointegration was ignored, and exogeneity and parameter constancy were untested" (ibid., p. 779). The Swedish model contained a nonconstant parameter. Moreover, the residuals in an auxiliary regression for the model underlying the Swedish MCI were highly autocorrelated and heteroscedastic (ibid., pp. 780-781). The Norwegian model had unstable coefficients. None of the models had been tested for mis-specification, variables that might be co-integrated with y and p had been ignored, and exogeneity had only been assumed in each case.

Ericsson *et al.* (1999) quantified the uncertainty of estimating the MCI weights for models used by five central banks. Confidence intervals were calculated using a likelihood ratio statistic approach. They are presented in Table 2.3. The large estimation uncertainties associated with the relative weights indicate that, for each country, the usefulness of the calculated MCI as a guide to monetary policy is questionable. Deviations exceeding 100 basis points were possible for time horizons as short as one quarter. Moreover, the direction of movement of the MCIs was affected by the choice of statistically acceptable values of their relative weights.

2.5.2 Choice of weights and variables

A range of relative MCI weights can be calculated for any particular country, depending on the models and sample periods used (Table 2.2). The choice of weights affects the magnitude of changes in an MCI. Figure 2.3a plots three New Zealand MCIs based on interest rate to exchange rate ratios of 1:3, 1:2 and 1:1. They show the same overall trends and are identical when the exchange rate is constant, as in the second quarter of 1985. However, the three diverged significantly after the last quarter of 1990 when the value of the currency began to fluctuate significantly. For example, from 1990 until 1992 the three curves indicate a softening of policy stance as the economy went through a recessionary period. A sharp fall in the exchange rate provoked the RBNZ into lowering the settlement cash target from $20 million to zero in early 1993 in an attempt to dampen inflationary pressures. The resulting increase in interest rates caused the MCI curves to move closer together.

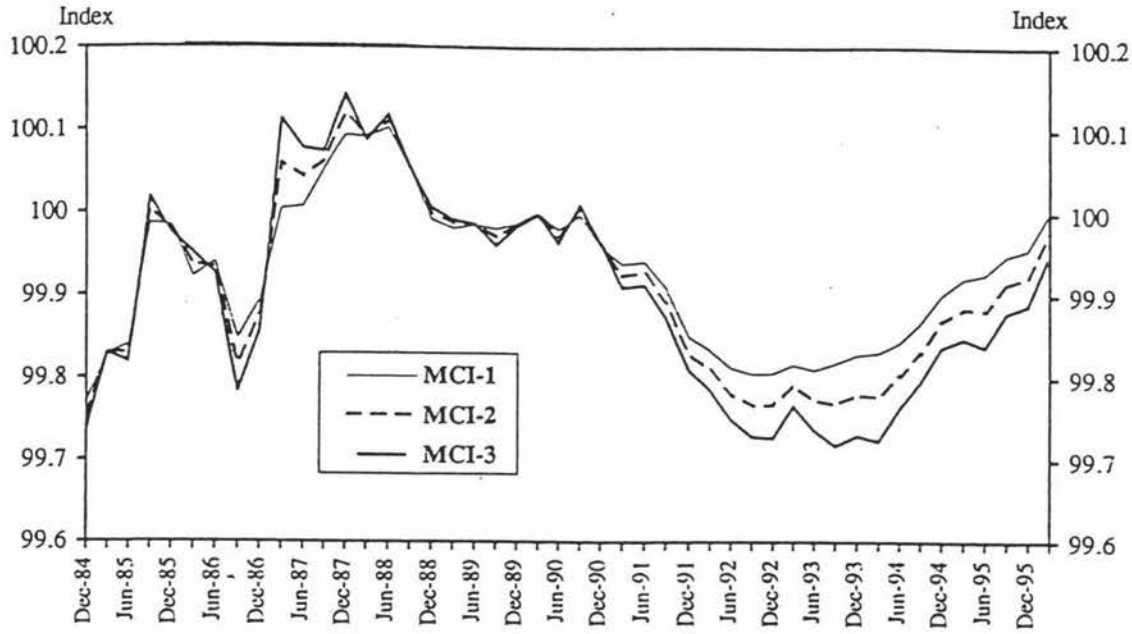
Table 2.3 MCI Relative Weights and Their Estimated Confidence Intervals

Calculation	Country				
	Canada	New Zealand	Norway	Sweden	United States
MCI Relative Weight					
Published	3	2	3	3 to 4	Not Given
Estimated	3.56	1.75	2.15	2.02	-3.69
Confidence Interval					
95% level	[0.74, ∞]	[0.30, 7.31]	[0.00, ∞]	[1.06, 2.96]	[-∞, ∞]
90% level	[1.06, ∞]	[0.52, 5.05]	[0.36, 26.6]	[1.27, 2.76]	[-∞, ∞]
67.5% level	[1.80, 9.60]	[0.97, 3.04]	[1.00, 4.98]	[1.61, 2.43]	[-8.45, 1.84]

Source: Ericsson, N.R. *et al.*, 1999, p. 43.

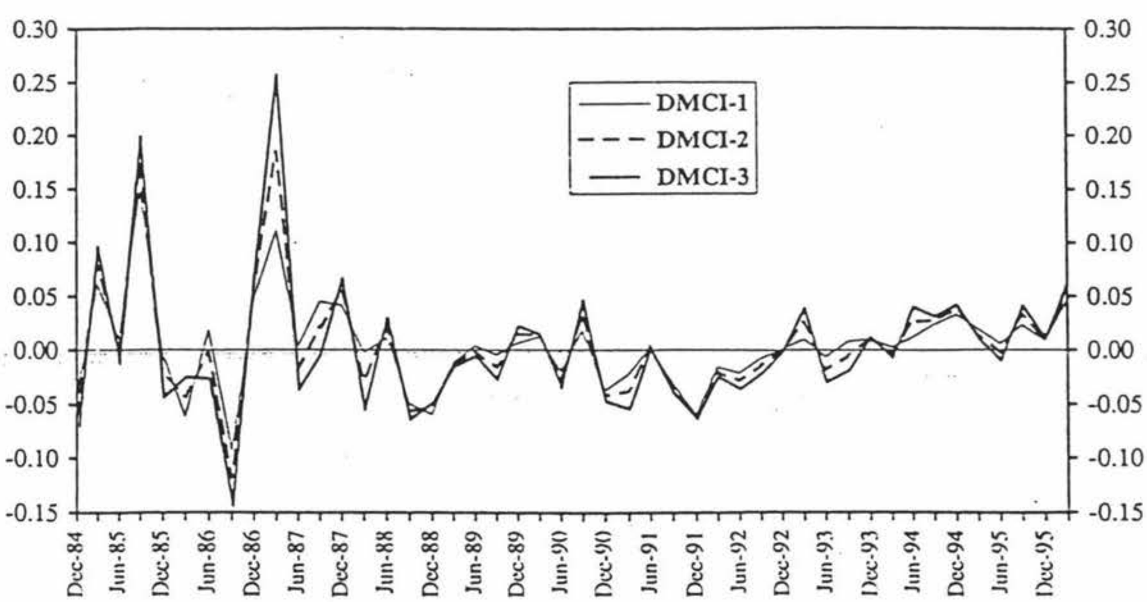
MCIs with different weights may contradict each other. Consider Figure 2.3b, which plots the first difference of the MCI curves shown in Figure 2.3a. Changes in the three MCIs have the same sign in most quarters, indicating that most shocks hitting the economy move interest rates and the exchange rate in the same direction. However, the signs sometimes differ. For example, in early 1991, the MCI with the smallest relative weight indicates a moderate tightening of monetary conditions while the other curves, which place relatively more weight on the interest rate, show either no change or a moderate loosening. It is important to know which MCI ratio is appropriate given that the MCI curves can give such contradictory information.

Figure 2.3a Actual Monetary Conditions (based to equal 100 in 1990q1)



Reserve Bank of New Zealand Bulletin, 1996, p. 227.

Figure 2.3b Quarterly Change in Actual Monetary Conditions (Real)



Reserve Bank of New Zealand Bulletin, 1996, p. 228.

2.6 Possible Uses of the MCI in Monetary Policy

Freedman (1994, p. 73) has been a leading advocate of the use of MCIs in the formulation and implementation of monetary policy. He describes two situations where an MCI could assist policymakers[6]. The first situation is caused by an expansionary demand shock. The RBNZ can judge how much the weighted sum of short-term interest rates and the exchange rate should change to keep inflation within the target but cannot judge in advance how that change should be distributed between them. That is determined in financial markets by such factors as the length of time higher interest rates are expected to last and the sensitivity of movements in the expected exchange rate to movements in the actual exchange rate. Exchange rate changes mainly affect traded goods whereas interest rate changes mainly influence the interest-rate-sector (i.e. investment in machinery and equipment, construction, and spending on durable consumer goods). If the central bank focussed only on interest rates, it might tighten excessively in the case where currency appreciation was responsible for most of the downward pressure on aggregate demand. By focussing on a combination of interest rate and exchange rate changes, the central bank can avoid the potential error of ignoring a key monetary policy channel when stimulating or restraining the economy.

The second situation involves a change in an MCI element (ibid., p. 74). Consider an exogenous shock that induces investors to shift out of assets denominated in the domestic currency. The resulting depreciation changes the actual MCI but not the desired MCI. If the central bank were previously satisfied with the setting of monetary conditions it would now be faced with an overly expansionary situation and hence should take action to return monetary conditions to their previous level. An MCI would indicate the size of the interest rate change required to offset the easing from the depreciation. The central bank might not react quickly enough to offset the expansionary effect of the depreciation if it did not have a construct such as the MCI to act as a guide.

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[6] Freedman's discussion summarises the case put forward by other proponents of the MCI concept. These include Crow (1993), Reserve Bank of New Zealand (1996), Hansson and Lindberg (1994), and Theissen (1995).

2.7 Operational Considerations in the Use of an MCI

Mayes and Virén (2000) concluded that MCIs are best used as operational guides for monetary policy in the period between full revisions of a central bank's forecasts (usually at three or six month intervals) when it is difficult to identify the reason for changes in monetary conditions. They also observed that MCIs do not take account of all factors affecting prices and so need to be used in combination with other information. Thus MCIs should not be used to compare time periods without an analysis of the whole range of external factors influencing inflation in each period.

Stevens (1998, pp. 41-42) warned that a central bank might adopt an overly tight (or loose) monetary policy in reaction to external shocks if it maintained a precise band around a target MCI. This is because no direct relationship exists between policy instruments and the exchange and interest rates. Frankel and Rose (1994) supported this view. They found that the influence of variables not directly influenced by monetary policy made it impossible to find stable empirical relationships that could explain exchange rate changes. These variables included the current account balance, external debt, productivity rates, political uncertainty, overseas interest rates and the terms of trade. A central bank must also remember that currency fluctuations affect prices with a lag, and that many are temporary and reversible (Stevens, 1998, p. 42). It should therefore consider carefully what each movement means before deciding whether to adjust interest rates in an offsetting direction. Action should be taken only after the market has established a new trading range for the exchange rate that appears likely to last.

The exchange rates of small open economies tend to be volatile on a day-to-day basis. Grimmond (1998) argued that this volatility would spread to the short end of the yield curve if the central bank were continually adjusting short-term interest rates to offset currency fluctuations. Traders in financial markets trying to anticipate trends in order to make money would try to anticipate the central bank's interpretation of and response to movements in the MCI as they observed its actual path evolve over time. There would inevitably be a shift toward other financial instruments where interest rates were more stable, even though they might be less suitable for the purposes of market operators. Increased uncertainty in financial markets would offset many of the gains hoped for by the introduction of the MCI. The Bank could only overcome this problem by keeping the market well informed of its thinking about how desired conditions were evolving. That might be unrealistic given the uncertainty inherent in incoming data.

Actual and desired monetary conditions sometimes move in the same direction. The central bank should only make adjustments if changes in one are unmatched by changes in the other. Consider, for example, a favourable change in the terms of trade that increases the demand for exports (Freedman, 1994, p. 77). The resulting currency appreciation raises the actual MCI and is associated with a rise in the desired MCI because inflationary pressures increase as the economy expands. A second example is when the market responds directly to news about the state of aggregate demand (Freedman, 1994, p. 78). Suppose new information indicates that the economy is expanding more rapidly than previously thought. The anticipated increase in interest rates puts upward pressure on the currency. However, faster growth also increases the desired MCI and so the central bank may not need to react to the tightening of the MCI.

Gerlach and Smets (2000) developed two models to examine some analytical and practical questions raised by MCIs. The first model was used to derive rules for using MCIs as operational targets for monetary policy. It contained three major relationships. The first defined the optimal inflation rate as the weighted average of the private sector's expected inflation target and the actual inflation target. The second defined the monetary authority's reaction function to exchange rate movements in terms of a short-term interest rate. The value of this policy instrument was determined by a constant inflation target, an exchange rate shock and an excess demand shock. The optimal adjustment rule was for the monetary authority to raise interest rates in response to unfavourable exchange rate shocks and positive demand shocks. This presupposes that the central bank knows the causes and magnitudes of any shocks hitting the economy. The third relationship defined the real MCI as a weighted average of the real interest rate and the real exchange rate with the weight on the exchange rate depending solely on the elasticities of aggregate demand to the exchange and interest rates. It indicated that the MCI should rise to offset excess demand pressures and fall if the inflation target is relaxed. A monetary authority therefore only needs to know the current state of excess demand in order to determine the amount interest rates need to be adjusted to achieve the appropriate MCI target.

Policymakers generally do not know the causes of exchange rate movements when they occur and so Gerlach and Smets (2000) applied these rules to a situation where there is imperfect information. Their model demonstrated that policy makers should avoid adjusting short-term interest rates to offset exchange rate changes in countries where the latter are typically caused by demand disturbances. This may explain why central banks such as the RBA and the Bank of England have decided not to use an MCI. The model also showed that central banks should be more ready to adjust interest rates in countries where exchange rate movements are typically caused by changes in the credibility of monetary and fiscal policy. An operating target automatically achieves the desired monetary policy stance in such circumstances. Consider, for example, a credibility shock that occurs while monetary conditions are stable and at an appropriate level. If interest rates remain constant, the exchange rate will depreciate giving rise to a positive output gap and an increase in inflation. This outcome can be avoided if the central bank keeps the MCI constant by raising interest rates.

Gerlach and Smets (2000) developed a second model, equation (2.5), to find out how central banks respond in practice to exchange rate movements.

$$(2.5) \quad \Delta R_t = \Gamma_0 + \Gamma_1 \Delta e_t + \Gamma_2 R_{t-1} + \Gamma_3 e_{t-1} + \Gamma_4 \pi_t + \Gamma_5 y_t^g + \nu_t$$

where:

R_t = the central bank's policy rate,

e_t = the nominal effective exchange rate,

π_t = the rate of core as opposed to headline inflation over the previous four quarters

y_t^g = the output gap measured as the difference between the logarithm of real GDP and potential output using the Hodrick-Prescott filter current output gap,

ν_t = a random error term.

They estimated reaction functions for the Australian, Canadian and New Zealand central banks, all of whom conduct monetary policy under floating exchange rates and have an inflation target. Parameter estimates showed that the Australian policy rate did not respond significantly to changes in the TWI. However, the RBNZ and BC both had strong policy responses with the latter being the stronger of the two. These results are not unexpected given that the BC and the RBNZ both used their MCIs as operating targets, whereas the RBA attributed most exchange rate movements to underlying real disturbances that did not warrant being offset by policy. The smaller value of the Canadian parameter is consistent with the larger weight on the exchange rate in the New Zealand MCI.

Gerlach and Smets (2000) concluded that any central bank using an MCI as an operational target for monetary policy must be able to identify the reasons for exchange rate changes. The target MCI should be adjusted if changes are due to underlying supply and demand developments and held constant if other factors are responsible. In the latter case interest rates should be adjusted to offset the impact of the exchange rate on aggregate demand. The authors also concluded that:

> ... if it is not straightforward to distinguish between the sources of the exchange rate changes, the optimal weight is smaller than implied by the elasticities of aggregate demand. In particular, when ... exchange rate changes are due to changes in the equilibrium real exchange rate, it is optimal not to respond to exchange rate changes and the corresponding MCI-weight on the exchange rate will be close to zero.
>
> (Gerlach and Smets, 2000, p. 1696)

Tactical considerations over the timing of adjustments to monetary conditions impose an asymmetry on the conduct of policy that may prevent a central bank from moving the MCI back "on course" when it strays off the desired track (Ericsson et al., 1999; Freedman, 1995; Zelmer, 1996). Attempts at tightening policy stance are likely to succeed because they tend to reinforce market confidence in the central bank's commitment to its inflation objectives. On the other hand, actions aimed at easing policy stance that are unexpected by market participants are less likely to succeed. Suppose that an easing of conditions is considered appropriate at a time when there is uncertainty in the exchange market. Movements of the actual exchange rate might cause significant movements in the expected exchange rate if it is not anchored. Any action to reduce the overnight rate therefore runs the risk of weakening the exchange market and raising interest rates in the money and bond markets. The loss of confidence in the Bank's resolve to keep inflation within its target range therefore raises interest rate premiums and prevents the desired easing of monetary conditions taking place. The best approach might be for the Bank to let short-term interest rates remain high until markets become more stable (Freedman, 1994, p. 77). The Bank can speed up this process by clearly enunciating its interpretation of events so that market participants understand the direction the Bank is trying to move in and the reasons why.

2.8 The Use of MCIs in Other Countries

MCIs are used by a variety of organisations[7]. For example, the International Monetary Fund (IMF) and the OECD calculate MCIs when evaluating the monetary policies of different countries; and firms such as Deutsche Bank, Goldman Sachs, JP Morgan and Merrill Lynch use them to estimate monetary conditions in national economies. The central banks of Norway, Sweden, Canada and New Zealand have each published an MCI and, to varying degrees, have used their respective indexes in the conduct of monetary policy. Attempts have also been made to construct an MCI for the European Monetary Union (EMU).

2.8.1 Norway, Sweden and Canada

Norway and Sweden. The Norwegian and Swedish central banks have used their MCIs in a very limited fashion, as indicators of monetary conditions when formulating monetary policies (Norges Bank, 1995; Hansson and Lindberg, 1994). Sweden's Riksbank stopped calculating an MCI in 1998 citing the difficulty of obtaining an accurate result.

Canada. The BC and the RBNZ are the only central banks to have used an MCI as an operational target for monetary policy. The Canadian experiment has aroused the interest of researchers eager to assess the impact of the MCI regime on the implementation of monetary policy.

Barker (1996) examined how the BC's daily policy operations flowed through to the components of the MCI and how the speed and elasticity of financial market reaction to those operations were affected by the adoption of new operating procedures in June of

[7] See Table 2.2.

1994[8]. His analysis was in two parts. The first part utilised the ARDL technique to determine how changes in the MCI and its components were related to their own lagged changes, as well as to changes in U.S. interest rates and policy variables. The policy tools were:

1. The cash setting surprise defined as direct clearers' projected closing level for settlement balances less the dollar amount supplied
2. Policy operations in the overnight market
3. Policy operations in the treasury bill market
4. Policy operations in the foreign exchange market
5. Changes in the operating band of the overnight rate.

The second part of the analysis utilised a VAR model to generate IR and FEV functions.

Barker's study produced two principal conclusions. First, the change in the BC's operating framework appeared to shift the major impact of the BC's operations to movements in the operating band of the overnight rate. Second, in each operating framework there was a statistically significant relationship between the BC's policy tools and the components of the MCI. The influence of these instruments remained small relative to the amount of variation in the data.

Clinton and Zelmer (1997, p. 24) looked at how the Canadian MCI regime affected market uncertainties. During the 1990s, financial markets were at times so affected by uncertainty that "… the strategic easing of monetary conditions often had to give way to the tactical necessity of promoting orderly markets." Zelmer (1996) discusses several episodes when the BC allowed interest premiums to rise temporarily because it believed that the markets would have interpreted any easing as a relaxation of its inflation goals. This would have triggered higher premiums and so prevented the desired easing of monetary conditions in the long-term.

Neufeld (1996), quoted in Zelmer (1996), blamed the MCI for exacerbating the problem. He claimed that markets thought that the MCI target was rigid and that the BC would intervene to keep monetary conditions fairly constant. This belief was encouraged by the BC not giving the markets sufficient guidance about the appropriate path of the MCI and the long lags in its effect on inflation. This situation implied a

[8] Canadian operating procedures are discussed in Farrahmand (1995).

systematic negative relationship between interest rates and the value of the Canadian dollar even in periods where market conditions were relatively tranquil. Zelmer (1996) disagreed. He suggested that any negative relationship was present only when fiscal and political events undermined confidence in Canada. The resulting portfolio shocks caused interest rates and the value of the currency to move in opposite directions but did not affect the desired longer-term path of monetary conditions.

Clinton and Zelmer (1997, pp. 24-31) examined whether the BC's focus on the MCI exacerbated market uncertainties. They compared daily movements of the Canada-U.S. short-term interest rate spread with changes in the value of the Canadian dollar (in U.S. cents) from 1982 to 1996. Regressions were run on a rolling 3- and 12-month basis to identify periods where the negative relationship was statistically significant. A permanent inverse relationship between interest rate spreads and exchange rate movements would have indicated that the BC's operational focus on the MCI hindered policy implementation as described by Neufeld (1996). However, the time pattern of the coefficients showed that periods characterised by an inverse relationship tended to be associated with portfolio shocks. Hence the BC's focus on the MCI did not appear to systematically hinder the implementation of monetary policy.

2.8.2 The Euro area countries

Mayes and Virén (2000) analysed the results of numerous investigations into the magnitude and dynamics of real exchange and interest rate effects on individual countries within the Euro area. They concluded that while the extent and timing of the impact of given changes in these rates differed between countries their relative impacts were similar across individual economies over the short term. This seemed to indicate that an MCI ratio could be computed for the Euro group as a whole. Mayes and Virén (2000) did this by taking a weighted average (according to GDP weights) of the results of two unrestricted VAR model analyses of quarterly time series data obtained for all Euro area countries (except Luxembourg and Greece) over the period 1972-1997. Their results were imprecise and so the implied value of each calculated MCI ratio had a large confidence level. They attributed this to the small size of the data samples. Nevertheless they were sufficiently confident in the computed average of 3.5 to conclude that the Euro area would tend to behave like a large open economy rather than a closed economy when it came into being on 1st January 1999.

2.9 Concluding Comments

Since the early 1970s, considerable research has been conducted into the causes of high inflation. Strategies devised to combat the phenomenon have focussed on reforming central banks and a closely related approach known as "inflation targeting". These initiatives have been an integral part of the economic programmes of many governments in recent years and have had much success in achieving price stability and improving the credibility of monetary policy. Researchers such as Thiessen (1995) have tried to determine how uncertainty undermines the effectiveness of monetary policy channels such as interest rates and inflation expectations. The MCI was developed as a way of overcoming uncertainty. It incorporates model-based estimates of the effect of monetary policy on the economy by broadening an interest-rate target to include exchange rate effects. However, the MCI concept has limitations. These arise from tactical difficulties, the choice of weights, the underlying model's assumptions, and the associated uncertainty of the estimated relative weights. Moreover, an MCI focuses on only two of many potential variables in the monetary transmission mechanism. These problems have caused researchers such as Eika *et al.* (1996) to conclude that an MCI is unlikely to be a useful operational policy tool. Thus it is perhaps not surprising that the central banks of Canada and New Zealand are the only ones to have used MCIs as operational targets for monetary policy.

3 NEW ZEALAND AND THE MCI

3.0 Introduction

This chapter reviews the conduct of monetary policy in New Zealand since the mid-1960s and describes important reforms aimed at controlling inflation. Section 3.1 covers the period from about 1960 until 1989. These years saw a progressive worsening of key economic variables, which increased pressure for fundamental economic reforms. A period of reform began in 1984 and culminated in the RBNZA-89, which is examined in section 3.2. As indicated in section 3.3, these reforms succeeded in achieving price stability. Section 3.4 describes the technical instruments and "open mouth operations" used to implement monetary policy. However, the RBNZ sometimes failed to achieve its inflation goals because of difficulty in accurately informing financial markets about the appropriate level of monetary conditions. This problem, which is outlined in section 3.5, caused the RBNZ to adopt the MCI as an operational target in an effort to improve communication with financial markets. Section 3.6 examines the problems faced by the RBNZ when it introduced the MCI regime. These related mainly to the selection of an appropriate ratio and bandwidth and were never satisfactorily resolved. The evolution of monetary conditions and the effectiveness of the MCI regime in general are discussed in section 3.7. The RBNZ replaced the MCI regime with an OCR system in March 1999. Section 3.8 outlines the reasons for this change and describes the general features of the new system. Section 3.9 ends the chapter with some concluding comments.

3.1 Monetary Policy Before 1989

The RBNZA-64 gave successive governments considerable discretion over the conduct of monetary policy[9]. Ministers of Finance could direct the RBNZ to target any of a number of conflicting objectives without public scrutiny. The RBNZ was unable to give a clear public commitment to stabilizing prices and so the inflation rate became highly variable (Figure 3.1). Also, high inflation did not prevent unemployment from reaching historically high levels (Figure 3.2). This accords with the conventional

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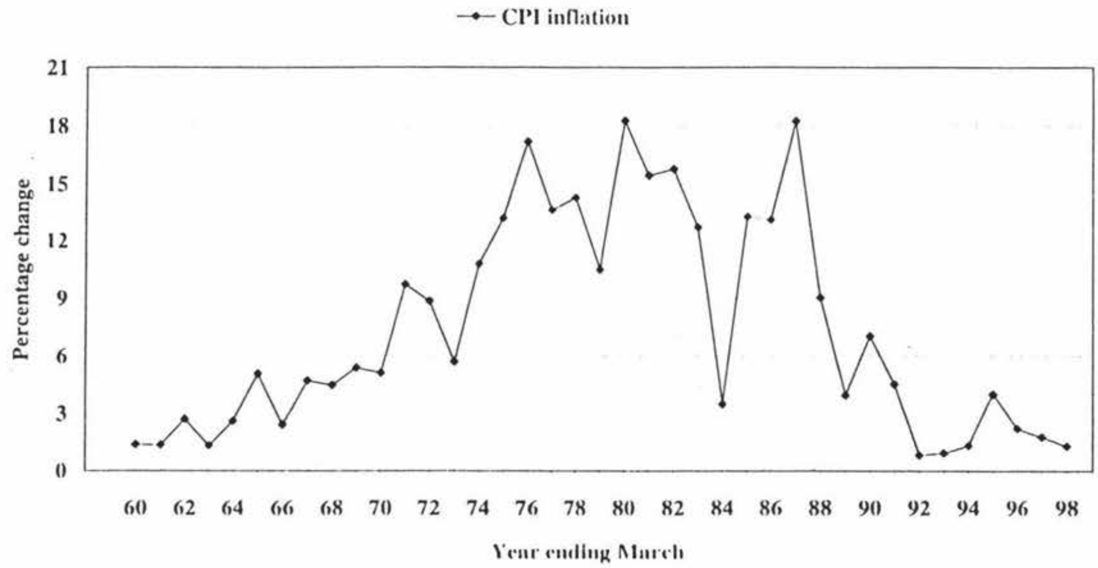
[9] Section 8 of the RBNZA-64 sets out the aims of monetary policy and is reproduced in Appendix 1.

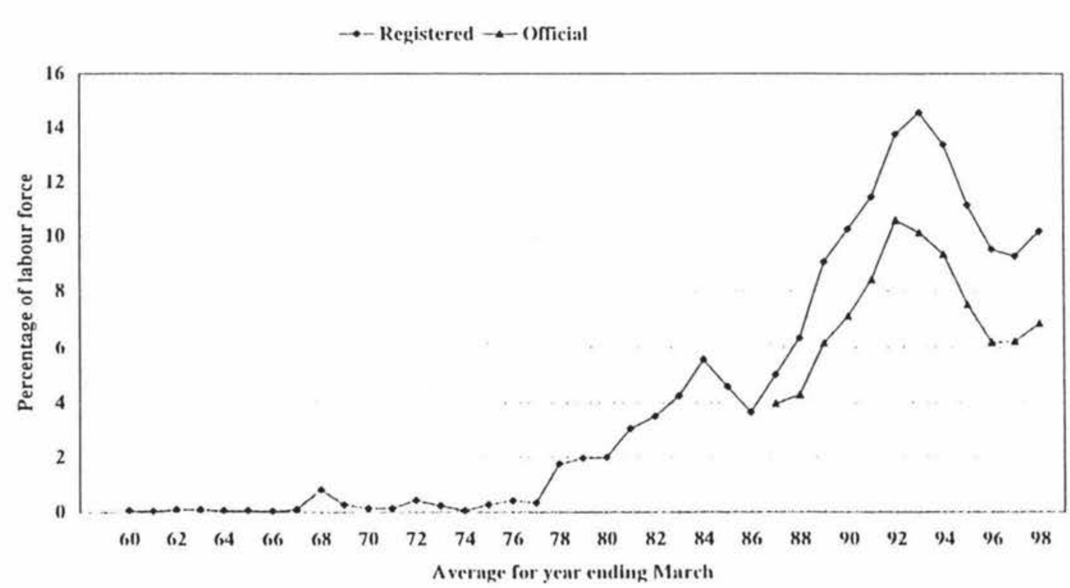
wisdom that monetary policy has no permanent effect on real economic variables because the long-run Phillips Curve is vertical (Friedman, 1968; Phelps, 1968).

Figure 3.1 Consumer Price Inflation (CPI) in New Zealand



Source: Dalziel & Lattimore, 1999, p. 42.

Figure 3.2 Unemployment in New Zealand



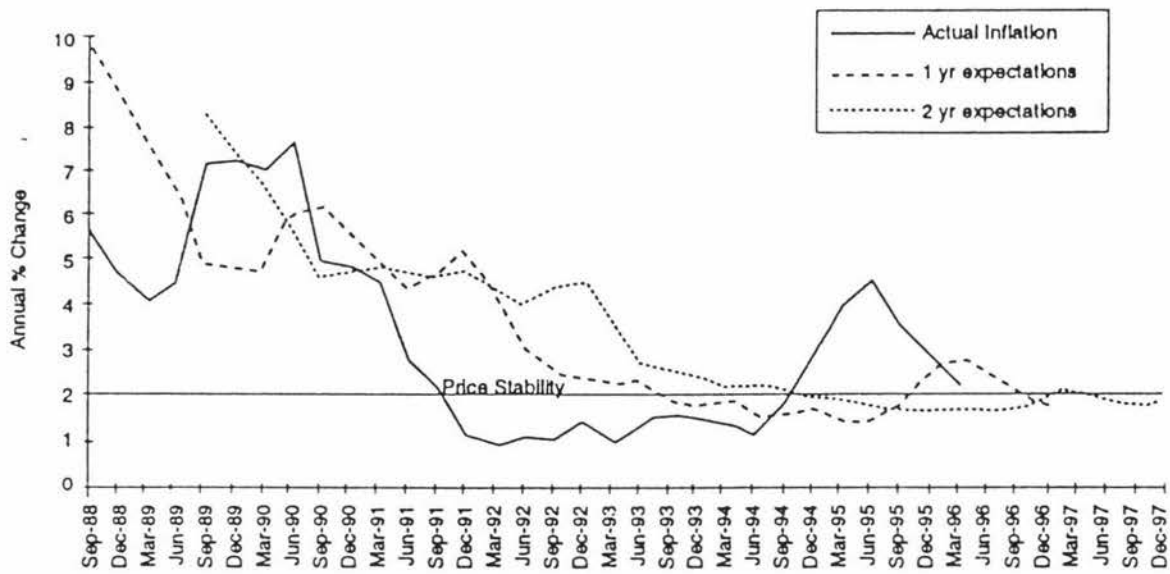
Source: Dalziel & Lattimore, 1999, p. 14.

The level of credit was tightly controlled prior to 1984 (Dalziel and Lattimore, 1999, pp. 40-43). The financial system was unable to adapt to changes in the economic environment and so the government had to continually introduce additional regulations to keep the system functioning. Dalziel and Lattimore (ibid., p. 42) describe this approach and the problems it created. Consider, for example, what happened when, in May 1967, the Minister of Finance instructed trading banks to reduce overdraft limits by 10-percent in an effort to reduce inflationary pressure. This intervention encouraged financial disintermediation by superannuation funds, building societies, savings banks, life insurance companies and finance companies. The money supply expanded significantly and the government was forced to impose minimum 'public sector security ratios' on non-bank institutions. This system was extended to the trading banks in June 1973 when they became subject to minimum reserve asset ratios, which the Minister of Finance was able to adjust as he saw fit.

These policies had serious implications for price stability. During the 1960s, the money supply grew at an average rate of just over 6-percent whereas real economic growth averaged 4-percent. This monetary expansion was consistent with the 3-percent average rate of inflation recorded during that period. Prices (property prices in particular) rose at a greater rate after the end of the 1960s. Strict controls on interest rates were maintained and so the real interest rate became negative. Individuals borrowed huge sums to purchase property and this caused the money supply to expand dramatically in the early 1970s. Large fiscal deficits later in the decade caused the money supply to grow at an average rate of about 15-percent. Economic growth was low during these years and so inflation climbed to double figures.

Inflationary expectations rose in response to these developments (Figure 3.3). Price setters worried about the impact of policy changes on inflation built risk premiums into prices to compensate for uncertainty about future inflation. This was especially evident in the wage setting process where employees tried to protect real wages by obtaining compensation for expected inflation (Boston, 1984). At the same time, firms willingly paid higher wages because they knew that their products would sell at higher prices as inflation increased the prices of competing goods. A survey by Beaumont and Reddell (1992) indicates that this situation tended to be self-perpetuating. They compared actual inflation rates with surveyed expectations of inflation between the years 1982 and 1991, and found that people were reluctant to transact on the basis of low predicted inflation until it was a reality. Moreover, Figure 3.3 indicates that it takes time before inflationary expectations respond to changes in actual inflation. The success of any policy aimed at stabilising prices after a period of high inflation therefore depends on the credibility of that policy and its ability to achieve the desired outcome quickly.

Figure 3.3 New Zealand Inflationary Expectations



Source: Kirchner, 1997, p.112.

These results provide strong support for the central bank reforms discussed in section 2.1. There it was found that inflation targeting and initiatives to strengthen CBI were important in establishing the credibility of monetary policy.

3.2 The Reserve Bank of New Zealand Act 1989 (RBNZA-89)[10]

The character of New Zealand's monetary policy and its operating procedures are discussed in McCallum (1995), Walsh (1995b), Dotsey (1991) and Grimes (1990). The RBNZA-89 is particularly interesting because of the way it was designed to reduce inflationary expectations quickly and keep them low. It incorporates the ideas of reputation and delegation, and puts into effect the notion advanced by Fischer (1990) that central banks should have instrument independence but not goal independence. It

[10] Appendix 2 contains those parts of the RBNZ-89 relating to the conduct of monetary policy.

also incorporates two ideas advanced by Walsh (1995b). The first is that of having a contractual relationship between the central bank governor and government. The second is of making price stability the sole objective of monetary policy in order to eliminate the inflationary bias that can arise from discretionary policy.

The RBNZA-89 has six distinctive features relating to the conduct of monetary policy (Archer, 1997; Dawe, 1992):

1) Section 8 stipulates that price stability is the only goal of monetary policy. This eliminates the inflation bias that existed previously when policy was often directed simultaneously at multiple conflicting objectives.

2) Section 9 requires the RBNZ and government to agree on and publish specific inflation targets in a Policy Targets Agreement (PTA). The PTA sets down the current CPI inflation target and specifies the circumstances in which CPI inflation can depart from the target. These circumstances relate chiefly to supply-side shocks. Examples include increases in the price of imported goods such as petrol, increases in the rate of the Goods and Services Tax (GST), and unusual climatic conditions.

3) The RBNZ has the independent authority to choose instruments and take whatever monetary policy actions it deems necessary, within the limits of its statutory powers, to accomplish its inflation target. It therefore has "greater independence from political influence" than most other central banks (Walsh, 1995b, p. 1180). This power accords with the theory that "central banks should have independence only with regard to instrument settings, not objectives" (McCallum, 1995, p. 37).

4) The legislation contains mechanisms that facilitate public debate and scrutiny of announced inflation targets and any observed deviations from them. For example, the RBNZ is subject to external performance audits and must submit an annual report. It must also publish six-monthly policy statements that review the conduct of monetary policy during the previous six months and outline its intended implementation over the ensuing six months. These documents are

detailed and subject to parliamentary scrutiny. Markets can therefore have greater confidence about the commitment of the RBNZ to its primary function.

5) Government can unilaterally over-ride the primary objective with a limited life Order in Council for one year. In these circumstances, a new PTA specifying a new target must be signed and published.

6) The RBNZ Governor, in whom all authority is invested, can be sacked for non-performance in relation to the target set down in the PTA. The Board has the responsibility of monitoring the performance of the RBNZ and its Governor on behalf of the Minister of Finance. The criteria used to assess performance include meeting policy targets and the RBNZ's statutory objective as well as obtaining consistency between policy targets and each Monetary Policy Statement (MPS). This makes one person (the Governor) accountable for the outcome of monetary policy. The Governor's compensation is based on the realised rate of inflation and is the closest to be found anywhere to a performance-based contract[11].

3.3 Monetary Policy After 1989

Ammer and Freeman (1995, p.171) described the RBNZ's price stability objective as 'ambitious', 'elaborate' and 'credible'. They also found that full central bank credibility had not been achieved five years after the introduction of the RBNZA-89, despite the stabilization of actual and expected inflation at low levels. Indeed, they attributed New Zealand's continued weak economic performance to uncertainty about the long-term credibility of monetary policy. This view was reinforced by Johnson (1997) who used the variance of inflation forecast errors as a measure of credibility. He found that inflation targets were not instantly credible over the 18 countries in his sample and that New Zealand produced the third highest variance and was overall unsuccessful at establishing a credible disinflation path.

[11] Briault *et al.* (1996) point out that the RBNZ is not fully accountable because the minutes of monetary policy formulation meetings are not published. Nevertheless, their index rated the RBNZ as the second most accountable central bank in a sample of 14 countries.

Expectations in New Zealand appear to be driven largely by recent inflation, lending support to the adaptive expectations hypothesis, which suggests that expectations fall following a reduction in actual inflation (McCallum, 1989). Moreover, households and labour unions typically have higher expectations than the financial and business sectors. This means that all the implications and effects of monetary policy on prices and costs have to be made clear if expectations are to be lowered (ibid., 1989).

Changes to the PTA regarding the target may affect expectations and therefore credibility. Consider the decision of the National-New Zealand First coalition government in December 1996 to increase the inflation target band from 0-2% to 0-3%. The sole objective of price stability was also altered to include output and employment considerations. These amendments showed that the RBNZ is not truly independent of government influence and confirmed that while it had been granted instrument independence it had relatively less goal independence. In fact, Pollard (1993) considered that such cooperation between the RBNZ and the government in the determination of monetary policy objectives made the former theoretically dependent.

The conferment of instrument independence might be enough to eliminate the type of political business cycles that characterized New Zealand's money growth rate prior to 1989 if the instruments are credible. For example, changes to the settlement cash target imposed on registered banks were infrequent after the passing of the RBNZA-89 because the release of press statements was generally sufficient to alter interest rates in the desired direction. This indirect method of policy implementation might make it more difficult to control the magnitude of interest rate changes, but it can be effective in avoiding policy delays (McCallum, 1995). The highly observable and politically sensitive nature of interest rates might cause central banks with direct control over short-term rates to delay policy.

Given this framework, it is instructive to consider a report in the *New Zealand Sunday Star Times* (10 January 1993) that reveals just how aggressively the RBNZ behaved in order to establish its anti-inflation credentials. Inflation of 0.8-percent had been predicted for the 1993 calendar year providing the TWI remained above 54.0. However, inflation seemed likely to exceed the upper limit of the target band laid down in the PTA when the TWI fell to 52.3 during the first week of January 1993. The responded on 6 January by reducing the amount of settlement cash from $20 million to zero. Trading banks competed aggressively for funds and this raised domestic interest rates relative to foreign rates. The increased demand for New Zealand denominated securities pushed the TWI to 53.5, which was high enough to prevent import prices from threatening inflation targets. Mortgage rates rose by up to a percentage point and business lending rates rose enough to jeopardize the economic recovery then under way. The RBNZ loosened conditions on 8 January by increasing the amount of settlement cash to $5 million in order to minimize any slow down in economic growth. Nevertheless, the RBNZ, despite this partial reversal, succeeded in lowering inflation expectations by showing that it was prepared to sacrifice economic recovery in order to maintain price stability.

Archer (1997) described how the RBNZA-89 created an environment where financial markets largely implemented monetary policy on behalf of the RBNZ. The narrow inflation target band set by the PTA enabled the RBNZ to use its quarterly inflation forecasts as a basis for policy decisions. These forecasts were detailed and included any assumptions made about the nominal exchange rate, which is a major determinant of future inflation. Knowledge of how other influences were likely to affect the price level allowed the RBNZ to calculate a desired exchange rate path that would keep inflation within the target band. In the deregulated interest rate environment, price setters had an incentive to anticipate actions the RBNZ might take to keep the exchange rate on its desired path. As information about future inflation became available, financial market analysts could predict the likely impact on the RBNZ's views about future inflation, the exchange rate path consistent with the inflation target, and the accompanying interest rate configuration (ibid., p.11). They adjusted interest rates and the exchange rate along paths indicated by the RBNZ's published statements to an extent that central bank intervention was rarely required. On most occasions when the RBNZ released its statements it was merely confirming and validating adjustments in monetary conditions that had already occurred.

3.4 Monetary Policy Instruments

3.4.1 Technical instruments

The RBNZ has used several technical instruments to influence short-term interest rates since the passing of the RBNZA-89 (Huxford and Reddell, 1996; Tait and Reddell, 1992). Only one, the cash target, is a supply-side instrument. The others are demand side controls.

Cash target. New Zealand banks must hold part of their reserve assets on deposit with the RBNZ to facilitate settlement transactions with each other and with the government. Hence the supply of settlement cash is an instrument. An increase in settlement cash means that financial institutions can compete less aggressively because of a lower probability of having to discount Reserve Bank bills (RBBs). Decreased demand for settlement cash and RBBs leads to easier monetary conditions, everything else being equal (Tait and Reddell, 1992, p. 70). The liquidity forecast variation (LFV) is the difference between the expected cash release and the actual dollars supplied. A positive (negative) number means that the RBNZ injected (withdrew) more money than was forecast.

Reserve Bank bills. RBBs are 91-day non-risk instruments. They are issued twice weekly and are not traded on the money market. RBBs are a substitute for settlement cash because holders can discount them to the RBNZ whenever they need to. An increase in their supply means easier monetary conditions and lower interest rates (ibid., p. 71).

Open market operations. The RBNZ carries out OMOs by selling or purchasing government bonds. The sale of a government bond reduces the monetary base when the private sector pays for it through the banking system. An open-market purchase increases the monetary base when the RBNZ pays the private sector for bonds (ibid., p. 71).

Interest rate on settlement cash (ISC). Banks can be discouraged from holding excess balances in their settlement accounts by increasing the margin below market interest rates paid on settlement balances. This eases monetary conditions and reduces interest rates (ibid., p. 71).

Overnight discount margin (ODM). The ODM is the penalty cost of obtaining extra cash via the discounting process. The RBNZ can change it by changing the demand for settlement cash, adjusting the penalty incurred when discounting, altering the supply of RBBs, or adjusting the interest rate paid on settlement cash. A rise in the ODM increases the cost of doing the current volume of banking business. Each direct clearer would then tend to bid more aggressively for wholesale deposits, discourage lending, and attempt to increase its access to settlement cash in OMOs to avoid discounting costs. On the other hand, a fall in the ODM loosens monetary conditions and reduces interest rates as banks minimise the holding of settlement cash by lending and competing less aggressively for funds (ibid., 1992, p. 71).

Treasury bills (TBs). A TB (sometimes known as a T-bill) is a risk free security. It is issued on the money market by the RBNZ on behalf of the Government and, at issue, has around 90 days to maturity. TBs are tendered on both a weekly and a daily basis and are useful in smoothing out fluctuations in government revenue flows (ibid., p. 164). (Huxford and Reddell (1996, pp. 310-311) describe how the RBNZ uses TBs as part of its liquidity management of settlement cash. For example, on days when forecast injections of settlement cash exceed forecast withdrawals, the RBNZ can withdraw cash from the banking system by selling TBs in exchange for settlement cash.

3.4.2 Open mouth operations

Prior to the OCR regime, the RBNZ relied heavily on "open mouth operations" (comments, speeches and publications about its monetary policy stance) to influence conditions (Guthrie and Wright, 2000). Bonato *et al.* (1999) examined how "open mouth operations" influenced public expectations about the RBNZ's monetary policy stance. They used data from the RBNZ's quarterly survey of expectations, which samples firms, financial institutions, and government agencies considered to be opinion leaders. The analysis used an ordered probit model in which expected monetary conditions were a function of the expected 90-day bill rate, the log of the nominal TWI (lagged three quarters), and some "narrative" measures of monetary policy changes. The results showed that public announcements by the RBNZ had a statistically significant impact on public expectations. This implied that observed differences between expectations and realizations of monetary conditions result from the public and the RBNZ having different assessments of future conditions. Bonato *et al.* also found that there was no real evidence that the RBNZ's 2:1 MCI ratio held for all respondents. In the decade to mid-1998 there were numerous periods when respondents placed a much higher weight on their expected interest rate movements, with a trade-off ratio in the region of 6:1. Respondents from sectors more exposed to international trade tended to place a higher weight on the exchange rate.

Since the passing of the RBNZA-89, the RBNZ has relied heavily on "open mouth operations" to achieve its desired conditions and has rarely used the five technical instruments described in section 3.4.1. The mere threat of using those instruments was generally enough to persuade markets to deliver the desired conditions. For example, the cash target, which is a key policy lever, was used only four times in the decade after 1989. This was because financial institutions had a cost incentive to eliminate any excess or shortfall in their settlement accounts (Tait and Reddell, 1992, pp. 69-70). Excess balances were expensive because they did not earn interest while shortfalls had to be met by overdraft loans from the RBNZ at a penalty rate of interest. Thus downward pressure was placed on the overnight rate and other short-term interest rates whenever account holders as a group had excess settlement cash. This caused them to bid for short-term deposits less aggressively, buy more short-term liquid assets, and made them less likely to grant one-day loans to dealers. Conversely, faced with an overall shortfall, financial institutions reacted in a way that raised short-term interest rates. These institutions therefore could not afford to ignore the RBNZ's public statements for as long as policy was credible.

3.5 Signaling and Communication Problems

Central banks use signaling techniques to inform financial markets about the intended state of monetary conditions. Signaling by the RBNZ has three features (Reserve Bank of New Zealand, 1997b, pp. 215-217). First, it includes information about the RBNZ's view of future inflation pressures so that markets can understand and anticipate policy concerns. Second, the RBNZ's operations don't directly target or set interest or exchange rates and so are poor guides to its preferred conditions. Third, interest rates and exchange rates by themselves cannot approximate conditions because both are important monetary policy channels.

The RBNZ's attempts at signaling were occasionally unsuccessful and caused conditions to move in unintended ways. Mayes and Riches (1996, pp.13-14) describe one such occasion, which occurred in 1995. Prior to 1995 the RBNZ tended to emphasize the exchange rate when describing the desired level of conditions because it was the more variable element and had a more direct effect on inflation. However, in early 1995 the market appeared to take more notice of short-term interest rates as an indicator of the RBNZ's attitude to policy with some market participants believing that the 90-day rate had a floor of nine-percent. The RBNZ tried to correct this mistaken perception by giving the market an idea of the mix of interest rates and the exchange rate compatible with its forecast inflation profile over the ensuing few quarters. The June 1995 MPS stated that "... a somewhat higher level of interest rates could be coupled with a slightly lower average level of the exchange rate, or vice versa, without altering the overall degree of monetary policy pressure" (Reserve Bank of New Zealand, 1995a, p. 37). The TWI rose to 62.27 on 12 July but declined thereafter. Interest rates fell below 9-percent in response to the appreciation and remained there even after the exchange rate began to depreciate. However, the RBNZ believed that monetary conditions were still too tight despite the fall in interest rates. On 10 July it issued another statement hoping to encourage a further fall in interest rates that would restore conditions to their level at the time of the June MPS. It stated that "...the Reserve Bank can accept some small market-driven fall in interest rates relative to those prevailing at the time of the Monetary Policy Statement" (Reserve Bank of New Zealand, 1995b, pp. 46-7). This statement was ambiguous about the difference between changing the level of monetary conditions and altering the mix. It appeared to reinforce a perception that conditions needed to be easier than those prevailing at the time of the June MPS. The RBNZ issued further statements in an effort to restore monetary conditions to their desired level but was unsuccessful. Direct action was required and so it reduced the cash settlement target on August 11 and again on August 25.

There were two reasons for confusion in the market on this occasion (Mayes and Riches, 1996, p. 14). First, the RBNZ and financial market analysts had different perceptions about the amount of inflationary pressure in the economy. Second, the two developed different opinions about the appropriate degree of monetary stringency once the RBNZ stopped aiming for an inflation rate near the top of its target range. This was partly due to confusion over the respective roles of interest rates and the exchange rate and partly because the transmission mechanism of monetary policy through to inflation was inadequately understood (Mayes and Razzak, 1998). The language used in RBNZ statements reflected this uncertainty. It relied on qualitative terminology such as 'tighter' or 'looser' monetary conditions, which meant different things to different people. The RBNZ was unable to control the mix of monetary conditions because it could not give the market unambiguous messages that related to both interest rates and the exchange rate.

The transmission mechanism has three components. They are interest rates, the direct effect of the exchange rate on inflation and the indirect effect of the exchange rate on the demand for exports and import-competing goods and services. The second of these is a short-run mechanism and the only one of the three that can be expressed quantitatively[12]. The RBNZ tended to focus on this because the size and timing of the impact of the other components was inadequately understood. This short-run emphasis caused the RBNZ to underestimate inflationary pressures building up in the economy during 1993 and 1994 and so caused inflation to exceed the target range during 1995-7 (Mayes and Razzak, 1998, p.13).

Mayes and Riches (1996) describe other occasions when the RBNZ had to issue more than one statement to explain how it wanted monetary conditions to change. The MCI appeared to be the solution to this communication problem. It was a quantitative tool that could be used to give the market seemingly unambiguous signals about conditions.

3.6 The New Zealand MCI Ratio

The RBNZ was faced with a dilemma when it decided to adopt the MCI regime:

> ... the needs of policy ran ahead of the empirical work and it became necessary to employ a rounded estimate of the MCI ratio before we had fully tested the consequences of doing so. The alternative of not specifying a ratio and letting the market guess what the Bank might actually believe would have been more harmful both to credibility and to the usefulness of market signals.
>
> (Mayes and Razzak, 1998, p. 21)

The selection of an MCI ratio was fraught with difficulty, as it demanded a balance between the short and long-run transmission channels of monetary policy to prevent inflation bouncing from one side of the target band to the other. Consider, for example, a situation where inflation is above or at the upper edge of the band and inflationary pressures are rising. A strong direct effect through the exchange rate might be desirable

[12] Razzak (1994) calculated a pass-through coefficient of about 0.3 over 12 months.

to suppress prices quickly, however the long-term indirect effects might reduce demand so quickly that inflation challenges the lower bound eighteen months or two years later.

Researchers attempted to calculate an MCI ratio accurate enough to have practical uses. Nadal-de Simone *et al.* (1996) did the initial work. Their model of an open economy contained the main elements of the transmission mechanism, plus a reaction function for the monetary authority and a role for expectations. The last term was important given the transparent policy framework operating in New Zealand. The model yielded an MCI ratio less than unity. It also revealed the important role of foreign interest rates, foreign demand, expected values of the exchange rate and current values of the exchange rate in determining domestic demand pressures. These results differed from other estimations of MCIs in that the model incorporated all monetary policy channels influencing inflation and not just the indirect impacts of interest rates and exchange rates. They also confirmed some of the difficulties suggested by Ericsson *et al.* (1997) in the estimation of MCIs from a single equation IS curve (Hansson, 1993).

Dennis (1997a) approached the problem using a structural VAR model that allowed a longer lag structure. The results indicated that nominal interest rates affected inflation more quickly than did the exchange rate and that the appropriate MCI varied with the time horizon used. The calculated MCI ratio of 1:1.7 was plausible given the estimate of 1:3 for the more open Canadian economy (Duguay, 1994) and 1:2 for both Norway and Sweden (Ericsson et al., 1997), which are similar to New Zealand. Dennis (1997a) estimated three output gap equations to obtain MCI ratios that varied from 1.65 to 1.98. These results indicated that it was impossible to calculate an exact value for the MCI ratio, however the RBNZ had felt confident enough in December 1996 to publish an MCI with a ratio of 1:2.

A bandwidth can be drawn around the target MCI to show the maximum extent conditions can vary without threatening the inflation objective. However, different demand shocks have different impacts on aggregate demand and hence inflation. Dennis and Roger (1997) argued that a band is appropriate only when the source of a demand shock is unknown because the precise change required in desired conditions cannot be calculated. Unfortunately, a calibrated model is really only useful in estimating bands for identifiable shocks. Dennis and Roger (1997) concluded that the best method of establishing a band was by choosing an average value across different sorts of identifiable shocks. They estimated a band equivalent to 75 basis points of the 90-day interest rate on each side of the desired conditions as being appropriate.

In June 1997 the RBNZ began setting limits to fluctuations of the MCI. It announced a bandwidth equivalent to plus/minus 50 MCI points at the time inflation projections were published but which widened progressively over the ensuing three months.

3.7 Monetary Conditions Under the MCI Regime

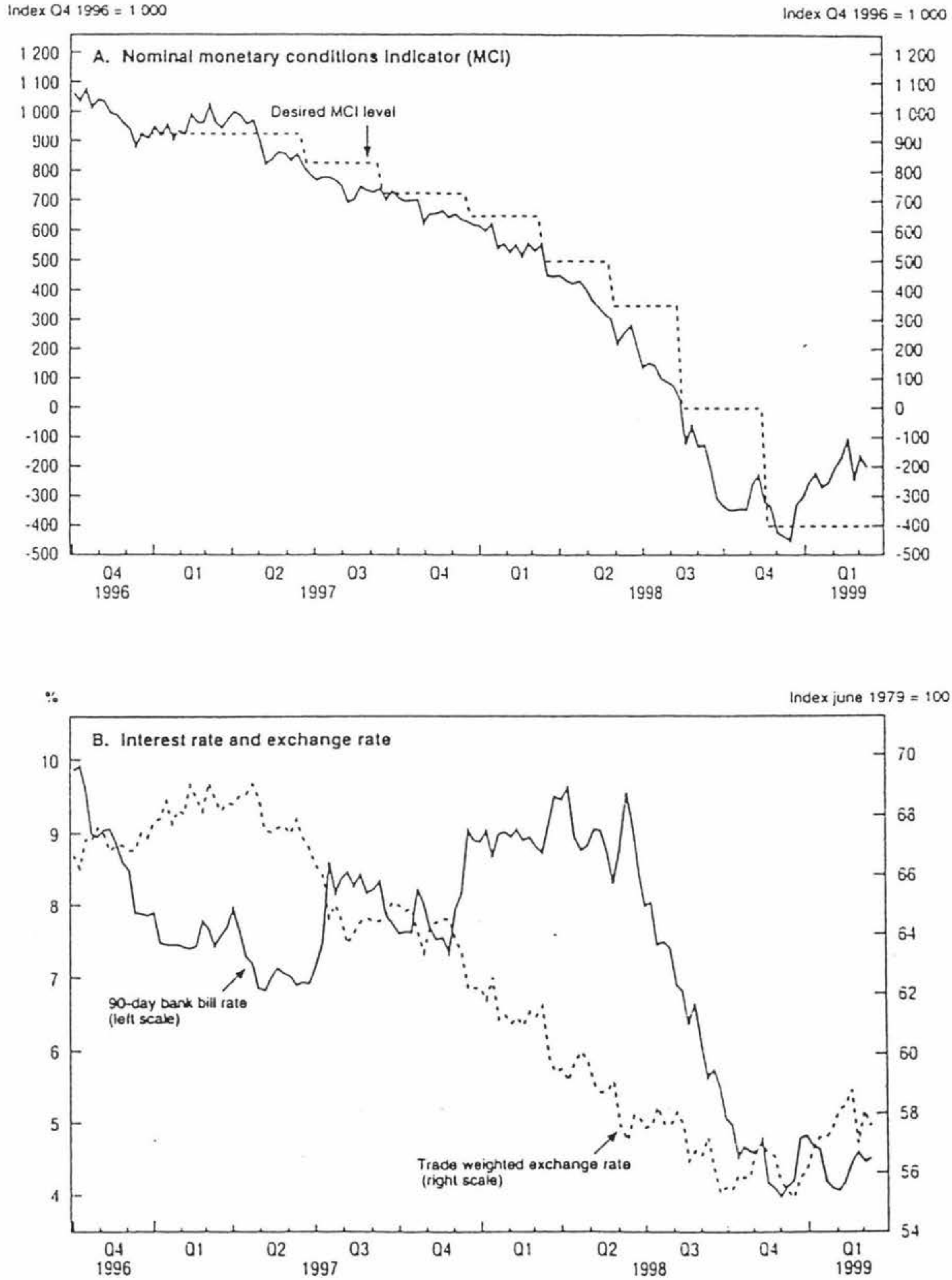
The RBNZ decided on desired conditions quarterly and used the MCI to show the tolerance to portfolio shocks in the period between projections. It required substantial information that the projections were wrong for a change in desired conditions to be announced explicitly between forecasts.

Figure 3.4 shows the evolution of monetary conditions measured in terms of the MCI. It reveals a general easing of inflationary pressures and that markets tended to ease conditions more rapidly than indicated in the RBNZ's quarterly projections. The RBNZ ascribed these trends to:

> ... the fact that financial markets reassess the outlook for the economy and monetary policy on a continuous basis, while the Bank makes a formal reassessment only quarterly. Consequently, ... markets will adjust interest rates and the exchange rate on the basis of new information on economic developments, well before the Bank incorporates this information into its quarterly projections. Over the past year, new information ... led to a progressive shading down of growth and inflation prospects. Thus markets have generally anticipated that the next step in monetary policy would be in the direction of easing conditions by more than had previously been indicated. By and large ... the Bank's resets of desired monetary conditions have involved catching up to where markets have already moved actual monetary conditions. This tendency ... to successfully anticipate the Bank's reassessment of appropriate conditions reflects the fact that both the Bank and the markets share the same information, and that the Bank's commitment and approach to inflation targeting are transparent and well understood.
>
> (Reserve Bank of New Zealand, 1998a, p. 6).

Some commentators took an opposite view. Bennett (1999) attacked the MCI regime for exacerbating exchange rate volatility and creating uncertainty by reducing the

Figure 3.4 New Zealand Monetary Conditions



Source: OECD, 1999, p. 43.

transparency of monetary policy. He claimed that while market players assumed a tolerance band around the RBNZ's announced target nobody knew its size. Some assumed a 50-point band while others suspected a margin exceeding 100 points and others suspected no band at all. Bennett also claimed that the markets doubted the RBNZ would intervene because to do so would have encouraged hedge-fund speculation to profit from rigidities.

Edlin (1997) also questioned whether there was a precise relationship that indicated how much interest rates needed to change whenever the TWI shifted. He noted how on 18 August, about six weeks after the MCI regime was established, the TWI had fallen by 4.6-percent whereas the 90-day bill yield had risen just 1.4-percent. The MCI ratio over that short period was 1:3.2 not 1:2.

Grimmond (1998) claimed that the MCI regime increased volatility in financial markets with the daily volatility of the NZ90 being 66-percent higher in the first nine months of the MCI regime than in the preceding nine months. This volatility was caused by the Asian financial crisis and exacerbated by the rigidity of the MCI. Markets generally responded to overseas shocks in a mechanical way due to their tendency to trade at the bottom of the RBNZ's comfort zone. This was because the MCI ratio of 1:2 was too low and so impaired the efficiency of the financial sector and the operation of monetary policy. Grimmond (1998) justified his argument by pointing out that Canada had a similar trade dependency and yet used a 1:3 ratio. Use of a 1:3 ratio would have resulted in an 11-percent increase in interest rate volatility instead of the 66-percent observed.

Hunt and Orr (1999) used the RBNZ's Forecasting and Policy System (FPS) model to determine which was the better of two approaches to implementing monetary policy. The first assumed that unknown economic events caused unexpected exchange rate movements. The appropriate policy response in such cases was to do nothing between inflation reviews, and allow monetary conditions to vary with the exchange rate. The second approach, which underlay the MCI regime, assumed that exchange rate changes occur in isolation. This implied that short-term interest rates should be used to offset exchange rate shocks. The simulation results suggested that the second strategy improved economic performance only if exchange rate shocks were the only source of unexpected macroeconomic activity. It did not reduce the variability of inflation or output when other surprises affecting economic outcomes were interrelated. The authors concluded that the best approach was for the RBNZ to hold interest rates constant between inflation forecasts because exchange rate shocks do not occur in isolation. This study complements that of Gerlach and Smets (2000), which was described in section 2.7. There it was found that any central bank using an MCI as an operational target must be able to identify the reasons for exchange rate changes. If that is not possible, then the optimal MCI weight is smaller than that implied by the elasticities of aggregate demand.

New Zealand and Australia both have substantial trade links with Asia and yet the two countries were affected differently by the Asian financial crisis, which developed after the collapse of the Thai baht on 2 July 1997[13]. The *Economist* (1999) attributed this to the MCI regime. The Australian dollar underwent a substantial depreciation, which made exports more competitive in markets outside Asia and increased export earnings. A fall in the Australian 90-day bank bill rate (A90) to 5-percent also helped maintain growth and reduce unemployment to 7.5-percent, it's lowest in eight years. Meanwhile, inflation in the December 1998 year was 1.6-percent, which was below the target range of 2-3 percent. On the other hand, in New Zealand the NZ90 rose to 10-percent before declining to 5-percent after mid-1998 when the MCI target was relaxed. This was the opposite of what the weakening economy needed because exports and domestic demand both slumped. Inflation fell more sharply than intended, to 0.4-percent in the year to December 1998 and consumer prices fell by 0.8-percent in the fourth quarter. GDP grew in the third quarter although output was still 1.3-percent down on a year earlier.

Figure 3.5 was constructed from data supplied by the financial services departments of the RBNZ and the RBA. It plots the paths of the A90 and the NZ90 from 1 January 1995 until 31 May 1999. The patterns of change described above by Grimmond (1998) and the *Economist* (1999) are evident. The NZ90 increased significantly after the introduction of the MCI regime, reaching nearly 10-percent by mid-1998. In contrast, the A90 fell to about 5-percent over the same period. The introduction of the MCI regime also coincided with a marked increase in the volatility of the NZ90.

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[13] Krugman (2000, pp. 83-101) describes how the collapse of the Thai baht precipitated the Asian financial crisis.

Figure 3.5 The New Zealand and Australian 90-day Bank Bill Rates (1 January 1995 to 31 May 1999)

3.8 The Official Cash Rate (OCR) System

The RBNZ replaced the MCI regime with an OCR system on 17 March 1999. The implementation arrangements (Reserve Bank of New Zealand, 1999a, pp. 46-50) shifted the operational focus of monetary policy from controlling the quantity of settlement cash to controlling its price. For example, the band of plus or minus 25 basis points means that the RBNZ pays an interest rate 0.25 percentage points below the OCR for money deposited in settlement accounts, and provides overnight cash at 0.25 percentage points above the OCR. This gives it substantial influence over the NZ90 although it still fluctuates according to changes in market perceptions of the medium-term inflation outlook.

The OCR system was designed to improve the signalling of the RBNZ's policy intentions to the market. Hence it contains mechanisms to reduce economic uncertainties that would otherwise create excessive changes in the size and frequency of instrument resets and reversals (Reserve Bank of New Zealand, 1999b, pp. 21-22). First, the RBNZ conducts quarterly reviews of its economic projections that take new information into account. These projections are published so that financial markets understand the RBNZ's view of the economy and its likely future policy actions. Second, the RBNZ's focus on the mid-point of the inflation target range maximises the likelihood of future inflation falling within that range. It is therefore less likely that significant policy actions will be needed to offset small changes in inflationary pressure. Third, financial markets receive the same information as the RBNZ and are kept informed of its objectives and the way that it forms its views. For example, the RBNZ is keen for markets to understand that monetary policy should focus on the economy's medium-term outlook and not short-term fluctuations in activity. Thus each MPS contains projection tables with half-yearly rather than quarterly values of key variables. This tends to obviate the necessity of shifts in policy instruments because market prices generally respond appropriately to relevant information as it emerges between formal OCR resets.

The RBNZ no longer expresses its implementation decision in terms of a projected MCI but still uses it to discuss the projected path for monetary conditions:

> ... the use of tight indicative bands increased the day-to-day and week-to-week volatility of interest rates, and did not allow sufficiently for the range and scale of events that impact on the New Zealand economy. Comments on conditions were still required, or threatened, sometimes on an uncomfortably frequent basis. We progressively moved away from enunciating intra-quarter bands around the stated desired level of the MCI, allowing greater intra-quarter flexibility in monetary conditions. However, the trade-off has been some reduction in the meaningfulness of any particular stated level of the MCI.
>
> (Reserve Bank of New Zealand, 1999a, p. 47).

3.9 Concluding Comments

The New Zealand economy performed poorly in many areas after the early 1960s. A series of economic and financial reforms were introduced after 1984 that deregulated the economy and made it more competitive. Policymakers were particularly concerned to reduce inflation expectations and so made dramatic changes to monetary policy. The RBNZA-89 became the centrepiece of monetary reform and put into practice the theories of delegation, reputation and CBI discussed in chapter 2. In doing so it created an implementation regime where financial markets largely carried out monetary policy on behalf of the RBNZ and which relied heavily on public announcements, or "open mouth operations". However, the RBNZ's signalling techniques were sometimes ambiguous and so it adopted the MCI as an operational target in order to better inform financial markets of how it wanted conditions to change.

The adoption of the MCI regime posed a dilemma, as there was uncertainty about what value the MCI ratio should have. Considerable research went into calculating a ratio accurate enough to have practical uses, and eventually a ratio of 1:2 was chosen. It was given a bandwidth equivalent to plus/minus 50 MCI points at the time inflation projections were published but which widened progressively over the ensuing three months. The MCI regime was controversial and the RBNZ was forced to defend it against criticism from commentators such as Bennett (1999) and Grimmond (1999). Particularly interesting is a claim by the *Economist* (1999) that the Australian economy performed better during the Asian financial crisis in the late 1990s because the MCI regime raised New Zealand interest rates unnecessarily.

4 METHODOLOGY

4.0 Introduction

This chapter describes the four methodologies used in this thesis. Section 4.1 outlines the development of a questionnaire used to find out how the MCI regime influenced the way financial market participants perceived the RBNZ's conduct of monetary policy. Section 4.2 describes a series of rolling 10-week regressions used to determine if the MCI regime improved the RBNZ's communication of monetary policy to financial markets. The regressions used daily data to estimate the relationship between the N.Z.-U.S. exchange rate and the N.Z.-U.S. 90-day interest rate spread. An identical study was conducted with Australian data in order to make a comparative analysis. Section 4.3 describes the ARDL technique, which was used to analyse the relationships between RBNZ policy actions, the MCI and its two components. Section 4.4 explains the VAR methodology, which was used to test for block Granger causality as well as to obtain IR functions and FEV decompositions. Section 4.5 ends the chapter with some concluding comments.

4.1 The Survey[14]

4.1.1 The survey objective

The survey was designed to obtain information about how the MCI regime affected market perceptions of the RBNZ's monetary policy stance. This information was used as an interpretative guide to the results obtained from the empirical analyses described in sections 4.2, 4.3 and 4.4.

4.1.2 The relevant population

The selection of a suitable population was difficult. The Society of Corporate Treasurers was approached for the names of people employed as financial analysts during the MCI regime. This information was not forthcoming and it was suggested

[14] Appendix 3 contains a copy of the survey.

that the trading banks be approached as they had considerable knowledge about the operation of monetary policy during that period. However, these institutions were also unwilling to identify current or past employees with first hand experience of the MCI regime. Two banks refused to supply that information because of the Privacy Act 1993.

It was obviously impossible to identify individuals who could assist with the survey and so copies were sent to the chief economists of the six largest banks operating in New Zealand. The small sample size made a thorough statistical analysis of the responses impractical, however it was assumed that the opinions of these individuals were a good indicator of the attitudes prevailing within financial markets.

4.1.3 The survey form

Surveys are conducted using personal interviews, telephone interviews and mail questionnaires[15]. The form or method chosen depends on the survey population, the objectives of the survey, and the constraints to undertaking it. Each approach has its advantages and disadvantages with the mail questionnaire generally considered the least favourable.

Personal and telephone interviews allow an interviewer to tailor questions to fit the respondent's circumstances (Mitchell and Carson, 1989). The interviewer can skip irrelevant questions and explain those that the respondent is unsure about. Compared to an equivalent mail questionnaire, an interviewer is likely to obtain more responses to each individual question. On the other hand, mail questionnaires take less time to conduct and are not subject to interviewer bias.

Mail questionnaires have two main disadvantages compared to interviews: sample selection bias and low response rates (ibid.). Sample selection bias occurs when, for example, a small proportion of low-income earners returns a questionnaire because they have difficulty understanding or reading it. Such problems can be overcome if respondents are familiar with or take an active interest in the subject, and if the questionnaire is well designed (ibid.).

[15] Dillman (1978, pp. 74-76) uses 24 performance criteria to rank the three techniques. Generally speaking, face-to-face interviews were found to be the most favourable and mail questionnaires the least favourable method of eliciting information from respondents.

This study used the mail survey approach because it was the most economical method since it did not incur any expensive travel costs (Gardner, 1978). This was a significant consideration given that the interviewees resided in Auckland and Wellington.

4.1.4 Respondent impressions

The importance of a survey to the respondent is influenced by its professional appearance (Dillman, 1978). A survey should be in booklet format, have carefully designed cover pages, be on good quality paper and be a high quality print job if respondents are to have confidence in it and its sponsors (Gardner, 1978). It should also be aesthetically pleasing while maintaining question and page structure. Respondents are then less likely to miss individual questions or whole sections (Dillman, 1978).

A survey must have a covering letter explaining the study topic and emphasising the importance of the respondent to the survey's success. Its basic aim should be to communicate the appeal of the survey (ibid.). The letter used in this survey was reproduced on Massey University letterhead to emphasise the non-commercial nature of the survey, its professional image, and the reputable stature of the institution from which the survey was conducted[16].

The front cover is important because it largely determines the respondent's first impressions of the survey. It should include the study title, any needed directions, and the name and address of the institution conducting the survey (ibid.). It is an offsetting colour to the white pages used in the rest of the questionnaire. The first inside page should background the survey topic. This sets the scene for the rest of the survey and gives respondents a neutral description of the problem so they can start thinking about their own experiences.

4.1.5 Questions

Survey questions must be written for a particular population, a particular purpose, and placed in a sequence that retains the respondent's attention (Dillman, 1978). The questions in this questionnaire were written for chief economists of banks who had

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[16] Appendix 3 contains a copy of the covering letter used for this survey.

some experience of the MCI regime. Their style and sequence were designed so that respondents could make informed decisions. Three questions were asked about each question in the survey (ibid., p. 118):

1. Will it obtain the desired type of information?
2. Is the question structured in an appropriate way?
3. Is the precise wording satisfactory?

The questionnaire was constructed in a manner that would allow it to be its own advocate when these questions were answered in the affirmative. This was important because a questionnaire comes under the respondent's complete control when there is no interviewer (ibid.).

The questionnaire developed for this study contained four parts. They were (1) respondent knowledge and experience of the MCI regime; (2) the effect of the MCI on interest rates between July 1997 and May 1998; (3) the effectiveness of the tolerance band around the target MCI; and (4) respondent details. The order was chosen to get respondents thinking about the general operation of the MCI regime before focusing specifically on interest rates and the bandwidth. The preamble and written transitions helped establish a vertical flow by giving the questionnaire continuity.

The first question in a survey is often the most important because it has a big influence on whether the questionnaire ends up in the mailbox or the rubbish bin (ibid.). The first question in this survey was chosen to be applicable to everyone. It did not contribute to the objectives of the survey but was designed to bridge the gap between the background and the remaining questions.

4.1.6 Possible biases affecting this survey

A bias is a one-sided influence that causes actual answers to deviate from the true ones. Effort minimisation is one form of strategic behaviour that might have introduced a bias to this questionnaire. It causes respondents to make little effort in thinking about their answers and might even induce some not to respond at all. It is likely to occur if respondents have no active interest in the outcome of the survey that would counterbalance effort minimisation.

Sample selection bias occurs when people can choose for themselves whether or not to answer the questionnaire (Mitchell and Carson, 1989). It is likely to occur if respondents find the questionnaire difficult to understand or irrelevant. Pre-testing usually leads to changes in the questionnaire that reduce this type of bias.

4.1.7 Pre-testing

Pre-testing is an effective method of enhancing a survey's reliability. It eliminates bias by making a questionnaire clearer and by ensuring that respondents can make informed decisions (ibid.). Ambiguous areas within the questionnaire can be revised and background mistakes corrected. Respondents are therefore less likely to choose not to return or complete a questionnaire because it is difficult to understand. Their answers are also less likely to be influenced by wrong information. Pre-testing may involve trying the questionnaire on experts, colleagues, friends or acquaintances (Gardner, 1978). Small focus groups may also be used to discuss the questionnaire in general and individual questions in particular. The following questions should be asked at the conclusion of pre-testing:

1. Does each question measure what it intends to measure?
2. Are all the words understood?
3. Are questions interpreted similarly by all respondents?
4. Does each close-ended question have an answer that applies to each respondent?
5. Does the questionnaire create a positive impression, one that motivates people to answer it?
6. Are the questions answered correctly? (Are some missed, and do some elicit uninterpretable answers?)
7. Does any aspect of the questionnaire suggest bias on the part of the researcher?

(Dillman, 1978, p. 156)

Adjustments need to be made if any of these questions (with the exception of the last) cannot be answered in the affirmative.

The questionnaire in this study was developed and revised according to the recommendations of experts in survey and question construction: the thesis supervisors and members of the Massey University ethics committee. It was also tested on a limited number of financial analysts using a pilot survey. All this resulted in a number of suggestions with revisions made accordingly.

4.1.8 Follow-up mailings

In any questionnaire, follow-up mailings after the original posting must be prepared in order to obtain a good response rate. "Without follow-up mailings, response rates would be less than half those normally obtained using the Total Design Method..." (Dillman, 1978, p. 180).

The first follow-up is a postcard sent as a reminder to those who haven't returned their questionnaire, and a thank you to those who have. It is normally sent one week after the questionnaire is mailed out. The postcard is convenient to researcher and respondent alike, and introduces variety to the survey process (ibid.). A second follow-up three weeks after the original mail-out can be sent to non-respondents. It consists of a shorter covering letter informing non-respondents that their questionnaire has not been received, and also contains a replacement questionnaire with another return envelope (ibid.). The covering letter appeals for the questionnaire's return. A third follow-up, which is generally sent seven weeks after the original mailing, is very similar. For the purposes of this research, it was expected that the second and third follow-ups warranted the expense and time necessary to undertake them. The small size of the survey population made follow-ups an easy task given the available resources.

4.2 Rolling Regressions

The Economist (1999) noted that New Zealand's economy was affected more severely by the Asian financial crisis than Australia's[17]. It blamed the MCI regime for this, claiming that it was responsible for raising the NZ90 to nearly 10-percent during the 1998 recession. In contrast, the A90 fell to 5-percent despite a similar depreciation of the Australian currency and exposure to the international economy[18].

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[17] This article is described in greater detail in section 3.7.

[18] The operation of Australian monetary policy is described in Appendix 4.

The rolling regressions described in this section were used to investigate this claim. Two opposing hypotheses were investigated:

Hypothesis 1:

"Market participants believed that the RBNZ's MCI target was very rigid."

Hypothesis 2:

"The RBNZ's operational focus on the MCI helped market participants anticipate its policy response to portfolio shocks and did not systematically hinder policy implementation."

The situation described by hypothesis 1 might have been caused by the RBNZ's desired MCI being consistently above the actual MCI[19]. This would have caused market participants to conclude that the RBNZ was so worried about its inflation goals being jeopardised by a depreciating exchange rate that it wanted interest rates kept high to keep conditions broadly unchanged.

The second hypothesis implies that any negative relationship between interest rates and the exchange rate was caused by political or economic uncertainties. Variations in market confidence caused portfolio shocks that did not affect the desired long-run path of monetary conditions but changed short-term interest rates in a way that offset the macroeconomic impact of exchange rate changes.

These hypotheses preclude each other. Hypothesis 1 implies a systematic negative relationship between interest rate changes and the value of the New Zealand dollar. Hypothesis 2 implies that any observed negative relationship was short-term and only occurred in association with specific portfolio shocks. The main empirical distinction between these hypotheses is whether or not there was a prolonged inverse relationship between changes in short-term interest rates and the value of the New Zealand dollar. The MCI regime is unlikely to have hindered policy implementation if such behaviour was confined to periods associated with identifiable portfolio shocks.

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[19] See Figure 3.4 in section 3.7.

Evidence for and against these hypotheses was obtained from equation (4.1). This equation is similar to that used by Clinton and Zelmer (1997, p.33) to determine how the Canadian MCI regime influenced market perceptions of monetary policy[20].

$$(4.1)\quad \Delta \text{Spread}_t = \beta_0 + \beta_1 \Delta \log XR_t + \beta_2 \Delta \log XR_{t-1} + \beta_3 \Delta \log XR_{t-2} + \beta_4 \Delta \log XR_{t-3} + \varepsilon_t$$

1) ΔSpread_t is the daily change in the spread between the NZ90 (or A90) and the U.S. 90-day bankers' acceptance discount rate.
2) $\Delta \log XR_t$ is the daily percentage change in the N.Z. (or Australian) dollar (in U.S. cents).
3) $\Delta \log XR_{t-1}$, $\Delta \log XR_{t-2}$ and $\Delta \log XR_{t-3}$, are respectively the first, second and third lags of the daily percentage change in the exchange rate.
4) ε_t is an error term.
5) $t = 1,2,3, \ldots, n$

Equation (4.1) was used to run a series of 10-week rolling regressions for Australia and New Zealand over the period 22 October 1989 to 15 April 1999. The interest rate spread was used instead of the level in order to focus on changes affecting individual countries, as opposed to common international changes. The first three lags of the daily percentage change in the exchange rate were included in the New Zealand regressions as they were all significantly correlated with changes in the current interest rate spread. The first two lags were the only significant lags in the Australian regressions.

The regressions were based on Ordinary Least Squares (OLS) and so the methodology was subject to the following assumptions:

1. The relationship between the variables is based on a linear regression model. The error term, ε_t, is **normally distributed** with a **mean of zero**, and a **constant variance, σ^2**. That is, the error terms are homoscedastic, not heteroscedastic. In notation form, $\varepsilon_i \sim N(0, \sigma^2)$.

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[20] The study by Clinton and Zelmer (1997) is described in section 2.8.1. The Canadian study differed from this analysis by conducting the rolling regressions on a 12- instead of a 10-week basis and including only one lag of the daily percentage change in the exchange rate.

2. There is zero covariance between the pairs of error terms. That is, the successive error terms are independent of each other, cov $\varepsilon_i \varepsilon_j = 0$. The error terms are said to be independent of each other if they are not autocorrelated.
3. The independent variable is non-stochastic.

(Watsham and Parramore, 1997, p. 191).

The sums of the exchange rate coefficients ($\beta_1 + \beta_2 + \beta_3 + \beta_4$ for New Zealand and $\beta_1 + \beta_2 + \beta_3$ for Australia) are plotted on graphs at the midpoint of each regression period. For example, the sum of $\beta_1 + \beta_2 + \beta_3 + \beta_4$ for a regression run from 1 January 1998 to 31 March 1998 appears at 15 February 1998. A one-tailed t-test with a 95-percent level of significance was used to test the null and alternative hypotheses, which were:

H_o:	$\beta_1 + \beta_2 + \beta_3 + \beta_4 = 0$	H_o:	$\beta_1 + \beta_2 + \beta_3 = 0$
H_1:	$\beta_1 + \beta_2 + \beta_3 + \beta_4 < 0$	H_1:	$\beta_1 + \beta_2 + \beta_3 < 0$

The estimated coefficients are possibly biased because the exchange rate and interest rates may respond to common portfolio shocks. Thus it is their time patterns and not their values per se that are of interest. The results obtained from this methodology are reported in section 5.2. The relationship between the interest rate spread and the exchange rate are depicted in Figure 5.1 for New Zealand and in Figure 5.2 for Australia.

4.3 The Auto-Regressive Distributed Lag (ARDL) Methodology

The data series used in this section were tested for stationarity and found to be a mixture of stationary and non-stationary variables. This indicated that an OLS regression would give spurious results. It was therefore decided to use the ARDL method of cointegration for this analysis because it can be used regardless of the order of integration of the variables. Subsection 4.3.1 discusses the concept of stationarity. Subsection 4.3.2 explains the ARDL method of cointegration developed by Pesaran and Shin (1995). Subsection 4.3.3 describes the summary statistics and diagnostic tests reported by Microfit 4.0 for the ARDL analysis.

4.3.1 Stationarity

A stochastic process, Y_t, is stationary if it has a "constant mean, a constant variance and a covariance that depends only on the time between lagged observations" (Watsham and Parramore, 1997, p. 230). These conditions can be represented algebraically as follows:

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

These calculations do not incorporate any time factors and so their means, variances and auto-covariances are independent of time. A stochastic process is non-stationary if any one of these conditions is not fulfilled.

Granger and Newbold (1974) used Monte Carlo experimentation to show that an OLS regression with non-stationary variables may produce spurious results, a point later explained theoretically by Phillips (1986, 1987). This implies that the statistics computed for a regression model that uses means, variances and auto-variances of non-stationary variables are time dependent and unlikely to converge to their true values as the sample size increases. Conventional statistics such as the t-test, the $\overline{R}^2$ statistic and the Durbin-Watson statistic become inaccurate and even misleading once their distributions cease to follow the correct asymptotic sampling distribution. Ignoring non-stationarity can thus induce a bias towards rejecting the null hypothesis of no relationship between variables when it should not be rejected.

A non-stationary series has a unit root. Several tests have been developed to test for stationarity by determining whether or not variables have unit roots. These include the Sargan and Bharava (1983) CRDW-test and the Phillips and Perron (1988) non-parameter test. This study utilises the Dickey-Fuller (1979) approach, which is also known as the Dickey-Fuller (DF) or Augmented Dickey-Fuller (ADF) test.

The following first order auto-regressive process shows how to test for stationarity:

(4.2) $Y_t = \rho Y_{t-1} + \varepsilon_t$ where $\varepsilon_t \sim (0, \sigma_\varepsilon^2)$

The first difference can be written as:

(4.3) $\Delta Y_t = Y_t - Y_{t-1}$ or,

(4.4) $\Delta Y_t = \delta Y_{t-1} + \varepsilon_t$ where $\delta = (\rho - 1)$.

A unit root exists if ρ equals 1 in equation (4.2), and the process is said to be non-stationary, also called a random walk. The series is stationary if ρ is less than one.

The DF unit root test poses the following statistical hypotheses:

$$H_o : \rho = 1$$
$$H_a : \rho < 1$$

The standard *t*-distribution cannot be used if variables are non-stationary and so Dickey and Fuller (1979) computed a test statistic, $\tau = (\rho\text{-}1)/SE(\rho\text{-}1)$, using Monte Carlo techniques. The value of τ is significant if it exceeds the t_α critical value in which case the null hypothesis is rejected and the data series is considered stationary. The data are deemed to be non-stationary if the test statistic is less than the critical value.

The DF test can also be applied to regressions with a constant (equation 4.5), and with a constant and a time trend (equation 4.6).

(4.5) $\Delta Y_t = \beta_o + \delta Y_{t-1} + \varepsilon_t$

(4.6) $\Delta Y_t = \beta_o + \delta\, Y_{t-1} + \beta_1 t + \varepsilon_t$

Not all series are best represented by autoregressive processes and so these equations may be unsuitable for testing unit roots. This poses a problem for the DF test as it is based on an autoregressive process which assumes that the errors are independent and have a constant variance (Enders, 1995). Dickey and Fuller (1981) overcame this problem by developing the ADF test, which involves adding an unknown number of lagged first differences of the dependent variable to eliminate autocorrelation in the residuals. Equations (4.4), (4.5) and (4.6) can be rewritten as equations (4.7), (4.8) and (4.9) respectively.

(4.7) $$\Delta Y_t = \delta Y_{t-1} + \sum_{i=2}^{p} \beta_i \Delta y_{t-i+1} + \varepsilon_t$$

(4.8) $$\Delta Y_t = \beta_o + \delta Y_{t-1} + \sum_{i=2}^{p} \beta_i \Delta y_{t-i+1} + \varepsilon_t$$

(4.9) $$\Delta Y_t = \beta_o + \delta Y_{t-1} + \sum_{i=2}^{p} \beta_i \Delta y_{t-i+1} + \beta_2 + \varepsilon_t$$

The number of lags introduced into the unit root test is important. Too few may cause the null hypothesis to be rejected too often, while too many reduce the power of the test due to losses in the degrees of freedom. There is no clear indication in the literature as to how many lags should be included although Enders (1995) suggests that the best approach is to begin with a large number of lags and reduce them until the highest significant lag is reached.

Differencing measures the change in value of successive observations and can be used to remove non-stationarity (Charemza and Deadman, 1997, pp. 96-97). A data series is integrated of order one, or I(1), if it has to be differenced once (ΔY_t) to become stationary. 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 number of times the series must be differenced in order to induce stationarity. Unfortunately, the process of differencing data may result in the loss of potentially valuable long-run information.

4.3.2 The ARDL methodology

The ARDL procedure was applied to two investigations. The first examined relationships between the RBNZ's daily policy operations and movements in the MCI and its components. The second looked at the effect of interest rate volatility on the relationship between the NZ90 and its determinants. The methodology was applied to single-equation models in which the MCI and its components (FX and NZ90) were dependent variables. These equations are defined as:

(4.10) $$\Delta MCI = A(L)\Delta MCI_{t-1} + B(L)\Delta US90_t + EC_{t-1} + D(L)\Phi P + \varepsilon_t$$

(4.11) $$\Delta FX = A(L)\Delta FX_{t-1} + B(L)\Delta US90_t + C(L)\Delta NZ90_t + EC_{t-1} + D(L)\Phi P + \varepsilon_t$$

(4.12) $$\Delta NZ90 = A(L)\Delta NZ90_{t-1} + B(L)\Delta US90_t + C(L)\,\Delta FX_t + EC_{t-1} + D(L)\Phi P + \varepsilon_t$$

The explanatory variables in each model consist of the lagged dependent variable, the US90 and a vector, P, containing five policy variables. The equations for FX and NZ90 each also contain a variable representing the other MCI component. The policy variables are[21]:

ODM	Overnight Discount Margin
LO	Liquidity Operations
LFV	Liquid Forecast Variation
TBS	Treasury Bill Sales
ISC	Interest on Settlement Cash

The US90 represents the general state of international financial markets. The N.Z.-U.S. exchange rate was used in equations (4.11) and (4.12) because it is the natural link between movements in the New Zealand and U.S. interest rates used in these models. It also accounts for a substantial percentage of the TWI and so its use is not expected to affect the results significantly despite the MCI being defined in terms of the TWI. The terms A(L), B(L), C(L) and D(L) are lag operators where:

(4.13) $$A(L)Y_t = a_0 Y_t + a_1 Y_{t-1} + \ldots a_p Y_{t-p}$$

The error correction (EC_{t-1}) term used in the ARDL methodology anchors the short-term dynamics of the system by specifying an equilibrium point to which the endogenous variables are converging (Pesaran and Pesaran, 1997, pp. 394-395).

[21] A description of these policy variables is given in section 3.4.1.

ARDL models are dynamic in nature because they explicitly consider the behaviour of a variable over time. The term "distributed" indicates that the effect of the independent variable on the dependent variable is spread over a measurable number of finite periods. This enables the ARDL modelling procedure to test for short- and long-run relationships between sets of variables (Hendry, 1995). Short-run relationships between variables do not persist over long periods and so temporary disturbances to the links between variables can be picked up in the regressions. Likewise, the long-run relationship is useful in assessing shocks that constantly occur over time. It can be used regardless of the order of integration of the variables and so avoids pre-testing problems associated with other cointegration methodologies. Consequently the ARDL technique minimises the possibility of spurious relations through non-stationary data while retaining valuable long-run information (ibid.). The system has an augmentation procedure that uses the minimum number of lags on each variable consistent with statistical significance to remove serial correlation from the error terms (Pesaran and Pesaran, 1997, p. 393).

The ARDL methodology has two parts (ibid., pp. 393-395). The first part uses an F statistic to test the significance of lagged levels of the variables. The F statistic has a non-standard asymptotic distribution regardless of the integration of the variables. Two sets of critical values have been computed for different numbers of regressors and according to whether the ARDL model contains an intercept and/or trend (ibid., pp. 477-478). One set assumes all variables to be I(1) and the other assumes them to be all I(0). This band covers all possible combinations of the variables into I(1) and I(0), or even fractionally integrated ones. The null hypothesis postulates no long-run relationship and can be rejected (accepted) if the F statistic is above (below) the upper (lower) bound. The ARDL technique can be applied irrespective of the order of integration of the underlying variables if the computed F statistic falls outside this band. If the computed F statistic falls inside the band then additional information about the order of integration is necessary to determine the significance of the long-run relationship.

The second part of the methodology consists of a two-stage procedure. The first stage selects the orders of the lags in the ARDL model using one of four choice criteria. They are Theil's (1971) $\overline{R}^2$ criterion proposed by Pesaran and Smith (1994), the Akaike information criterion (AIC) proposed by Akaike (1973, 1974), the Schwarz Bayesian criterion (SBC) proposed by Schwarz (1978) and the Hannan-Quinn Criterion (HQC) proposed by Hannan and Quinn (1979). Pesaran and Pesaran (1997, pp. 352-355) comment briefly on the properties of the last three criteria, which differ mainly in the penalties imposed for the inclusion of additional parameters. The SBC (AIC) leads to the most (least) parsimonious model because it imposes the largest (smallest) number of penalties (ibid., p.353). Lütkepohl (1991) discusses the consistency properties of these statistics. The SBC and HQC are consistent in that, for large samples, they lead to the correct model choice if the 'true' model is part of the set under consideration. This does not mean that the SBC is better than the AIC or $\overline{R}^2$ statistics as the 'true' model may not be part of the set of models being considered. Common sense is therefore needed when selecting the best statistic for determining the optimal lag length. The second stage of this part of the ARDL procedure estimates the selected model using the OLS method.

4.3.3 Summary statistics and diagnostic tests

Microfit 4.0 computes a number of summary statistics and diagnostic tests. The summary statistics used in this study are $\overline{R}^2$, residual sum of squares (RSS), standard error of regression (SER) and the F statistic. Pesaran and Pesaran (1997, pp. 349-352) describe the Lagrange Multiplier (LM) test statistic, and the F test, which are both used to test for residual serial correlation, functional form mis-specification, normality of error terms and heteroscedasticity.

Spurious regression is likely in time series analyses if serial correlation is present, especially when the regression equation contains lagged values of the dependent variable, namely y_{t-1}, y_{t-2}, and so on (ibid., p.72). The LM and F versions of the tests for serial correlation (respectively AR-λ^2 and AR-F) enable one to reject or accept the null hypothesis of no serial correlation against the alternative hypothesis of serial correlation. A significant result is evidence of serial correlation. The Durbin-Watson statistic is also used to test for autocorrelated error terms but is only applicable to models with a single one-period lag (Hendry and Doornik, 1996). Consequently this analysis uses the Durbin-*h* test, which was developed by Durbin (1970) as a large-sample test for first-order serial correlation when lagged dependent variables are present. Ramanathan (1995, p. 543) describes the steps involved in the Durbin-*h* test.

The LM and F versions of Ramsey's Reset test (respectively RESET- λ^2 , and RESET-F) are used to test models for functional form mis-specification (Pesaran and Pesaran, 1997, p. 350). The null hypothesis is the existence of a linear relationship. In this study, a result that passes the 5-percent level of probability is considered to be significant evidence for mis-specification.

The null hypothesis of the normality test is that the error terms have a normal distribution. Microfit 4.0 only computes an LM statistic to test this hypothesis. Pesaran and Pesaran (1997, p. 72) state that " the normality assumption is important in small samples, but is not generally required when the sample under consideration is large enough". Consequently the normality assumption is not important in this study as the samples are large enough to generate normality via the Central Limit Theorem[22].

Microfit 4.0 reports an LM and an F test (H- λ^2 and H-F respectively) for the null hypothesis of constant conditional variance of the error terms (ibid., p. 351).

4.4 The Vector-Autoregression (VAR) Methodology

4.4.1 VAR methodology[23]

Sims (1980) developed the VAR methodology to meet the need for a multivariate model that could estimate relationships among jointly endogenous variables without placing a-priori restrictions on them. All variables in the model are endogenous and can be written as linear functions of their own lagged values and the lagged values of all other variables in the model. The system is very complicated because of the large number of variables that can potentially be included. The number of coefficients to be estimated equals the squared number of endogenous variables times the number of lags used by the model. The degree of complexity therefore tends to grow exponentially and so it is generally useful to consider partially specified systems where only some variables are treated as endogenous and modelled conditionally on the remaining variables.

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[22] The sizes of the samples used in this analysis are given in Table 5.6.

[23] Pesaran and Pesaran (1997, pp. 420-429) give a detailed econometric explanation of the VAR methodology described in this section.

4.4.2 Block Granger causality

Block Granger causality is a "statistical measure of the extent to which lagged values of a set of variables are important in predicting another set of variables once lagged values of the latter set are included in the model" (Pesaran and Pesaran, 1997, p. 131). It is therefore a test of causality between variables in a VAR framework. The null hypothesis of non-causality is tested using a log-likelihood ratio (LR) statistic. Non-causality exists if the coefficient of the jointly determined variables in the VAR is not statistically different from zero. Granger causality tests may give misleading results if the variables in the VAR contain unit roots. This problem can be overcome by using the VAR model in first differences. Pesaran and Pesaran (1997, p. 423) provide a detailed econometric description of block Granger causality.

4.4.3 Forecast error variance (FEV) decompositions

FEV decompositions show the relative proportion of each variable's forecast variance due to each endogenous variable in a model. If a shock to one variable, x, explains none of the forecast variance of variable y, series y is said to be exogenous. Conversely, if shocks to series x explain all of the forecast variance of series y, series y is said to be endogenous. This analysis uses FEV decompositions to determine how the relative proportion of changes in FX and NZ90 accounted for by other variables changed following the introduction of the MCI regime. There are orthogonalised and generalised versions of the FEV decompositions. Pesaran and Pesaran (1997, pp. 427-429) give a detailed econometric explanation of both versions. Orthogonalised FEV decompositions are dependent on the ordering of the variables in the VAR.

4.4.4 Impulse-response (IR) functions

An IR function measures the time profile of the effect of a one standard deviation innovation on the future states of a dynamical system. Two types of IR functions have been developed: the orthogonalized IR function advocated by Sims (1980), and the generalised IR function more recently proposed by Koop *et al.* (1996) and Pesaran and Shin (1997). Pesaran and Pesaran (1997, pp. 423-427) give a detailed econometric explanation of both versions. The two differ in the relative importance they place on the ordering of the variables in the VAR. Orthogonalised IR functions are highly dependent on the order of the variables and are therefore normally analysed in the context of different VAR orderings. However, this approach is impractical when dealing with a large number of variables, especially when the researcher has little knowledge of the correct order of the variables. The generalised approach was developed in order to overcome this limitation and so provides results that are independent of the ordering of the variables in the VAR. The ordering of the variables in the VAR is only important when the error terms of the various regression equations in the VAR system are correlated. When they are not, the orthogonalised and generalised methods give similar results.

4.5 Concluding Comments

This chapter described the four methodologies utilised in this thesis. The first was a mail questionnaire that had to meet several requirements in order to produce valid results. These included the selection of a suitable sample population, an appearance that would impress respondents, and a question construction and sequencing that would minimise any biases. Pre-testing and the use of follow-up mailings were also described. The remaining methodologies were econometric tools that provided a useful basis for examining the relationships existing between the MCI, its components, the US90 and RBNZ policy variables. The first methodology consisted of a series of rolling regressions, which explored the link between the NZ-90 and the NZ-U.S. exchange rate. It was based on a simple relationship used in a Canadian study by Clinton and Zelmer (1997). The second methodology was the ARDL method of cointegration recently developed by Pesaran and Shin (1995). It has two major attractions. The first is that, unlike other cointegration methodologies, it does not require knowledge of whether the variables under consideration are I(0) or I(1). Secondly, it uses an appropriate augmentation to avoid the problems of serial correlation that arise in the use of residual-based cointegration methods. The final methodology was the VAR methodology. It provides a multivariate framework for analysing the nature of the relationship between a number of variables, with block Granger causality, IR functions and FEV decompositions being major by-products. Block Granger causality is an indicator of predictability and does not necessarily imply a cause-effect relationship. FEV decompositions indicate the relative importance of the variables in a VAR in explaining changes in particular variables. IR functions give an indication of the dynamics of a system by showing how variables in a VAR respond to a one standard deviation shock to a selected variable.

5 RESULTS

5.0 Introduction

This chapter presents results obtained from the four methodologies described in chapter four. Section 5.1 presents findings from the survey sent to chief economists at six New Zealand banks. These findings are used, where possible, to explain the results obtained from other methodologies used in by this study. Section 5.2 presents the results obtained from the rolling regressions. They show the nature of the relationship existing between the exchange rate and interest rates in New Zealand and Australia over a ten-year period. Section 5.3 provides information from the ARDL procedure about the relationships between the RBNZ's policy actions, the US90, the MCI and its components. It also looks at the effect of the interest rate cycle on the NZ90. Section 5.4 presents results from block Granger causality tests, FEV decompositions and IR functions. Section 5.5 closes the chapter with some concluding comments.

5.1 Survey Results

The survey (see Appendix 3) obtained information on how the MCI regime affected attitudes and perceptions prevailing within financial markets. The final cut-off date for questionnaire returns was approximately seven weeks after the surveys were first sent out. Five of the six surveys were returned after the seven-week period giving a response rate of 83.3%. However, while these are the response rates for the questionnaires returned, the number of individual questions answered varied. This appeared to be due to respondents having insufficient knowledge to give an accurate response (e.g. one respondent declined to answer questions 8 and 9 because he didn't know what new types of transactions were produced by the banks) rather than an unwillingness to answer the question. The presence of unanswered questions was not a serious problem, as the small sample size meant that statistical techniques such as regression analysis could not be used to analyse the responses.

5.1.1 Section 1: Knowledge and experience of the MCI regime

Question 1

Respondents who worked under the MCI regime.

All respondents worked with the MCI during the MCI regime.

Question 3

The understanding of monetary policy.

	Number
Was made harder by the MCI	1
Was made easier by the MCI	1
The MCI had no affect	3

Questions 4 and 5

Purpose of the MCI.

Two respondents stated that the MCI was supposed to identify desired conditions when interest rates and the exchange rate changed relative to each other. Three respondents stated that the MCI was designed to summarise how conditions were moving relative to the RBNZ's desired level between statements. One respondent also stated that it related the effects of real interest rates and the real exchange rate to real spending and inflation.

Questions 6 and 7

The RBNZ did not always indicate that it was unhappy when the MCI deviated significantly from its announced path.

This reaction confused one respondent because it heightened uncertainty about the RBNZ's tolerance of deviations despite the +/- 50-basis point comfort zone. Two respondents were not confused because they believed that deviations reflected changing views on the inflation outlook and hence changing views on the appropriate level of the MCI. Two respondents indicated that they were sometimes confused because their understanding of the MCI regime was evolving during this period. The Asian financial crisis made things worse and confusion inevitably set in once the RBNZ changed the MCI target band.

Questions 8 and 9

New transactions.

Four respondents agreed that the MCI produced new transactions. These were tailored products incorporating bank bills (and bank futures) and foreign exchange (and foreign exchange forwards/options) for those wishing to speculate or hedge on MCI movements.

Question 10

Impact of new transactions on monetary conditions.

Two respondents believed that the new transactions had an insignificant effect on monetary conditions. A third stated that they pushed the MCI lower as investors/traders attempted to profit from ongoing easing.

Questions 11 and 12

Effect on the exchange rate.

All respondents believed that the MCI affected the N.Z. dollar. It did this in three ways. First, it transferred some of the volatility in the exchange rate to short-term interest rates. Second, it provided some (albeit limited) support for the currency when the MCI fell too far below the RBNZ's desired level. Third, it created confusion about the RBNZ's policy stance and this damaged the credibility of the RBNZ in the eyes of investors.

5.1.2 Section 2: Impact on interest rates from July 1997 to May 1998

Question 13

The impact of the MCI on the way respondents adjusted interest rates.

	Number
Became more reluctant to raise rates	0
Became less reluctant to raise rates	0
Did not affect the approach to changing rates	2
Didn't know	1

Comment: One respondent noted that the MCI made interest rates more volatile and so they had to be adjusted up and down more frequently.

Question 14

Likelihood of the RBNZ intervening to keep the exchange rate stable.

	Number
The RBNZ became less likely to intervene	1
The RBNZ became more likely to intervene	1
Never believed that the RBNZ would intervene	3
Always believed that intervention was likely	0
No opinion	0

Question 15

Likelihood of the RBNZ intervening to adjust interest rates when the MCI exceeded the +/- 50-point tolerance band

	Number
The RBNZ became less likely to intervene	1
The RBNZ became more likely to intervene	2
Never believed that the RBNZ would intervene	1
Always believed that intervention was likely	0
No opinion	0

Comments: Two respondents stated that the tolerance band was only supposed to be tight in the week or two after an MPS. The MCI would inevitably move as new information about the economy and the inflation outlook came to hand. Two respondents noted that the RBNZ did intervene by jawboning.

Questions 16 and 17

Opinions about the rigidity of the target MCI and the consequences for short-term interest rates.

	Number
It was too rigid	5
It was not rigid enough	0
It was used with the correct flexibility	0
Didn't know	0

Comments. Respondent comments can be summarised as follows:

- Other elements (e.g. the shape of the yield curve, fiscal policy, international inflation, asset prices and their wealth effects, unit labour costs, terms of trade, feed-through coefficient and the perceived level of spare capacity) that affected the MCI were also changing. The problem was that the RBNZ placed too tight a response band around the MCI (+/- 50-basis points compared to +/- 150-point band under the exchange rate target zone approach previously employed).

- The RBNZ didn't take account of the changing external environment (e.g. the Asian financial crisis and low international inflation) and the drought which pushed the currency lower. The MCI was being pushed lower for a reason but the RBNZ was slow to respond and this resulted in interest rates going up during the recession in 1998.

Question 18

Opinions about changes in the rigidity of the MCI target.

	Number
It became less rigid	5
It became more rigid	0
The rigidity didn't change	0

5.1.3 Section 3: Effectiveness of the MCI tolerance band

Questions 19 and 20

Did respondents believe that the RNZ changed its tolerance band without informing the market?

	Number
Yes	4
No	0
Didn't know	1

Comment. Respondents indicated that the tolerance band should have been adjusting as new information came to hand because its projected path was conditional on economic developments. It appeared to widen through 1998 but it was difficult to discern if this just reflected new information on the inflation outlook.

Question 21

Did respondents begin ignoring the tolerance bands before the RBNZ removed them?

The responses submitted by the five respondents were:

- No.
- Not really.
- When they failed to act following breaches of the bands.
- Never entirely ignored them but started to treat them as wider.
- Band decayed with time between MPSs.

5.1.4 Section 4: Respondent details

Question 22

Respondent occupation.

Three respondents described themselves as economists, one as a chief dealer and one as a financial market economist.

Question 23

Employer.

Two employers were described as trading banks, two as investment banks and one as a corporate institution.

5.1.5 Summary of survey results

The small size of the sample group limited the usefulness of the survey results. Nevertheless, answers given by respondents do provide interesting insights into the MCI regime. First, the RBNZ adopted the MCI as an operational target for monetary policy in order to reduce uncertainty and improve its communication with financial markets. Answers to questions 3, 4, 5, 6 and 7 indicate that this objective may not have been achieved. For example, some respondents were confused by changes in the bandwidth. Second, answers given to questions 8, 9, 10, 11 and 12 indicate that the MCI regime did produce new transactions and influenced the exchange rate. Further research might reveal the consequences of these developments, especially for monetary conditions. Third, the answers to questions 16 and 17 indicate that the target MCI was too rigid when the Asian financial crisis struck. The RBNZ did not take into account things like the Asian financial crisis and the drought, which were pushing the currency lower. This, according to the survey answers, raised interest rates when the economy went into recession in 1998. These results are consistent with two studies described earlier in this thesis[24]. Gerlach and Smets (2000) found that the optimal MCI weight is smaller than that implied by the elasticities of aggregate demand if it is not always possible to identify the causes of exchange rate changes. Hunt and Orr (1999) used the RBNZ's FPS model to show that the practice of using short-term interest rates to offset exchange rate shocks was inappropriate if exchange rate shocks were not the only source of unexpected macroeconomic activity.

5.2 Rolling Regressions

The New Zealand exchange rate and interest rate data used in this analysis were obtained from Datastream International; the RBA supplied the Australian data. The Shazam 7.0 econometrics computer programme (White, 1997) was used to calculate the exchange rate coefficients.

Table 5.1 lists periods when the sum of the New Zealand exchange rate coefficients ($\beta_1 + \beta_2 + \beta_3 + \beta_4$ in equation 4.1) was negative at the 95% level of significance[25]. Table 5.2 does the same for the Australian coefficients ($\beta_1 + \beta_2 + \beta_3$ in equation 4.1). These results indicate that the two economies had different experiences over the ten-year period covered by the analysis. Most noticeably, New Zealand had a larger number of extended periods when the sum of the coefficients was significantly negative. This is perhaps not surprising given the different approaches to monetary policy adopted by the RBNZ and RBA.

Figure 5.1 plots the sums of the New Zealand coefficients obtained from equation 4.1. Figure 5.2 does the same for Australia. The top half of each figure shows how the value of the exchange rate changed over the sample period. This makes it easy to match up the time pattern of the coefficients, which are shown in the lower part of each figure, with periods of exchange rate depreciation. Shaded areas represent periods consisting of twenty or more days when the rolling regressions generated statistically significant negative coefficients[26].

[24] The study by Gerlach and Smets (2000) is described in section 2.7, and the study by Hunt and Orr (1997) is described in section 3.7.

[25] This methodology was explained in section 4.2

[26] A period of twenty days was chosen because of the difficulty in marking periods of shorter duration on the graphs. Computer software that could accurately shade regions with statistically negative coefficients was unavailable and so these areas were marked by hand.

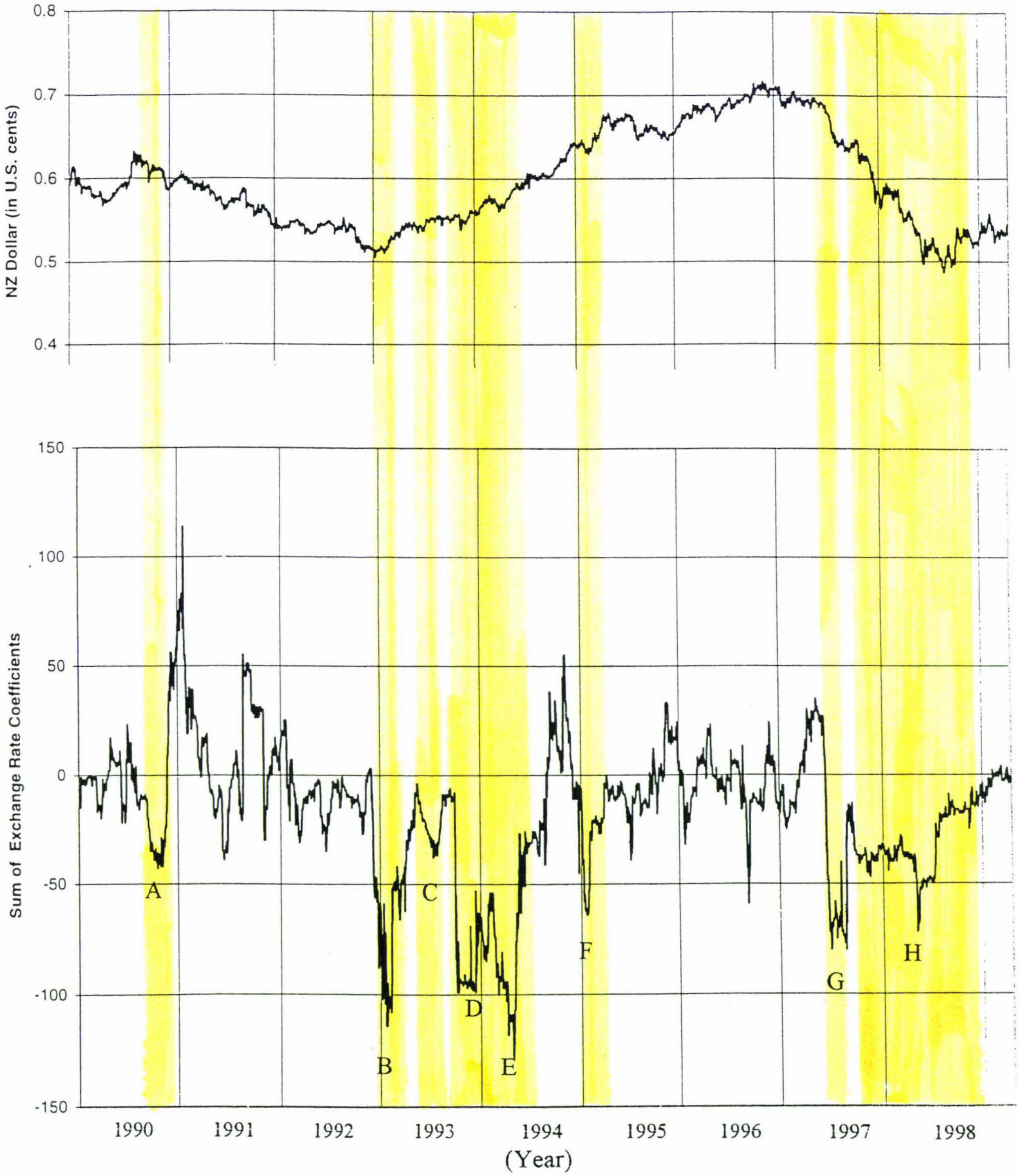
Table 5.1 Periods with Significant Negative Exchange Rate Coefficients (New Zealand Rolling Regressions).

Period	Number of days
5-7 January 1990	3 days
19 March 1990 to 25 March 1990	7 days
10 September 1990 to 13 November 1990	64 days
7 June 1991 to 26 June 1991	19 days
31 October 1991 to 3 November 1991	4 days
15 October 1992 to 10 November 1992	16 days
8 January 1993 to 13 February 1993	36 days
24 February 1993 to 28 April 1993	63 days
2 June 1993 to 12 August 1993	71 days
1 October 1993 to 15 May 1994	227 days
19 August 1994 to 21 August 1994	3 days
10 January 1995 to 8 February 1995	29 days
27 February 1995 to 26 March 1995	27 days
4 July 1995 to 11 July 1995	8 days
19 July 1995 to 22 July 1995	4 days
13 November 1995 to 20 November 1995	7 days
5 September 1996 to 15 November 1996	11 days
21 January 1997 to 4 February 1997	15 days
12 June 1997 to 20 August 1997	69 days
16 September 1997 to 15 November 1998	425 days

Table 5.2 Periods with Significant Negative Exchange Rate Coefficients (Australian Rolling Regressions)

Period	Number of days
14 December 1990 to 31 December 1990	17 days
22 July 1992 to 28 October 1992	98 days
4 June 1993 to 7 October 1993	125 days
21 March 1995 to 23 March 1995	2 days
2 May 1998 to 5 October 1998	166 days

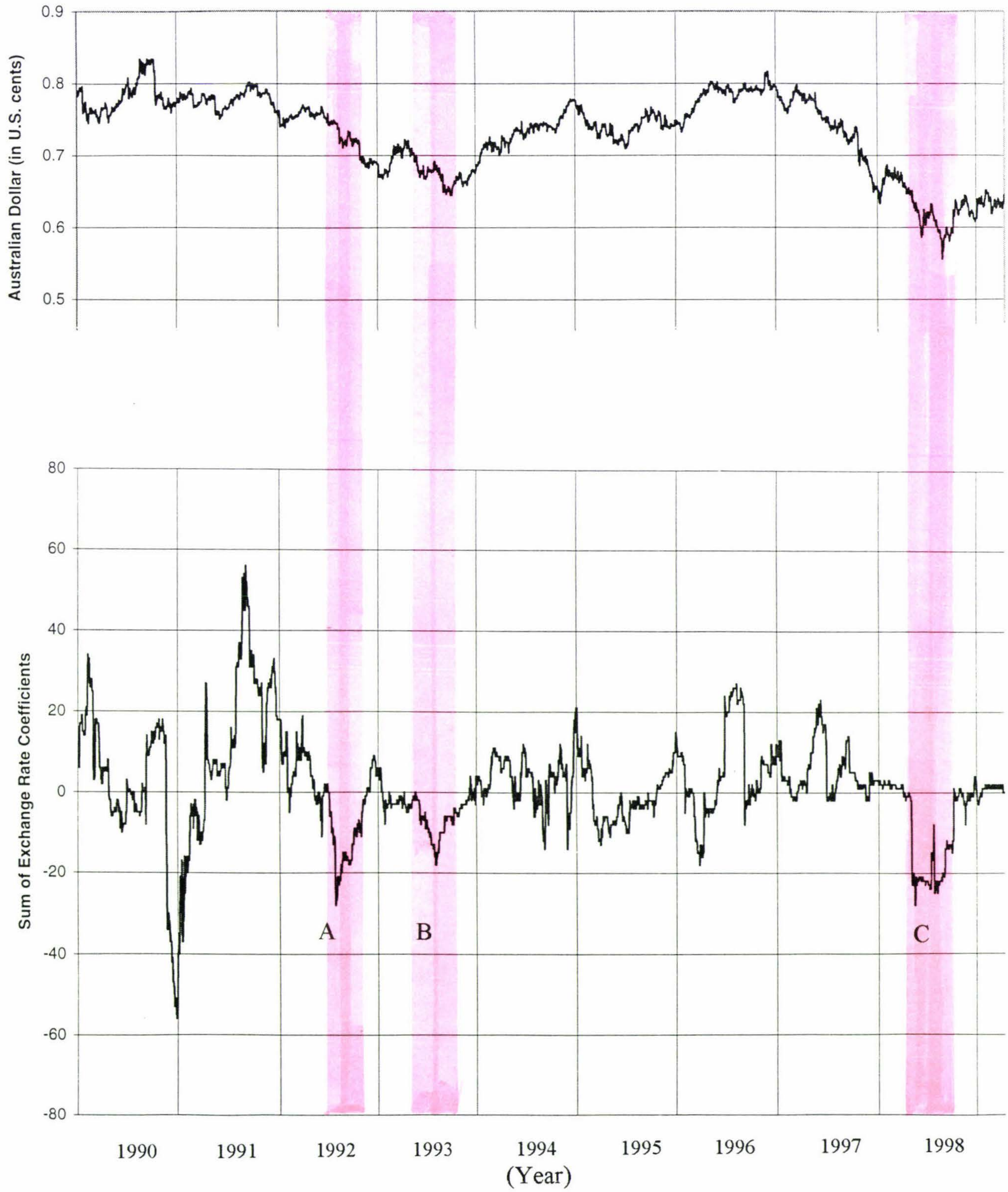
Figure 5.1 Sensitivity of the NZ-US Interest Rate Spread to Exchange Rate Changes



Notes:

1. The exchange rate coefficients were calculated from equation 4.1 using the SHAZAM econometrics programme.
2. Shaded areas represent statistically significant negative coefficients

Figure 5.2 Sensitivity of the Australian-US Interest Rate Spread to Exchange Rate Changes



Notes: See Figure 5.1.

Portfolio shocks occur when market participants alter their premiums for political and economic uncertainties affecting the economy. This is the most likely explanation for negative spikes such as point B in Figure 5.2. In such cases, the inverse relationship between short-term interest rates and the exchange rate disappeared and the coefficients returned to zero once the uncertainty abated. Tables 5.3 and 5.4 list events likely to have generated the negative spikes labelled in Figures 5.1 and 5.2.

Two periods in Figure 5.1 are particularly interesting. The first lasted from December 1992 until May 1994. The RBNZ altered monetary policy settings only once during that time, in January 1993 when the amount of settlement cash was reduced to zero in order to maintain the credibility of monetary policy[27]. That intervention was enough to convince financial markets of the RBNZ's resolve to meet its inflation goals. Thereafter the RBNZ was able to use public statements to prevent any undue easing of monetary conditions. These "open mouth operations" therefore appear to have had a strong effect on the relationship between short-term interest rates and the exchange rate. This supports the finding by Bonato *et al.* (1999) that RBNZ announcements have a significant impact on public expectations[28].

The second period lasted from mid-1997 until late 1999. The New Zealand dollar peaked in value in late-1996 and then depreciated dramatically before stabilising in late-1998. A significant inverse relationship developed between short-term interest rates and the exchange rate in late June 1997. This coincided with the introduction of the MCI regime and lasted, with one short break, until November 1999, just before the adoption of the OCR system. Figure 5.2 shows that the Australian exchange rate changed along similar lines but that the pattern of change in the coefficients differed. The inverse relationship in Australia was confined to a 166-day period in 1998. This was almost a year after the MCI regime was adopted in New Zealand and when the worst effects of the Asian financial crisis were being felt.

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[27] This incident is described in section 3.3.

[28] The study by Bonato *et al.* (1999) is discussed in section 3.4.2.

Table 5.3 Events Generating Inverse Relationships in Figure 5.1

Event	Description of Event
A	The 1990 General Election.
B	The RBNZ reduces the settlement cash target to zero in order to maintain the credibility of monetary policy in the face of rising inflationary pressure.
C	The government releases its 1993 Budget. A deficit of $2.3 billion is projected for the 1993/4 fiscal year.
D	The 1993 General Election. Turbulence in foreign exchange markets due to problems in the European Monetary System.
E	The U.S. Federal Reserve increases the federal funds rate from 3 to 3.25 percent. Volatility in foreign exchange markets.
F	Volatility in foreign exchange markets due to the Mexican financial crisis. The U.S. Federal Reserve Board increases both the federal funds and discount rates by 0.50 percentage points to 6.0 and 5.25 percent respectively.
G	The RBNZ adopts the MCI as an operational target for monetary policy.
H	The Asian financial crisis reduces import prices and causes international investors to reduce their holdings of New Zealand dollars. The MCI regime remains in force.

Table 5.4 Events Generating Inverse Relationships in Figure 5.2

Event	Description of Event
A	A widening of the current account deficit induced international investors to reduce their holdings of Australian dollars.
B	Export prices fall.
C	International investors reduce their holdings of Australian dollars as the Asian financial crisis threatens to impact on export prices.

These results suggest that the MCI regime hindered the implementation of monetary policy by creating a systematic negative relationship between the exchange rate and short-term interest rates. Figure 3.5 shows that an upward trend developed in the NZ90 in mid-1997 when this inverse relationship began. These results support the view advanced by the *Economist* (1999, p. 40) that the MCI regime deepened the 1998 recession by raising interest rates. They are also consistent with comments made in reply to questions 16 and 17 of the survey (see section 5.1.2) that the target MCI was too rigid and that the RBNZ underestimated the external influences which were pushing down the exchange rate, and hence the MCI.

5.3 The ARDL Results

5.3.1 Introduction

The results from ADF tests and the ARDL analysis are reported in this section. For each dependent variable, the ARDL results consist of the parameter estimates, an EC representation and the derived long-run coefficients. The data were initially partitioned according to changes in the RBNZ's operating framework. However, as is evident in Figure 5.3, the data can also be divided according to the interest rate cycle. This poses a problem because changes in financial market volatility may have been responsible for observed changes in the statistical relationship between variables. Two mechanisms are possible. First, external shocks may have caused financial markets to respond less smoothly than usual to RBNZ policy actions. Unsettled markets are more likely to have misinterpreted the RBNZ's signals as the volume of market "noise" increased. Second, external shocks may have reduced the relative impact of policy initiatives on money market rates by causing the RBNZ to react to market turbulence rather than focus on its strategic objectives. Consequently, a second series of regressions was conducted with the data partitioned according to the interest rate cycle.

Periods A and B together make up the pre-MCI sample, periods C and D comprise the interval covered by the MCI regime, and period E corresponds with the OCR regime. Interest rates increased in period A and trended downwards in period B. Period C saw rates trend upward with heightened volatility before falling dramatically in period D. There was an upward trend in rates during period E, but it was less pronounced than earlier trends and with reduced volatility.

Figure 5.3 The Interest Rate Cycle (90-day bank bill rate)

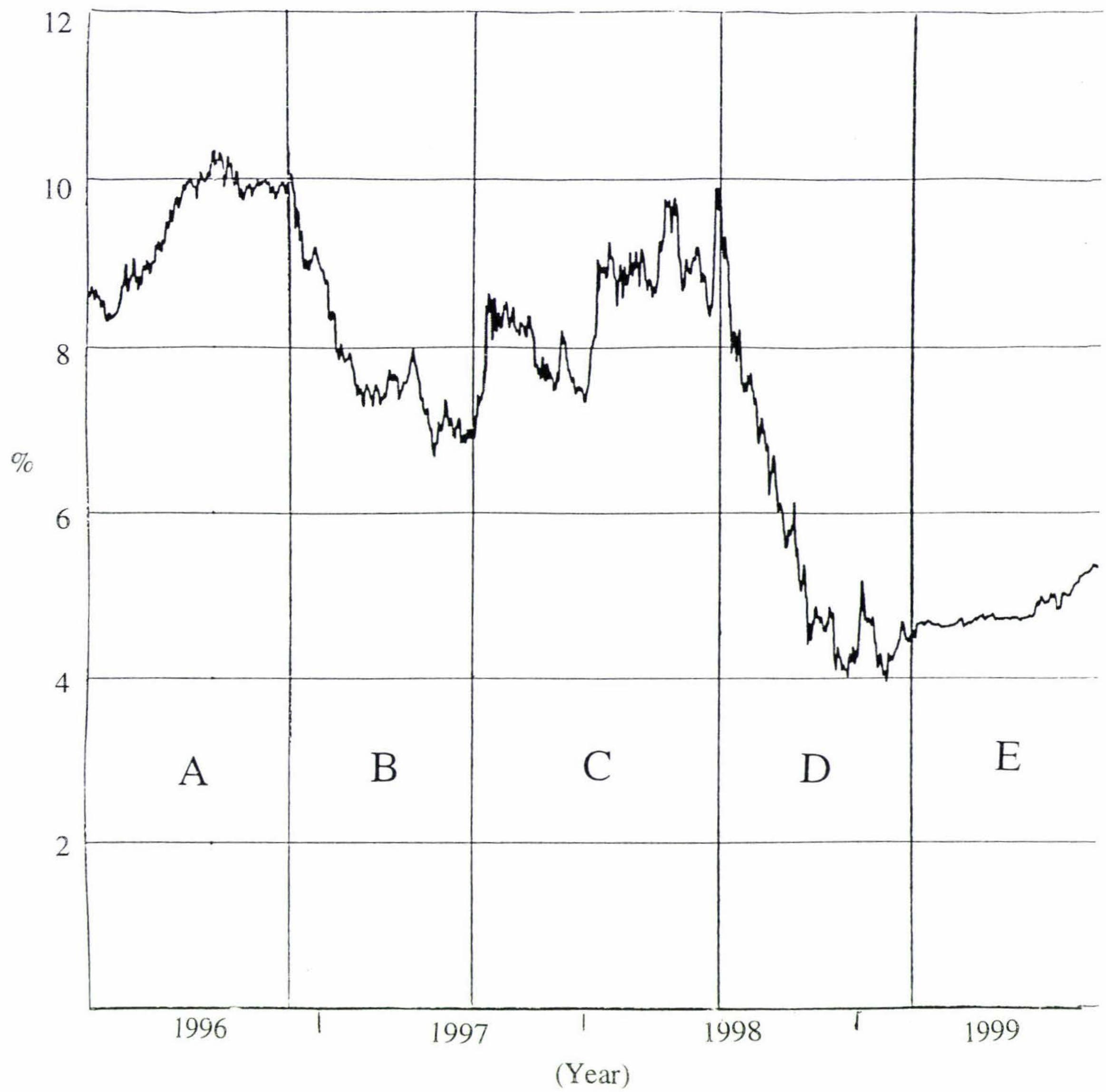


Table 5.5 lists all variables used in the ARDL analysis (RBBs were not included, as there was no suitable data available). Table 5.6 lists the dates of the sample periods and the number of observations in each sample. The dependent variables in the regressions were the MCI, FX and NZ90. The policy variables are described in section 3.4.1. Two numbers, the ODMG and ODMP, are quoted for the ODM under the OCR regime. The ISC was not included in models for the OCR regime as its value was constant throughout that period.

The test statistics and diagnostic tests reported for these results were described in section 4.3.3. The $\overline{R}^2$ statistics for the ARDL parameter estimates all exceed 0.960 because the data contain information about dynamic short-run relationships. The $\overline{R}^2$ statistics for the EC representations are much lower and range from 0.03 to 0.58. This is because the

Table 5.5 Variables Reported in the Chapter Five Results Tables

	Abbreviation	Variable
Conditioning Variables	MCI	Monetary Conditions Index
	FX	N.Z.-U.S. Exchange Rate (in U.S. cents)
	NZ90	New Zealand 90-day Bank Bill Rate
	US90	United States 90-day Bill Rate
	EC	Error Correction Term
Policy Variables	ODM	Overnight Discount Margin
	ODMG	Overnight Discount Margin (Government Securities)
	ODMP	Overnight Discount Margin (Private Paper)
	LO	Liquidity Operations
	LFV	Liquid Forecast Variation
	TBS	Treasury Bill Sales
	ISC	Interest Rate on Settlement Cash

Table 5.6 Sample Periods Used in the ARDL Analysis

	Sample Period	Dates	Number of Observations
Data partitioned according to the RBNZ's monetary policy operating framework.	Pre-MCI Period	8 January 1996 to 30 June 1997	376
	MCI Period	1 July 1997 to 16 March 1999	430
	OCR Period	17 March 1999 to 25 November 1999	161
Data partitioned according to the interest rate cycle.	Period A (Rising Rates)	8 January 1996 to 30 October 1996	199
	Period B (Falling Rates)	31 October 1996 to 30 June 1997	177
	Period C (Volatile Rates)	1 July 1997 to 15 June 1998	249
	Period D (Falling Rates)	16 June 1998 to 16 March 1999	181
	Period E (Rising Rates)	17 March 1999 to 25 November 1999	161

EC representations are calculated using differenced data and all information about any dynamic short or long-term relationships is lost when data is differenced[29].

Dummy variables (DVM, DVX and DVN) and explanatory variables transformed into squared terms were entered into the regression equations to improve the results obtained from the diagnostic test results. Dummy variables were created by identifying outliers in the data and matching them up with events that may have affected interest rates and/or the exchange rate. Examples included speeches by the RBNZ governor, national elections and changes to fiscal policy. Dummy variables were included in the reported results if they were significant and improved the diagnostic test results. No guidelines for using dummy variables in an ARDL analysis were found in the literature, and so models containing them were subjected to two regressions. The first regression was conducted with the dummy variables included in the models; the results are presented in sections 5.3.4 to 5.3.6. The results of the second regression, which was conducted without dummy variables, are presented in section 5.3.7. As will be seen, the dummy variables improved the diagnostic test results without significantly affecting the regression results or the conclusions that could be drawn from them. All dummy variables used in the ARDL analysis are described in Appendix 5.

The computer software Microfit 4.0 was used for the ARDL analysis and all data were obtained from the financial services department of the RBNZ.

5.3.2 Unit root tests

ADF tests for unit roots with and without trend were performed on all variables in each sample period. Tables 5.7. 5.8 and 5.9 display results obtained when the data series were partitioned according to the different operating frameworks. Tables 5.10, 5.11, 5.12 and 5.13 display results obtained when the data series were partitioned according to the interest rate cycle. Each ADF test started with eight lags; the model was reduced until the highest significant lag was reached. The null hypothesis of a unit root can be rejected if the absolute value of the ADF statistic is greater than the 95-percent critical value. The data series in such a case is said to be stationary. The variables used in this analysis are therefore a mixture of I(0), I(1) and I(2) variables, and would give spurious results if subjected

[29] The process of differencing a data series is discussed in section 4.3.1.

Table 5.7 Unit Root Tests for Variables in the Pre-MCI Period Sample

	Variables	Number Of Lags	Without Trend		With Trend	
			ADF Statistic	5% Critical Value	ADF Statistic	5% Critical Value
Levels	MCI	0	-2.279	-2.870	-1.781	-3.424
	FX	0	-2.837	-2.870	-2.423	-3.424
	NZ90	0	-0.098	-2.870	-1.658	-3.424
	US90	1	-1.378	-2.870	-2.741	-3.424
	ODM	3	-0.064	-2.870	-1.637	-3.424
	ISC	3	-0.022	-2.870	-1.607	-3.424
	LFV	0	-17.862*	-2.870	-17.850*	-3.424
	LO	0	-18.759*	-2.870	-18.737*	-3.424
	TBS	4	-3.500*	-2.870	-3.560*	-3.424
First Differences	MCI	0	-21.041*	-2.870	-21.200*	-3.424
	FX	0	-19.712*	-2.870	-19.790*	-3.424
	NZ90	0	-19.724*	-2.870	-19.894*	-3.424
	US90	0	-23.118*	-2.870	-23.102*	-3.424
	ODM	2	-10.294*	-2.870	-10.454*	-3.424
	ISC	2	-10.043*	-2.870	-10.226*	-3.424

Note: * Significant at the 5% level.

Table 5.8 Unit Root Tests for Variables in the MCI Period Sample

	Variables	Number Of Lags	Without Trend		With Trend	
			ADF Statistic	5% Critical Value	ADF Statistic	5% Critical Value
Levels	MCI	0	-0.618	-2.869	-1.573	-3.422
	FX	0	-2.114	-2.869	-1.742	-3.422
	NZ90	0	-0.245	-2.869	-1.975	-3.422
	US90	0	0.418	-2.869	-1.020	-3.422
	ODM	1	-0.984	-2.869	-2.179	-3.422
	ISC	1	-0.767	-2.869	-1.990	-3.422
	LFV	0	-19.814*	-2.869	-19.801*	-3.422
	LO	1	-2.628	-2.869	-2.675	-3.422
	TBS	0	-18.014*	-2.869	-18.181*	-3.422
First Differences	MCI	0	-21.116*	-2.869	-21.092*	-3.422
	FX	0	-21.745*	-2.869	-21.825*	-3.422
	NZ90	0	-20.127*	-2.869	-20.192*	-3.422
	US90	0	-21.451*	-2.869	-21.620*	-3.422
	ODM	0	-24.888*	-2.869	-24.874*	-3.422
	ISC	0	-23.826*	-2.869	-23.821*	-3.422
	LO	0	-22.648*	-2.869	-22.638*	-3.422

Note: * Significant at the 5% level.

Table 5.9 Unit Root Tests for Variables in the OCR Period Sample

	Variables	Number Of Lags	Without Trend		With Trend	
			ADF Statistic	5% Critical Value	ADF Statistic	5% Critical Value
Levels	MCI	0	-1.228	-2.880	-3.173	-3.439
	FX	0	-1.502	-2.880	-3.206	-3.439
	NZ90	0	0.700	-2.880	-1.474	-3.439
	US90	3	-0.450	-2.880	-2.562	-3.439
	ODMG	0	-0.115	-2.880	-0.451	-3.439
	ODMP	0	-1.781	-2.880	-0.757	-3.439
	LFV	0	-10.639*	-2.880	-10.795*	-3.439
	LO	0	-2.934*	-2.880	-2.891	-3.439
	TBS	1	-11.587*	-2.880	-10.107*	-3.439
First Differences	MCI	0	-13.579*	-2.880	-13.743*	-3.439
	FX	0	-12.979*	-2.880	-13.062*	-3.439
	NZ90	0	-11.227*	-2.880	-11.482*	-3.439
	US90	1	-19.765*	-2.880	-19.959*	-3.439
	ODMG	0	-12.329*	-2.880	-12.644*	-3.439
	ODMP	0	-12.252*	-2.880	-12.570*	-3.439
	LO	0	-2.934*	-2.880	-12.437*	-3.439

Note: * Significant at the 5% level.

Table 5.10 Unit Root Tests for Variables in Period A of the Interest Rate Cycle

	Variables	Number Of Lags	Without Trend		With Trend	
			ADF Statistic	5% Critical Value	ADF Statistic	5% Critical Value
Levels	MCI	0	-1.496	-2.887	-3.189	-3.450
	FX	0	-2.716	-2.887	-2.518	-3.450
	NZ90	0	0.018	-2.887	-3.689*	-3.450
	US90	0	-1.291	-2.887	-3.146	-3.450
	ODM	0	-0.947	-2.887	-1.811	-3.450
	ISC	0	-0.751	-2.887	-1.890	-3.450
	LFV	0	-11.729*	-2.887	-11.681*	-3.450
	LO	0	-10.926*	-2.887	-10.888*	-3.450
	TBS	0	-7.942*	-2.887	-7.930*	-3.450
First Differences	MCI	0	-10.540*	-2.887	-10.489*	-3.450
	FX	0	-10.937*	-2.887	-10.990*	-3.450
	US90	0	-12.019*	-2.887	-12.107*	-3.450
	ODM	0	-11.166*	-2.887	-11.124*	-3.450
	ISC	0	-10.225*	-2.887	-10.180*	-3.450

Note: * Significant at the 5% level.

Table 5.11 Unit Root Tests for Variables in Period B of the Interest Rate Cycle

	Variables	Number Of Lags	Without Trend		With Trend	
			ADF Statistic	5% Critical Value	ADF Statistic	5% Critical Value
Levels	MCI	1	-1.378	-2.879	-2.105	-3.437
	FX	0	-1.806	-2.879	-3.647*	-3.437
	NZ90	0	-2.189	-2.879	-2.269	-3.437
	US90	3	-0.641	-2.879	-1.883	-3.437
	ODM	3	-1.949	-2.879	-2.225	-3.437
	ISC	7	-2.041	-2.879	-2.319	-3.437
	LFV	0	-10.484*	-2.879	-10.473*	-3.437
	LO	0	-11.867*	-2.879	-11.823*	-3.437
	TBS	4	-4.601*	-2.879	-4.597*	-3.437
First Differences	MCI	0	-16.225*	-2.879	-21.092*	-3.437
	NZ90	0	-12.630*	-2.879	-20.192*	-3.437
	US90	1	-12.863*	-2.879	-21.620*	-3.437
	ODM	3	-6.309*	-2.879	-17.353*	-3.437
	ISC	3	-6.055*	-2.879	-23.821*	-3.437

Note: * Significant at the 5% level.

Table 5.12 Unit Root Tests for Variables in Period C of the Interest Rate Cycle

	Variables	Number Of Lags	Without Trend		With Trend	
			ADF Statistic	5% Critical Value	ADF Statistic	5% Critical Value
Levels	MCI	0	0.599	-2.874	-3.173	-3.430
	FX	0	-0.624	-2.874	-3.206	-3.430
	NZ90	0	-2.278	-2.874	-1.474	-3.430
	US90	3	-1.954	-2.874	-2.562	-3.430
	ODM	0	-2.865	-2.874	-0.451	-3.430
	LFV	0	-14.525*	-2.874	-10.795*	-3.430
	LO	0	-13.427*	-2.874	-2.891	-3.430
	TBS	5	-4.919*	-2.874	-10.107*	-3.430
First Differences	MCI	0	-19.846*	-2.874	-19.961*	-3.430
	FX	0	-17.299*	-2.874	-17.266*	-3.430
	NZ90	0	-15.121*	-2.874	-15.101*	-3.430
	US90	0	-19.984*	-2.874	-16.589*	-3.430
	ODM	0	-16.622*	-2.874	-12.644*	-3.430

Note: * Significant at the 5% level.

Table 5.13 Unit Root Tests for Variables in Period D of the Interest Rate Cycle

	Variables	Number Of Lags	Without Trend		With Trend	
			ADF Statistic	5% Critical Value	ADF Statistic	5% Critical Value
Levels	MCI	0	-2.107	-2.878	-1.442	-3.437
	FX	0	-2.432	-2.878	-1.615	-3.437
	NZ90	0	-1.862	-2.878	-2.592	-3.437
	US90	0	-0.433	-2.878	-2.583	-3.437
	ODM	1	-2.502	-2.878	-2.522	-3.437
	ISC	1	-2.512	-2.878	-2.188	-3.437
	LFV	1	-7.523*	-2.878	-7.768*	-3.437
	LO	0	-11.817*	-2.878	-11.938*	-3.437
	TBS	4	-3.914*	-2.878	-4.827*	-3.437
First Differences	MCI	1	-2.211	-2.878	-1.716	-3.437
	FX	0	-13.196*	-2.878	-13.156*	-3.437
	NZ90	0	-12.792*	-2.878	-13.051*	-3.437
	US90	1	-13.556*	-2.878	-13.537*	-3.437
	ODM	0	-17.222*	-2.878	-17.302*	-3.437
	ISC	0	-16.139*	-2.878	-16.267*	-3.437
Second Differences	MCI	0	-19.583*	-2.878	-19.684*	-3.437

Note: * Significant at the 5% level.

to an OLS regression. This study uses the ARDL method of co-integration to overcome this problem because it can be used regardless of the order of integration of the variables.

5.3.3 The F Test[30]

The F test was used to test the significance of the lagged variables in each ARDL model. The results are reported in Table 5.14. In every equation, the F statistic is below the lower bound of the critical value band at the 99-percent level of significance and so the null hypothesis of no long-run relationship can be accepted. Thus the ARDL co-integration technique can be used to estimate the short-run relationships between the variables in these equations and provide explanations for their values.

[30] The F test is described in section 4.3.2.

Table 5.14 ARDL Procedure: the F Test

Equation	Degrees of Freedom	Critical Value Band Intercept and No Trend* I(0)	I(1)	F statistic
The Pre-MCI Regime				
MCI	6	3.267	4.540	1.491
NZ-90	7	3.027	4.296	2.770
FX Rate	7	3.027	4.296	1.433
The MCI Regime				
MCI	6	3.267	4.540	1.127
NZ-90	7	3.027	4.296	2.593
FX Rate	7	3.027	4.296	1.319
The OCR Regime				
MCI	7	3.027	4.296	1.373
NZ-90	8	2.848	4.126	1.180
FX Rate	8	2.848	4.126	1.762
Period A (Rising Rates)				
NZ-90	7	3.027	4.296	0.956
Period B (Falling Rates)				
NZ-90	7	3.027	4.296	0.929
Period C (Volatile Rates)				
NZ-90	7	3.027	4.296	2.410
Period D (Falling Rates)				
NZ90	7	3.027	4.296	1.693
Period E (Rising Rates)				
NZ90	8	2.848	4.126	1.180

Note: The two sets of critical values were calculated at the 99-percent level of significance by Pesaran and Pesaran (1997, pp. 477-8).

5.3.4 Regression estimates for the MCI models

Tables 5.15a, 5.16a and 5.17a report parameter estimates, EC representations and estimated long-run coefficients for the MCI models. The results in Tables 5.15b, 5.16b and 5.17b were obtained from the same models, however the pre-MCI period model did not include any dummy variables. A comparison of tables 5.15a and 5.15b shows that the dummy variables improved all diagnostic test results and made the H-λ^2 and H-F test statistics insignificant.

The models in Table 5.15a pass all diagnostic tests except the MCI period H-λ^2 and H-F tests. The presence of heteroscedasticity is not unexpected as "the assumption that the conditional variance of the residuals is constant is often violated in analyses of financial and macro-economic time series, such as exchange rates, stock returns and interest rates" (Pesaran and Pesaran, 1997, p. 72). Heteroscedasticity makes parameter estimates less reliable by widening their confidence intervals. Evidence of a relationship between two variables may therefore mean little if it is statistically weak and heteroscedasticity is present. Thus the $US90_t$ coefficient in the MCI period should be ignored because it is only significant at the 10-percent level. Except for lagged values of the ODM in the pre-MCI period, the coefficients of all policy variables in Table 5.15a are insignificant. This suggests that the value of the MCI was unaffected by the RBNZ's policy instruments or by external influences as represented by the US90. A final feature of the results in Table 5.15a worth mentioning is that the MCI_{t-1} coefficient in each operating framework is significant at the 1-percent level.

EC representations for the MCI models are reported in Table 5.16a. First differences represent short-run dynamics while lags of level variables represent long-run dynamics (Granger, 1988, and Jones and Joulifan, 1991). The EC_{t-1} coefficient is significantly negative in each operating framework. This implies that an adjustment mechanism prevents the error terms from getting larger by forcing the MCI towards an equilibrium point. The mechanism was strongest in the pre-MCI period and weakest during the MCI regime, with the test statistics being -0.128 and -0.025 respectively. The pre-MCI coefficient in Table 5.16b was -0.059, and so the dummy variables increased the speed of the adjustment mechanism substantially.

5.15a ARDL Parameter Estimates for the MCI Models

Dependent Variable is MCI[#]			
Variable	Period		
	Pre-MCI Regime[a]	MCI Regime[b]	OCR Regime[c]
Intercept	78.101 (0.334)	60.584 (0.009)***	32.398 (0.748)
MCI_{t-1}	0.872 (0.000)***	0.975 (0.000)***	0.822 (0.000)***
MCI_{t-2}			0.104 (0.219)
$US90_t^{‡□}$	-1.379 (0.900)	-1.083 (0.051)*	2.003 (0.232)
$ODM_t^{†}$	0.982 (0.282)	-0.387 (0.901)	
$ODM_{t-1}^{†}$	-1.846 (0.000)***		
$ODM_{t-2}^{†}$	0.798 (0.011)**		
$ODMG_t^{□}$			-3.595 (0.432)
$ODMP_t^{□}$			1.443 (0.291)
$ISC_t^{†‡}$	0.948 (0.531)	0.262 (0.503)	
$LFV_t^{□}$	0.007 (0.862)	0.043 (0.296)	0.000 (0.803)
$TBS_t^{□}$	0.000 (0.673)	-0.004 (0.225)	0.000 (0.807)
$LO_t^{□}$	-0.002 (0.544)	-0.001 (0.643)	0.000 (0.043)**
Trend	0.108 (0.001)***	-0.085 (0.011)**	-0.405 (0.032)**
Dummy Variables			
DVM1	-17.053 (0.001)***		
DVM2	-20.578 (0.006)***		
DVM3	21.684 (0.011)**		
Test Statistics and Diagnostic Tests			
$\overline{R}^2$	0.967	0.998	0.968
SER	16.348	19.663	28.392
RSS	96214.6	162384	120105
F-statistic	F(13, 360) 843.9 (0.000)	F(8, 420) 22873 (0.000)	F(9, 149) 525 (0.000)
AR-λ^2	0.864 (0.353)	0.372 (0.542)	0.131 (0.718)
AR-F	F(1, 359) 0.831 (.363)	F(1, 419) 0.363 (0.547)	F(1, 148) 0.122 (0.728)
Durbin *h*-statistic	-0.890 (0.374)	-0.462 (0.644)	
RESET-λ^2	0.283 (0.595)	0.251 (0.616)	2.624 (0.105)
RESET-F	F(1, 359) 0.272 (0.602)	F(1, 419) 0.245 (0.621)	F(1, 148) 2.483 (0.117)
H-λ^2	2.394 (0.122)	9.190 (0.002)	1.432 (0.232)
H-F	F(1, 372) 2.396 (0.122)	F(1, 427) 9.347 (0.002)	F(1, 157) 1.426 (0.234)

Notes:
*, **, *** indicate the 10%, 5% and 1% levels of significance respectively.
[#] The p-value of each test statistic is given in brackets.
[a] The ARDL model has a lag structure of (2, 0, 2, 0, 0, 0, 0) based on the SBC.
[b] The ARDL model has a lag structure of (1, 0, 0, 0, 0, 0, 0) based on the SBC.
[c] The ARDL model has a lag structure of (2, 0, 0, 0, 0, 0, 0) based on the $\overline{R}^2$ Criterion.
[†] Indicates a variable that entered the regression equation as a squared term in the pre-MCI period.
[‡] Indicates a variable that entered the regression equation as a squared term in the MCI period.
[□] Indicates a variable that entered the regression equation as a squared term in the OCR period.

5.15b ARDL Parameter Estimates for the MCI Models Without Dummy Variables

Dependent Variable is MCI[#]			
Variable	Period		
	Pre-MCI Regime[a]	MCI Regime[b]	OCR Regime[c]
Intercept	45.426 (0.577)	60.584 (0.009)***	32.398 (0.748)
MCI_{t-1}	0.941 (0.000)***	0.975 (0.000)***	0.822 (0.000)***
MCI_{t-2}			0.104 (0.219)
$US90_t^{\ddagger\square}$	-2.897 (0.796)	-1.083 (0.051)*	2.003 (0.232)
$ODM_t^{\dagger}$	-0.036 (0.968)	-0.387 (0.901)	
$ODMG_t^{\square}$			-3.595 (0.432)
$ODMP_t^{\square}$			1.443 (0.291)
$ISC_t^{\dagger\ddagger}$	3.156 (0.055)*	0.262 (0.503)	
$LFV_t^{\square}$	0.019 (0.629)	0.043 (0.296)	0.000 (0.803)
$TBS_t^{\square}$	0.001 (0.156)	-0.004 (0.225)	0.000 (0.807)
$LO_t^{\square}$	-0.002(0.481)	-0.001 (0.643)	0.000 (0.043)**
Trend	0.033 (0.198)	-0.085 (0.011)**	-0.405 (0.032)**
Test Statistics and Diagnostic Tests			
$\overline{R}^2$	0.965	0.998	0.968
SER	16.917	19.663	28.392
RSS	104168.5	162384	120105
F-statistic	F(9, 364) 1135.4 (0.000)	F(8, 420) 22873 (0.000)	F(9, 149) 525 (0.000)
AR-λ^2	1.565 (0.211)	0.372 (0.542)	0.131 (0.718)
AR-F	F(1, 363) 1.525 (0.218)	F(1, 419) 0.363 (0.547)	F(1, 148) 0.122 (0.728)
Durbin *h*-statistic	-1.199 (0.231)	-0.462 (0.644)	
RESET-λ^2	1.025 (0.311)	0.251 (0.616)	2.624 (0.105)
RESET-F	F(1, 363) 0.997 (0.319)	F(1, 419) 0.245 (0.621)	F(1, 148) 2.483 (0.117)
H-λ^2	3.296 (0.069)	9.190 (0.002)	1.432 (0.232)
H-F	F(1, 372) 3.308 (0.070)	F(1, 427) 9.347 (0.002)	F(1, 157) 1.426 (0.234)

Notes:
*, **, *** indicate the 10%, 5% and 1% levels of significance respectively.
[#] The p-value of each test statistic is given in brackets.
[a] The ARDL model has a lag structure of (2, 0, 0, 0, 0, 0, 0) based on the SBC.
[b] The ARDL model has a lag structure of (1, 0, 0, 0, 0, 0, 0) based on the SBC.
[c] The ARDL model has a lag structure of (2, 0, 0, 0, 0, 0, 0) based on the $\overline{R}^2$ Criterion.
[†] Indicates a variable that entered the regression equation as a squared term in the pre-MCI period.
[‡] Indicates a variable that entered the regression equation as a squared term in the MCI period.
[□] Indicates a variable that entered the regression equation as a squared term in the OCR period.

Table 5.16a Error Correction Estimates for the MCI Models

Dependent Variable is $\Delta MCI^{\#}$			
Variable	Period		
	Pre-MCI Regime[a]	MCI Regime[b]	OCR Regime[c]
ΔMCI_1			-0.104 (0.219)
ΔTrend	0.108 (0.001)***	-0.085 (0.011)**	-0.405 (0.032)**
ΔIntercept	78.101 (0.334)	60.584 (0.009)***	32.398 (0.748)
$\Delta US90^{\ddagger\square}$	-1.379 (0.900)	-1.083 (0.051)*	2.003 (0.232)
$\Delta ODM^{\dagger}$	0.982 (0.282)	-0.387 (0.901)	
$\Delta ODM_1^{\dagger}$	-0.798 (0.011)**		
$\Delta ODMG^{\square}$			-3.595 (0.432)
$\Delta ODMP^{\square}$			-1.443 (0.291)
$\Delta ISC^{\dagger\ddagger}$	0.948 (0.531)	0.262 (0.503)	
$\Delta LFV^{\square}$	0.007 (0.862)	0.433 (0.296)	0.000 (0.803)
$\Delta LO^{\square}$	-0.002 (0.544)	-0.001 (0.643)	0.000 (0.043)**
$\Delta TBS^{\square}$	0.000 (0.673)	-0.004 (0.225)	0.000 (0.807)
DVM1	-17.053 (0.001)***		
DVM2	-20.578 (0.006)***		
DVM3	21.684 (0.011)**		
EC_{t-1}	-0.128 (0.000)***	-0.025 (0.027)**	-0.074 (0.069)*
Test Statistics			
$\overline{R}^2$	0.142	0.013	0.058
SER	16.348	19.663	28.392
RSS	96214.6	162384.1	120105.3
F-statistic	F(12, 361) 6.230 (0.000)	F(8, 420) 1.754 (0.084)	F(9, 149) 2.090 (0.034)

Additional Temporary Variables Created

$\Delta MCI = MCI - MCI(-1)$
$\Delta US90 = US90 - US90(-1)$
$\Delta ODM = ODM - ODM(-1)$
$\Delta LFV = LFV - LFV(-1)$
$\Delta DVM1 = \Delta DVM1 - \Delta DVM1(-1)$
$\Delta ISC = ISC - ISC(-1)$
$\Delta Intercept = Intercept - Intercept(-1)$
$\Delta ODM_1 = ODM(-1) - ODM(-2)$
$\Delta TBS = TBS - TBS(-1)$
$\Delta DVM2 = \Delta DVM2 - \Delta DVM2(-1)$
$\Delta ODMP = ODMP - ODMP(-1)$
$\Delta Trend = Trend - Trend(-1)$
$\Delta ODMG = ODMG - ODMG(-1)$
$\Delta LO = LO - LO(-1)$
$\Delta DVM3 = \Delta DVM3 - \Delta DVM3(-1)$

Pre-MCI Period

$EC_{t-1} = MCI + (0.513*ODM) + (10.800*US90) - (0.051*LFV) - (0.051*LO) - (0.003*TBS) - (0.848*Trend) - (7.424*ISC) - (611.870*Intercept) + (133.601*DVM1) + (161.216*DVM2) - (169.881*DVM3)$

MCI Regime

$EC_{t-1} = MCI + (42.466*US90) - (1.698*LFV) + (0.041*LO) + (3.327*Trend) + (0.170*TBS) + (15.175*ODM) - (10.266*ISC) - (2376.4*Intercept)$

OCR Regime

$EC_{t-1} = MCI + (48.362*ODMG) - (26.948*US90) - (0.001*LFV) + (5.447*Trend) + (0.0002*LO) - (0.00003*TBS) + (19.411*ODMP) - (435.841*Intercept)$

Notes: See Table 5.15a

Table 5.16b Error Correction Estimates for the MCI Models Without Dummy Variables

Dependent Variable is $\Delta MCI^{\#}$			
Variable	Period		
	Pre-MCI Regime[a]	MCI Regime[b]	OCR Regime[c]
ΔMCI_1			-0.104 (0.219)
ΔTrend	0.033 (0.198)	-0.085 (0.011)**	-0.405 (0.032)**
ΔIntercept	45.426 (0.577)	60.584 (0.009)***	32.398 (0.748)
ΔUS90[‡]	-2.897 (0.796)	-1.083 (0.051)*	2.003 (0.232)
ΔODM[†]	-0.036 (0.968)	-0.387 (0.901)	
ΔODMG			-3.595 (0.432)
ΔODMP			-1.443 (0.291)
ΔISC[†‡]	3.156 (0.055)*	0.262 (0.503)	
ΔLFV	0.019 (0.629)	0.433 (0.296)	0.000 (0.803)
ΔLO	-0.002 (0.481)	-0.001 (0.643)	0.000 (0.043)**
ΔTBS	0.001 (0.156)	-0.004 (0.225)	0.000 (0.807)
EC_{t-1}	-0.059 (0.003)***	-0.025 (0.027)**	-0.074 (0.069)*
Test Statistics			
$\bar{R}^2$	0.081	0.013	0.058
SER	16.917	19.663	28.392
RSS	104168.5	162384.1	120105.3
F-statistic	F(8, 365) 5.254 (0.000)	F(8, 420) 1.754 (0.084)	F(9, 149) 2.090 (0.034)

Additional Temporary Variables Created

ΔMCI = MCI – MCI(-1)
ΔUS90 = US90 – US90(-1)
ΔODM = ODM – ODM(-1)
ΔLFV = LFV – LFV(-1)
ΔODMP = ODMP – ODMP(-1)
ΔIntercept = Intercept – Intercept(-1)
ΔLO = LO – LO(-1)
ΔTBS = TBS – TBS(-1)
ΔODMG = ODMG – ODMG(-1)
ΔTrend = Trend – Trend(-1)
ΔISC = ISC – ISC(-1)

Pre-MCI Period

EC_{t-1} = MCI + (0.620*ODM) + (49.376* US90) – (0.322*LFV) + (0.040*LO) – (0.019*TBS) – (0.570*Trend) – (7.148*ISC) – (774.194*Intercept)

MCI Regime

EC_{t-1} = MCI + (42.466* US90) – (1.698*LFV) + (0.041*LO) + (3.327*Trend) + (0.170*TBS) + (15.175*ODM) – (10.266*ISC) – (2376.4*Intercept)

OCR Regime

EC_{t-1} = MCI + (48.362*ODMG) – (26.948* US90) – (0.001*LFV) + (5.447*Trend) + (0.0002*LO) – (0.00003*TBS) + (19.411*ODMP) – (435.841*Intercept)

Notes: See Table 5.15b.

Table 5.17a Estimated Long-Run Coefficients for the MCI Models

Dependent Variable is MCI[#]			
Variable	Period		
	Pre-MCI Regime[a]	MCI Regime[b]	OCR Regime[c]
Constant	611.870 (0.309)	2376.4 (0.007)***	435.841 (0.755)
US90[‡□]	-10.800 (0.899)	-42.466 (0.058)*	26.948 (0.376)
ODM[†]	-0.513 (0.941)	-15.175 (0.903)	
ODMG			-48.362 (0.498)
ODMP			-19.411 (0.407)
ISC[†‡]	7.424 (0.529)	10.266 (0.542)	
LFV[□]	0.051 (0.863)	1.698 (0.335)	0.000 (0.807)
LO[□]	-0.015 (0.552)	-0.041 (0.626)	0.000 (0.233)
TBS[□]	0.003 (0.679)	-0.170 (0.290)	0.000 (0.807)
Trend	0.848 (0.000)***	-3.327 (0.000)***	-5.447 (0.068)*
Dummy Variables			
DVM1	-133.601 (0.000)***		
DVM2	-161.216 (0.017)**		
DVM3	169.881 (0.021)**		

Notes: See Table 5.15a.

Table 5.17b Estimated Long-Run Coefficients for the MCI Models Without Dummy Variables

Dependent Variable is MCI[#]			
Variable	Period		
	Pre-MCI Regime[a]	MCI Regime[b]	OCR Regime[c]
Constant	774.194 (0.561)	2376.4 (0.007)***	435.841 (0.755)
US90[‡□]	-49.376 (0.792)	-42.466 (0.058)*	26.948 (0.376)
ODM[†]	-0.620 (0.968)	-15.175 (0.903)	
ODMG[□]			-48.362 (0.498)
ODMP[□]			-19.411 (0.407)
ISC[†‡]	7.148 (0.786)	10.266 (0.542)	
LFV[□]	0.322 (0.635)	1.698 (0.335)	0.000 (0.807)
LO[□]	-0.040 (0.499)	-0.041 (0.626)	0.000 (0.233)
TBS[□]	0.019 (0.207)	-0.170 (0.290)	0.000 (0.807)
Trend	0.570 (0.066)*	-3.327 (0.000)***	-5.447 (0.068)*

Notes: See Table 5.15b.

The static long-run coefficients are reported in Table 5.17a. A comparison with Table 5.17b shows that the inclusion of dummy variables in the pre-MCI model did not alter the significance of any of the coefficient estimates. All policy variables are insignificant. The US90 coefficient passes the 10-percent level of significance in the MCI period but this means little given the presence of heteroscedasticity. These results therefore show that there are no long-run relationships between the variables in any of the MCI models.

5.3.5 Regression estimates for the FX models

Tables 5.18a, 5.19a and 5.20a present parameter estimates, EC representations and estimated long-run coefficients for the FX models. The models pass all diagnostic tests reported in Table 5.18a, although the H-λ^2 and H-F tests for heteroscedasticity in the pre-MCI period only just exceed the 10-percent level of significance (the p-values are 0.102 and 0.103 respectively). The coefficient values in Tables 5.18b, 5.19b and 5.20b were computed without dummy variables. In Table 5.18b, the dummy variables reduced the significance of all diagnostic tests except for the AR-λ^2 and AR-F tests for serial correlation in the pre-MCI and OCR periods. The RESET-λ^2 and RESET-F tests in the MCI and OCR periods, and the H-λ^2 and H-F tests in the pre-MCI period, gave significant test statistics in the absence of dummy variables.

In Table 5.18a, contemporaneous changes in the dependent variable are correlated with lagged changes at the one-percent level of significance and all statistically significant policy coefficients are equal to zero. This may reflect the dynamics of the relationship between policy operations and the foreign exchange market. The RBNZ cannot determine how movements in monetary conditions are apportioned between changes in interest rates and the exchange rate, even if it has a target range for the MCI. The $NZ90_t$ and $US90_t$ coefficients have values of -0.021 and -0.004 during the MCI regime. These values are extremely small but highly significant. They suggest that an extremely small inverse relationship developed between the NZ90 and the FX and that the exchange rate became marginally more sensitive to fluctuations in the U.S. currency.

The EC_{t-1} coefficients in Table 5.19a are all negative and highly significant.. Thus whenever the exchange rate was above (below) its long-run forecast, there was downward

Table 5.18a ARDL Parameter Estimates for the FX Models

Variable	Dependent Variable is FX[#]		
	Period		
	Pre-MCI Regime[a]	MCI Regime[b]	OCR Regime[c]
Intercept	0.048 (0.015)**	0.053 (0.001)***	0.068 (0.008)***
FX_{t-1}[‡]	0.873 (0.000)***	0.838 (0.000)***	0.777 (0.000)***
FX_{t-2}[‡]	0.061 (0.246)	0.112 (0.003)***	0.120 (0.136)
$NZ90_t$[□]	0.000 (0.572)	-0.021 (0.000)***	-0.002 (0.072)*
$NZ90_{t-1}$[□]		0.020 (0.000)***	0.002 (0.034)**
$US\text{-}90_t$[□]	-0.001 (0.413)	-0.004 (0.008)***	0.000 (0.783)
ODM_t[†‡]	0.000 (0.943)	0.000 (0.428)	
ODM_{t-1}[†‡]	0.000 (0.012)**		
ODM_{t-2}[†‡]	0.000 (0.172)		
$ODMG_t$[□]			0.001 (0.067)*
$ODMP_t$[□]			0.002 (0.585)
ISC_t[‡]	0.002 (0.462)	0.001 (0.452)	
LFV_t[‡□]	0.000 (0.993)	0.000 (0.448)	0.000 (0.878)
TBS_t[‡□]	0.000 (0.032)**	0.000 (0.615)	0.000 (0.758)
LO_t[‡□]	0.000 (0.032)**	0.000 (0.142)	0.000 (0.574)
Trend	0.000 (0.086)*	0.000 (0.003)***	0.000 (0.187)
Dummy Variables			
DVX1	-0.003 (0.001)***		
DVX2	-0.002 (0.027)**		
DVX3	0.003 (0.008)***		
DVX4	0.003 (0.009)***		
DVX5		0.006 (0.001)***	
DVX6			-0.003 (0.014)**
DVX7			-0.003 (0.019)**
DVX8			0.002 (0.049)**
Test Statistics and Diagnostic Tests			
$\overline{R}^2$	0.957	0.996	0.950
SER	0.002	0.004	0.003
RSS	0.002	0.006	0.001
F-statistic	F(16, 357) 517 (0.000)	F(12, 415) 8427 (0.000)	F(14, 143) 215.2 (0.000)
AR-λ^2	0.314 (0.575)	0.008 (0.978)	1.380 (0.240)
AR-F	F(1, 356) 0.081 (0.585)	F(1, 414) 0.008 (0.978)	F(1, 142) 1.630 (0.265)
RESET-λ^2	0.528 (0.467)	1.929 (0.165)	1.793 (0.181)
RESET-F	F(1, 356) 0.503 (0.478)	F(1, 414) 1.874 (0.172)	F(1, 142) 1.630 (0.204)
H-λ^2	2.667 (0.102)	0.515 (0.473)	0.006 (0.939)
H-F	F(1, 372) 2.672 (0.103)	F(1, 426) 0.513 (0.474)	F(1, 156) 0.006 (0.939)

Notes:

*, **, *** indicate the 10%, 5% and 1% levels of significance respectively.

[#] The p-value of each test statistic is given in brackets.

[a] The ARDL model has a lag structure of (2, 0, 0, 2, 0, 0, 0, 0) based on the $\overline{R}^2$ Criterion.

[b] The ARDL model has a lag structure of (2, 1, 0, 0, 0, 0, 0, 0) based on the SBC.

[c] The ARDL model has a lag structure of (2, 1, 0, 0, 0, 0, 0, 0) based on the AIC.

[d] The Durbin *h*-statistic is not calculated if there is more than one lag of the dependent variable.

[†] Indicates a variable that entered the regression equation as a squared term in the pre-MCI period.

[‡] Indicates a variable that entered the regression equation as a squared term in the MCI period.

[□] Indicates a variable that entered the regression equation as a squared term in the OCR period.

Table 5.18b ARDL Parameter Estimates for the FX Models Without Dummy Variables

Variable	Dependent Variable is FX[#]		
	Period		
	Pre-MCI Regime[a]	MCI Regime[b]	OCR Regime[c]
Intercept	0.066 (0.001)***	0.058 (0.001)***	0.066 (0.007)***
FX_{t-1}‡	0.913 (0.000)***	0.850 (0.000)***	0.887 (0.000)***
FX_{t-2}‡		0.094 (0.013)**	
$NZ90_{t}$□	-0.001 (0.374)	-0.021 (0.000)***	-0.002 (0.069)*
$NZ90_{t-1}$□		0.020 (0.000)***	0.003 (0.012)**
$US\text{-}90_{t}$□	-0.002 (0.301)	-0.004 (0.007)***	0.000 (0.597)
ODM_{t}†‡	0.000 (0.467)	0.000 (0.624)	
ODM_{t-1}†‡	0.000 (0.036)**		
ODM_{t-2}†‡	0.000 (0.296)		
$ODMG_{t}$□			0.001 (0.184)
$ODMP_{t}$□			0.000 (0.210)
ISC_{t}‡	0.001 (0.867)	0.000 (0.475)	
LFV_{t}‡□	0.000 (0.841)	0.000 (0.869)	0.000 (0.708)
TBS_{t}‡	0.000 (0.108)	0.000 (0.539)	0.000 (0.559)
LO_{t}‡	0.000 (0.025)**	0.000 (0.304)	0.000 (0.010)***
Trend	0.000 (0.024)**	0.000 (0.001)***	0.000 (0.037)**
Test Statistics and Diagnostic Tests			
$\overline{R}^2$	0.954	0.996	0.947
SER	0.003	0.004	0.003
RSS	0.002	0.006	0.002
F-statistic	F(11, 362) 703.4 (0.000)	F(11, 416) 8963 (0.000)	F(10, 147) 280 (0.000)
AR- λ^2	0.114 (0.736)	0.453 (0.501)	0.831 (0.362)
AR-F	F(1, 361) 0.110 (0.740)	F(1, 415) 0.440 (0.507)	F(1, 146) 0.772 (0.381)
Durbin *h*-statistic[d]	0.487 (0.626)		-0.891 (0.373)
RESET- λ^2	1.104 (0.293)	3.118 (0.077)	6.774 (0.009)
RESET-F	F(1, 361) 1.068 (0.302)	F(1, 415) 3.046 (0.082)	F(1, 146) 6.539 (0.012)
H- λ^2	3.710 (0.054)	0.939 (0.333)	0.014 (0.906)
H-F	F(1, 372) 3.727 (0.054)	F(1, 426) 0.937 (0.334)	F(1, 156) 0.013 (0.907)

Notes:
*, **, *** indicate the 10%, 5% and 1% levels of significance respectively.
[#] The p-value of each test statistic is given in brackets.
[a] The ARDL model has a lag structure of (1, 0, 0, 2, 0, 0, 0, 0) based on the $\overline{R}^2$ Criterion.
[b] The ARDL model has a lag structure of (2, 1, 0, 0, 0, 0, 0, 0) based on the SBC.
[c] The ARDL model has a lag structure of (1, 1, 0, 0, 0, 0, 0, 0) based on the AIC.
[d] The Durbin *h*-statistic is not calculated if there is more than one lag of the dependent variable.
† Indicates a variable that entered the regression equation as a squared term in the pre-MCI period.
‡ Indicates a variable that entered the regression equation as a squared term in the MCI period.
□ Indicates a variable that entered the regression equation as a squared term in the OCR period.

Table 5.19a Error Correction Estimates for the FX Models

Dependent Variable is ΔFX#			
Variable	Period		
	Pre-MCI Regime[a]	MCI Regime[b]	OCR Regime[c]
ΔFX_1 ‡	-0.061 (0.246)	-0.112 (0.003)***	-0.120 (0.136)
ΔNZ90□	0.000 (0.572)	-0.021 (0.000)***	-0.002 (0.072)*
ΔTrend	0.000 (0.086)*	-0.355 (0.003)***	0.000 (0.187)
ΔIntercept	0.048 (0.015)**	0.053 (0.001)***	0.068 (0.008)***
ΔUS90□	-0.001 (0.413)	-0.004 (0.008)***	0.000 (0.783)
ΔODM† ‡	0.000 (0.943)	0.000 (0.428)	
ΔODM_1 † ‡	0.000 (0.172)		
ΔODMG□			0.000 (0.067)*
ΔODMP□			0.000 (0.585)
ΔISC‡	0.002 (0.462)	0.000 (0.452)	
ΔLFV‡□	0.000 (0.993)	0.000 (0.448)	0.000 (0.878)
ΔLO‡□	0.000 (0.032)**	0.000 (0.142)	0.000 (0.574)
ΔTBS‡□	0.000 (0.032)**	0.000 (0.615)	0.000 (0.758)
ΔDVX1	-0.003 (0.001)***		
ΔDVX2	-0.002 (0.027)**		
ΔDVX3	0.003 (0.008)***		
ΔDVX4	0.003 (0.009)***		
ΔDVX5		0.006 (0.001)***	
ΔDVX6			-0.003 (0.014)**
ΔDVX7			-0.003 (0.019)**
ΔDVX8			0.002 (0.149)
EC_{t-1}	-0.066 (0.004)***	-0.050 (0.004)***	-0.103 (0.011)***
Test Statistics			
$\overline{R}^2$	0.112	0.440	0.178
SER	0.002	0.004	0.003
RSS	0.002	0.006	0.001
F-statistic	F(15, 358) 4.216 (0.000)	F(11, 416) 31.583 (0.000)	F(13, 144) 3.696 (0.000)

Additional Temporary Variables Created

ΔFX = FX – FX(-1)
ΔFX_1 = FX(-1) – FX(-2)
ΔIntercept = Intercept – Intercept(-1)
ΔNZ90 = NZ90 – NZ90(-1)
ΔTrend = Trend – Trend(-1)
ΔUS90 = US90 – US90(-1)
ΔODM = ODM – ODM(-1)
ΔODM_1 = ODM(-1) – ODM(-2)
ΔISC = ISC – ISC(-1)
ΔLFV = LFV – LFV(-1)
ΔLO = LO – LO(-1)
ΔTBS = TBS – TBS(-1)
ΔODMG = ODMG – ODMG(-1)
ΔODMP = ODMP – ODMP(-1)
ΔDVX1 = DVX1 – DVX1(-1)
ΔDVX2 = DVX2 – DVX2(-1)
ΔDVX3 = DVX3 – DVX3(-1)
ΔDVX4 = DVX4 – DVX4(-1)
ΔDVX5 = DVX5 – DVX5(-1)
ΔDVX6 = DVX6 – DVX6(-1)
ΔDVX7 = DVX7 – DVX7(-1)
ΔDVX8 = DVX8 – DVX8(-1)

Pre-MCI Period

EC_{t-1} = FX + (0.006*NZ90) + (0.001*ODM) + (0.021* US90) – (0.000001*LFV) + (0.00002*LO) – (0.00004*TBS) – (0.034*ISC) – (0.734*Intercept) – (0.0001*Trend) + (0.048*DVX1) + (0.036*DVX2) – (0.046*DVX3) – (0.040*DVX4)

MCI Period

EC_{t-1} = FX + (0.010*NZ90) + (0.079* US90) + (0.000001*LO) + (0.000000001*LO) – (0.00000001*TBS) + (0.001*ODM) – (0.002*ISC) – (1.062*Intercept) – (0.0007*Trend) – (0.110*DVX5)

OCR Period

EC_{t-1} = FX – (0.003*NZ90) + (0.009*ODMG) + (0.0006* US90) – (0.00000003*LFV) + (0.0000000006*LO) + (0.000003*TBS) – (0.001*ODMP) – (0.661*Intercept) + (0.0003*Trend) + (0.034*DVX6) + (0.032*DVX7) – (0.017*DVX8)

Note: See Table 5.18a

Table 5.19b Error Correction Estimates for the FX Models Without Dummy Variables

Dependent Variable is $\Delta FX^{\#}$			
Variable	Period		
	Pre-MCI Regime[a]	MCI Regime[b]	OCR Regime[c]
ΔFX_1‡		-0.094 (0.013)**	
ΔNZ90	0.001 (0.374)	-0.021 (0.000)***	-0.002 (0.069)*
ΔTrend	0.000 (0.024)**	-0.000 (0.001)***	0.000 (0.037)**
ΔIntercept	0.066 (0.001)***	0.058 (0.001)***	0.066 (0.007)***
ΔUS90	-0.002 (0.301)	-0.004 (0.007)***	0.000 (0.597)
ΔODM†‡	0.000 (0.467)	0.000 (0.624)	
ΔODM_1†‡	0.000 (0.296)		
ΔODMG			0.001 (0.184)
ΔODMP			0.000 (0.210)
ΔISC‡	0.001 (0.867)	0.000 (0.475)	
ΔLFV‡	0.000 (0.841)	0.000 (0.869)	0.000 (0.708)
ΔLO‡	0.000 (0.025)**	0.000 (0.304)	0.000 (0.010)***
ΔTBS‡	0.000 (0.108)	0.000 (0.539)	0.000 (0.559)
EC_{t-1}	-0.087 (0.000)***	-0.056 (0.001)***	-0.113 (0.004)***
Test Statistics			
$\overline{R}^2$	0.054	0.426	0.121
SER	0.003	0.004	0.003
RSS	0.002	0.006	0.002
F-statistic	F(10, 363) 3.214 (0.001)	F(10, 417) 32.743 (0.000)	F(9, 148) 3.518 (0.001)
Additional Temporary Variables Created			

ΔFX = FX – FX(-1)
ΔLFV = LFV – LFV(-1)
ΔLO = LO – LO(-1)
ΔISC = ISC – ISC(-1)
ΔTBS = TBS – TBS(-1)
ΔFX_1 = FX(-1) – FX(-2)
ΔTrend = Trend – Trend(-1)
ΔUS90 = US90 – US90(-1)
ΔODM = ODM – ODM(-1)
ΔODMG = ODMG – ODMG(-1)
ΔIntercept = Intercept – Intercept(-1)
ΔNZ90 = NZ90 – NZ90(-1)
ΔODM_1 = ODM(-1) – ODM(-2)
ΔODMP = ODMP – ODMP(-1)

Pre-MCI Period
EC_{t-1} = FX + (0.007*NZ90) – (0.0003*ODM) + (0.020* US90) – (0.00001*LFV) – 0.006*ISC) + (0.00001*LO) – (0.000002*TBS) – (0.760*Intercept) – (0.0001*Trend)

MCI Period
EC_{t-1} = FX + (0.017*NZ90) + (0.074* US90) + (0.0000000001*LO) – (0.00000001*TBS) + (0.0007*ODM) – (0.002*ISC) – (1.034*Intercept) + (0.0007*Trend)

OCR Period
EC_{t-1} = FX – (0.006*NZ90) + (0.006*ODMG) + (0.0001* US90) – (0.583*Intercept) + (0.0004*Trend) – (0.00000008*LFV) + (0.000000002*LO) – (0.000000006*TBS) – (0.002*ODMP)

Notes: See Table 5.18b.

Table 5.20a Estimated Long-Run Coefficients for the FX Models

Dependent Variable is FX[#]			
Variable	Period		
	Pre-MCI Regime[a]	MCI Regime[b]	OCR Regime[c]
Intercept	0.734 (0.000)***	1.062 (0.000)***	0.661 (0.000)***
NZ90[□]	-0.006 (0.546)	-0.010 (0.424)	-0.003 (0.460)
US90[□]	0.021 (0.390)	-0.079 (0.000)***	0.000 (0.780)
ODM[†‡]	-0.001 (0.556)	-0.001 (0.428)	
ODMG[□]			-0.009 (0.124)
ODMP[□]			0.001 (0.559)
ISC[‡]	0.034 (0.451)	0.002 (0.461)	
LFV[‡]	0.000 (0.993)	0.000 (0.472)	0.000 (0.879)
LO[‡]	0.000 (0.093)*	0.000 (0.091)*	0.000 (594)
TBS[‡□]	0.000 (0.085)*	0.000 (0.619)	0.000 (0.759)
Trend	0.000 (0.007)***	0.000 (0.000)***	0.000 (0.232)
Dummy Variables			
DVX1	-0.048 (0.044)**		
DVX2	-0.036 (0.083)*		
DVX3	0.046 (0.052)*		
DVX4	0.040 (0.075)*		
DVX5		0.110 (0.035)**	
DVX6			-0.034 (0.089)*
DVX7			-0.032 (0.060)*
DVX8			0.017 (0.223)

Notes: See Table 5.18a.

Table 5.20b Estimated Long-Run Coefficients for the FX Models Without Dummy Variables

Dependent Variable is FX$^{\#}$			
Variable	Period		
	Pre-MCI Regime^{a}	MCI Regime^{b}	OCR Regime^{c}
Intercept	0.760 (0.000)***	1.034 (0.000)***	0.583 (0.000)***
NZ90$^{\square}$	-0.007 (0.340)	-0.017 (0.150)	0.006 (0.155)
US90$^{\square}$	-0.020 (0.281)	-0.074 (0.000)***	-0.001 (0.594)
ODM†‡	0.000 (0.838)	-0.001 (0.620)	
ODMG$^{\square}$			-0.006 (0.225)
ODMP$^{\square}$			-0.002 (0.308)
ISC‡	0.006 (0.865)	0.002 (0.481)	
LFV$^{\ddagger\square}$	0.000 (0.841)	0.000 (0.869)	0.000 (0.715)
LO$^{\ddagger\square}$	0.000 (0.060)*	0.000 (0.242)	0.000 (062)*
TBS$^{\ddagger\square}$	0.000 (0.135)	0.000 (0.545)	0.000 (0.567)
Trend	0.000 (0.001)***	-0.001 (0.000)***	0.000 (0.070)*

Notes: See Table 5.18b.

(upward) pressure on it in the following time period. This adjustment mechanism was strongest (weakest) during the OCR (MCR) period with the test statistics being -0.103 and -0.050 respectively. The EC_{t-1} coefficients are larger in Table 5.19b than in Table 5.19a, and so the adjustment mechanism was slower in the regression models containing dummy variables.

The long-run coefficients in Table 5.20a show that there was no significant statistical relationship between policy variables and the exchange rate. The highly significant value of -0.079 recorded for the US90 coefficient during the MCI period indicates that the exchange rate was more sensitive to external influences at that time. A look at Table 5.20b shows that the dummy variables did not substantially alter the estimates of the long-run coefficients or their levels of significance.

5.3.6 *Regression estimates for the NZ90 models*

Tables 5.21a, 5.22a and 5.23a present parameter estimates, EC representations and estimated long-run coefficients for the NZ90 models. The results in Tables 5.21b, 5.22b

Table 5.21a Parameter Estimates for the NZ90 Models

Dependent Variable is NZ90[#]			
	Period		
Variable	Pre-MCI Regime[a]	MCI Regime[b]	OCR Regime[c]
Intercept	2.934 (0.000)***	0.466 (0.443)	0.532 (0.041)**
$NZ90_{t-1}$	0.854 (0.000)***	0.871 (0.000)***	0.927 (0.000) ***
$NZ90_{t-2}$		0.076 (0.135)	
FX_t	-0.816 (0.248)	-17.900 (0.000)***	-0.456 (0.118)
FX_{t-1}		15.070 (0.000)***	
FX_{t-2}		4.500 (0.016)**	
FX_{t-3}		-1.919 (0.140)	
$US90_t^{\dagger}$	-0.011 (0.028)**	0.015 (0.733)	0.022 (0.260)
$ODM_t^{\dagger\ddagger}$	-0.031 (0.000)***	-0.005 (0.102)	
$ODM_{t-1}^{\ddagger}$		0.000 (0.888)	
$ODM_{t-2}^{\ddagger}$		0.006 (0.088)*	
$ODMG_t$			-0.047 (0.244)
$ODMP_t$			0.031 (0.022)**
$ISC_t^{\dagger\ddagger}$	0.065 (0.000)***	0.833 (0.000)***	
$ISC_{t-1}^{\ddagger}$		-0.018 (0.037) **	
$ISC_{t-2}^{\ddagger}$		-0.010 (0.187)	
$ISC_{t-3}^{\ddagger}$		-0.005 (0.043)**	
$LFV_t^{\ddagger}$	0.000 (0.335)	0.000 (0.932)	0.000 (0.241)
$TBS_t^{\ddagger}$	0.000 (0.117)	0.000 (0.731)	0.000 (0.536)
$LO_t^{\ddagger}$	0.000 (0.058)*	0.000 (0.231)	0.000 (0.887)
Trend	0.000 (0.178)	0.000 (0.305)	0.000 (0.134)
Dummy Variables			
DVN			-0.056 (0.001)***
Test Statistics and Diagnostic Tests			
$\overline{R}^2$	0.995	0.997	0.986
SER	0.081	0.107	0.025
RSS	2.149	4.674	0.094
F-statistic	F (9, 365) 7517.3 (0.000)	F (18, 409) 6868 (0.000)	F (10, 148) 1081 (0.000)
AR-λ^2	1.136 (0.286)	0.317 (0.574)	0.411 (0.522)
AR-F	F (1, 364) 1.106 (0.294)	F (1, 408) 0.302 (0.583)	F (1, 147) 0.381 (0.538)
Durbin *h*-statistic	1.141 (0.254)		0.626 (0.532)
RESET-λ^2	0.943 (0.330)	1.828 (0.176)	0.611 (0.434)
RESET-F	F (1, 364) 0.923 (0.337)	F (1, 408) 1.750 (0.187)	F (1, 147) 0.567 (0.453)
H-λ^2	0.358 (0.550)	0.0000006 (1.000)	0.806 (0.369)
H-F	F (1, 373) 0.356 (0.551)	F (1, 426) 0.0000001 (1.000)	F (1, 157) 0.799 (0.373)

Notes:

*, **, *** indicate the 10%, 5% and 1% levels of significance respectively.
[#] The p-value of each test statistic is given in brackets.
[a] The ARDL model has a lag structure of (1, 0, 0, 0, 0, 0, 0, 0) based on the SBC.
[b] The ARDL model has a lag structure of (2, 3, 0, 2, 3, 0, 0, 0) based on the AIC.
[c] The ARDL model has a lag structure of (1, 0, 0, 0, 0, 0, 0, 0) based on the SBC.
[d] The Durbin *h*-statistic is not calculated when there is more than one lag of the dependent variable.
[†] Indicates a variable that entered the regression equation as a squared term in the pre-MCI period.
[‡] Indicates a variable that entered the regression equation as a squared term in the MCI period.

Table 5.21b Parameter Estimates for the NZ90 Models Without Dummy Variables

Dependent Variable is NZ90[#]			
Variable	Period		
	Pre-MCI Regime[a]	MCI Regime[b]	OCR Regime[c]
Intercept	2.934 (0.000)***	0.466 (0.443)	0.436 (0.106)
$NZ90_{t-1}$	0.854 (0.000)***	0.871 (0.000)***	0.909 (0.000) ***
$NZ90_{t-2}$		0.076 (0.135)	
FX_t	-0.816 (0.248)	-17.900 (0.000)***	-0.449 (0.149)
FX_{t-1}		15.070 (0.000)***	
FX_{t-2}		4.500 (0.016)**	
FX_{t-3}		-1.919 (0.140)	
$US90_t^{\dagger}$	-0.011 (0.028)**	0.015 (0.733)	0.043 (0.024)**
$ODM_t^{\dagger\ddagger}$	-0.031 (0.000)***	-0.005 (0.102)	
$ODM_{t-1}^{\ddagger}$		0.000 (0.888)	
$ODM_{t-2}^{\ddagger}$		0.006 (0.088)*	
$ODMG_t$			-0.034 (0.413)
$ODMP_t$			0.028 (0.043)**
$ISC_t^{\dagger\ddagger}$	0.065 (0.000)***	0.833 (0.000)***	
$ISC_{t-1}^{\ddagger}$		-0.018 (0.037) **	
$ISC_{t-2}^{\ddagger}$		-0.010 (0.187)	
$ISC_{t-3}^{\ddagger}$		-0.005 (0.043)**	
$LFV_t^{\ddagger}$	0.000 (0.335)	0.000 (0.932)	0.000 (0.152)
$TBS_t^{\ddagger}$	0.000 (0.117)	0.000 (0.731)	0.000 (0.753)
$LO_t^{\ddagger}$	0.000 (0.058)*	0.000 (0.231)	0.000 (0.483)
Trend	0.000 (0.178)	0.000 (0.305)	0.000 (0.406)
Test Statistics and Diagnostic Tests			
$\overline{R}^2$	0.995	0.997	0.984
SER	0.081	0.107	0.026
RSS	2.149	4.674	0.101
F-statistic	F (9, 365) 7517.3 (0.000)	F (18, 409) 6868 (0.000)	F (9, 148) 1101 (0.000)
AR-λ^2	1.136 (0.286)	0.317 (0.574)	2.426 (0.119)
AR-F	F (1, 364) 1.106 (0.294)	F (1, 408) 0.302 (0.583)	F (1, 147) 2.293 (0.132)
Durbin *h*-statistic	1.141 (0.254)		1.552 (0.121)
RESET-λ^2	0.943 (0.330)	1.828 (0.176)	2.227 (0.136)
RESET-F	F (1, 364) 0.923 (0.337)	F (1, 408) 1.750 (0.187)	F (1, 147) 2.102 (0.149)
H-λ^2	0.358 (0.550)	0.0000006 (1.000)	1.054 (0.305)
H-F	F (1, 373) 0.356 (0.551)	F (1, 426) 0.0000001 (1.000)	F (1, 156) 1.048 (0.308)

Notes:
*, **, *** indicate the 10%, 5% and 1% levels of significance respectively.
[#] The p-value of each test statistic is given in brackets.
[a] The ARDL model has a lag structure of (1, 0, 0, 0, 0, 0, 0, 0) based on the SBC.
[b] The ARDL model has a lag structure of (2, 3, 0, 2, 3, 0, 0, 0) based on the AIC.
[c] The ARDL model has a lag structure of (1, 0, 0, 0, 0, 0, 0, 0) based on the SBC.
[d] The Durbin *h*-statistic is not calculated when there is more than one lag of the dependent variable.
[†] Indicates a variable that entered the regression equation as a squared term in the pre-MCI period.
[‡] Indicates a variable that entered the regression equation as a squared term in the MCI period.

Table 5.22a Error Correction Estimates for the NZ90 Models

Dependent Variable is ΔNZ90[#]			
Variable	Period		
	Pre-MCI Regime[a]	MCI Regime[b]	OCR Regime[c]
$\Delta NZ90_1$		-0.076 (0.135)	
ΔFX	-0.816 (0.248)	-17.900 (0.000)***	-0.456 (0.118)
ΔFX_1		-2.581 (0.097)*	
ΔFX_2		1.919 (0.140)	
ΔODM[†‡]	-0.031 (0.000)***	-0.006 (0.102)	
ΔODM_1[‡]		-0.006 (0.088)*	
ΔODMG			-0.047 (0.244)
ΔODMP			0.031 (0.022)**
ΔISC[†‡]	0.065 (0.000)***	0.036 (0.000)***	
ΔISC_1[‡]		0.016 (0.037)**	
ΔISC_2[‡]		0.005 (0.043)**	
ΔTrend	0.000 (0.178)	0.000 (0.305)	0.0003 (0.134)
ΔIntercept	2.934 (0.000)***	0.466 (0.443)	0.532 (0.041)**
ΔUS90[‡]	-0.011 (0.028)**	0.015 (0.733)	0.022 (0.260)
ΔLO[‡]	0.000 (0.058)*	0.000 (0.231)	0.000 (0.887)
ΔLFV[‡]	0.000 (0.335)	0.000 (0.932)	0.000 (0.241)
ΔTBS[‡]	0.000 (0.117)	0.000 (0.731)	0.000 (0.536)
ΔDVN			-0.056 (0.001)***
EC_{t-1}	-0.146 (0.000)***	-0.053 (0.016)**	-0.073 (0.012)**
Test Statistics			
$\overline{R}^2$	0.134	0.521	0.135
SER	0.081	0.107	0.025
RSS	2.419	4.674	0.094
F-statistic	F (9, 365) 7.480 (0.000)	F (15, 412) 32.128 (0.000)	F(10, 148) 3.474 (0.000)

Additional Temporary Variables Created

ΔISC = ISC – ISC(-1)
ΔFX = FX – FX(-1)
ΔNZ90 = NZ90 – NZ90(-1)
ΔTrend = Trend – Trend(-1)
ΔODM = ODM – ODM(-1)
ΔLFV = LFV – LFV(-1)
ΔIntercept = Intercept – Intercept(-1)
ΔISC_1 = ISC(-1) – ISC(-2)
ΔFX_1 = FX(-1) – FX(-2)
ΔLO = LO – LO(-1)
ΔTBS = TBS – TBS(-1)
ΔUS90 = US90 – US90(-1)
ΔODMP = ODMP – ODMP(-1)
ΔISC_2 = ISC(-2) – ISC(-3)
ΔFX_2 = FX(-2) – FX(-3)
$\Delta NZ90_1$ = NZ90(-1) – NZ90(-2)
ΔDVN = DVN– DVN(-1)
ΔODM_1 = ODM(-1) – ODM(-2)
ΔODMG = ODMG – ODMG(-1)

Pre-MCI Period
EC_{t-1} = NZ90 + (5.593*FX) + (0.076*US90) – (0.208*LO) + (0.00004*TBS) – (0.001*LFV) – (0.443*ISC) + (0.213*ODM) – (20.099*Intercept) + (0.001*Trend)

MCI Period
EC_{t-1} = NZ90 + (4.662*FX) – (0.054*ISC) – (0.272*US90) – (0.014*ODM) + (0.006*Trend) – (8.739*Intercept) + (0.0000002*TBS) + (0.000003*LFV) – (0.00000002*LO)

Post-MCI Period
EC_{t-1} = NZ90 + (6.218*FX) – (0.00004*LO) + (0.642*ODMG) – (0.418*ODMP) – (0.0005*LFV) – (0.296US90) + (0.00005*TBS) – (7.246*Intercept) – (0.004*Trend) + (0.764*DVN)

Notes: See Table 5.21a

Table 5.22b Error Correction Estimates for the NZ90 Models Without Dummy Variables

Dependent Variable is ΔNZ90[#]			
Variable	Period		
	Pre-MCI Regime[a]	MCI Regime[b]	OCR Regime[c]
$\Delta NZ90_1$		-0.076 (0.135)	
ΔFX	-0.816 (0.248)	-17.900 (0.000)***	-0.449 (0.149)
ΔFX_1		-2.581 (0.097)*	
ΔFX_2		1.919 (0.140)	
ΔODM[†‡]	-0.031 (0.000)***	-0.006 (0.102)	
ΔODM_1[‡]		-0.006 (0.088)*	
ΔODMG			-0.034 (0.413)
ΔODMP			0.028 (0.043)**
ΔISC[†‡]	0.065 (0.000)***	0.036 (0.000)***	
ΔISC_1[‡]		0.016 (0.037)**	
ΔISC_2[‡]		0.005 (0.043)**	
ΔTrend	0.000 (0.178)	0.000 (0.305)	0.000 (0.406)
ΔIntercept	2.934 (0.000)***	0.466 (0.443)	0.436 (0.106)
ΔUS90[‡]	-0.011 (0.028)**	0.015 (0.733)	0.043 (0.024)**
ΔLO[‡]	0.000 (0.058)*	0.000 (0.231)	0.000 (0.483)
ΔLFV[‡]	0.000 (0.335)	0.000 (0.932)	0.000 (0.152)
ΔTBS[‡]	0.000 (0.117)	0.000 (0.731)	0.000 (0.753)
EC_{t-1}	-0.146 (0.000)***	-0.053 (0.016)**	-0.091 (0.003)***
Test Statistics			
$\overline{R}^2$	0.134	0.521	0.068
SER	0.081	0.107	0.026
RSS	2.419	4.674	0.101
F-statistic	F (9, 365) 7.480 (0.000)	F (15, 412) 32.128 (0.000)	F(9, 148) 2.282 (0.020)

Additional Temporary Variables Created

ΔISC = ISC – ISC(-1)	ΔISC_1 = ISC(-1) – ISC(-2)	ΔISC_2 = ISC(-2) – ISC(-3)
ΔFX = FX – FX(-1)	ΔFX_1 = FX(-1) – FX(-2)	ΔFX_2 = FX(-2) – FX(-3)
ΔNZ90 = NZ90 – NZ90(-1)	ΔLO = LO – LO(-1)	$\Delta NZ90_1$ = NZ90(-1) – NZ90(-2)
ΔTrend = Trend – Trend(-1)	ΔTBS = TBS – TBS(-1)	ΔIntercept = Intercept – Intercept(-1)
ΔODM = ODM – ODM(-1)	ΔUS90 = US90 – US90(-1)	ΔODM_1 = ODM(-1) – ODM(-2)
ΔLFV = LFV – LFV(-1)	ΔODMP = ODMP – ODMP(-1)	ΔODMG = ODMG – ODMG(-1)

Pre-MCI Period

EC_{t-1} = NZ90 + (5.593*FX) + (0.076*US90) – (0.208*LO) + (0.00004*TBS) – (0.001*LFV) – (0.443*ISC) + (0.213*ODM) – (20.099*Intercept) + (0.001*Trend)

MCI Regime

EC_{t-1} = NZ90 + (4.662*FX) – (0.054*ISC) – (0.272*US90) – (0.014*ODM) + (0.006*Trend) – (8.739*Intercept) + (0.0000002*TBS) + (0.000003*LFV) – (0.00000002*LO)

OCR Regime

EC_{t-1} = NZ90 + (4.949*FX) – (0.00005*LO) + (0.378*ODMG) – (0.310*ODMP) – (0.0006*LFV) – (0.478US90) + (0.00003*TBS) – (4.812*Intercept) – (0.002*Trend)

Notes: See Table 5.21b

Table 5.23a Estimated Long-Run Coefficients for the NZ90 Models

Dependent Variable is NZ90[#]			
Variable	Period		
	Pre-MCI Regime[a]	MCI Regime[b]	OCR Regime[c]
Intercept	20.099 (0.000)***	8.739 (0.467)	7.246 (0.085)*
FX	-5.593 (0.248)	-4.662 (0.657)	-6.218 (0.181)
US90[†]	-0.076 (0.043)**	0.272 (0.724)	1.282 (0.202)
ODM[†‡]	-0.213 (0.000)***	-0.014 (0.770)	
ODMG			-0.642 (0.310)
ODMP			0.418 (0.036)**
ISC[†‡]	0.443 (0.000)***	0.054 (0.550)	
LFV[‡]	0.001 (0.338)	0.000 (0.932)	0.000 (0.299)
LO[‡]	0.000 (0.071)*	-0.230 (0.300)	0.000 (0.887)
TBS[‡]	0.000 (0.123)	0.000 (0.733)	0.000 (0.550)
Trend	-0.001 (0.169)	-0.006 (0.350)	0.004 (0.113)
Dummy Variable			
DVN			-0.764 (0.058)*

Note: See Table 5.21a.

Table 5.23b Estimated Long-Run Coefficients for the NZ90 Models Without Dummy Variables

Dependent Variable is NZ90[#]			
Variable	Period		
	Pre-MCI Regime[a]	MCI Regime[b]	OCR Regime[c]
Intercept	20.099 (0.000)***	8.739 (0.467)	4.812 (0.124)
FX	-5.593 (0.248)	-4.662 (0.657)	-4.949 (0.192)
US90[†]	-0.076 (0.043)**	0.272 (0.724)	0.478 (0.017)**
ODM[†‡]	-0.213 (0.000)***	-0.014 (0.770)	
ODMG			-0.378 (0.441)
ODMP			0.310 (0.040)**
ISC[†‡]	0.443 (0.000)***	0.054 (0.550)	
LFV[‡]	0.001 (0.338)	0.000 (0.932)	0.001 (0.208)
LO[‡]	0.000 (0.071)*	-0.230 (0.300)	0.000 (0.486)
TBS[‡]	0.000 (0.123)	0.000 (0.733)	0.000 (0.754)
Trend	-0.001 (0.169)	-0.006 (0.350)	0.002 (0.364)

Note: See Table 5.21b.

and 5.23b were obtained from the same models, but without the dummy variable in the OCR period model. The dummy variable substantially reduced the significance of the AR-λ^2, A-F, Durbin *h*-statistic, RESET-λ^2 and RESET-F test statistics. The models pass all diagnostic tests reported in Table 5.21.

The FX coefficient in Table 5.21a is insignificant in the pre-MCI and OCR periods, but its value of -17.900 in the MCI period is very large and highly significant. The rolling regressions in Figure 5.1 also showed that an inverse relationship existed between the NZ90 and FX during this period and that it was associated with a large fall in the value of the currency. These results are consistent with comments made in answer to questions 16 and 17 of the survey (see section 5.1.2) that the RBNZ's MCI target was too rigid. The significant positive coefficients on FX_{t-1} and FX_{t-2} (15.070 and 4.500) indicate that the NZ90 typically trended downward following a rise associated with a depreciation of the exchange rate.

The ISC coefficient in Table 5.21a is highly significant in the pre-MCI and MCI periods (the values are 0.065 to 0.833 respectively). The ISC_{t-1}, and ISC_{t-3}, coefficients in the MCI period were much smaller (-0.018 and -0.005 respectively) and were significant at the five-percent level. The sensitivity of the NZ90 to the ISC thus increased dramatically following the introduction of the MCI regime. The ODM_t coefficient in the pre-MCI period and the $ODMP_t$ coefficient in the OCR period were the only other significant policy variables. However their values were low, -0.031 and 0.031 respectively.

The EC_{t-1} coefficients in Table 5.22a are all significantly negative. The adjustment mechanism was strongest (weakest) in the pre-MCI (MCI) period with the respective coefficient values being -0.146 and -0.053. The mechanism was weaker in the OCR period model containing the dummy variable (the EC_{t-1} coefficient was -0.073 in Table 5.22a and -0.091 in Table 5.22b).

In Table 5.23a, the long-run ISC and ODM coefficients of the pre-MCI model are highly significant and have the expected signs. For example, the ODM coefficient (-0.213) has to be a negative number because it is the penalty cost of obtaining cash via the discounting process. Increases in the ODM ease monetary conditions and reduce interest rates by causing banks to minimise their holdings of settlement cash (Tait and Reddell 1992, p.71). Likewise, the ISC coefficient (0.443) has to be positive because increases in the ISC and short-term interest rates occur together (ibid., p.71). The US90 coefficient in the pre-MCI period model has a value of -0.076 and is significant at the 5-percent level. Thus the NZ90 was more influenced by external forces during the pre-MCI period than under the other two operating frameworks. The inclusion of a dummy variable in the OCR period model made the US90 coefficient insignificant. The p-value was 0.017 in Table 5.23b and 0.202 in Table 5.23a.

5.3.7 The interest rate cycle

This section analyses the relationships between the variables in the NZ90 models after partitioning the data on the basis of the interest rate cycle. Table 5.24 contains parameter estimates from the ARDL analysis, Table 5.25 displays the EC representation, and Table 5.26 displays the coefficients of the static long-run equilibrium. The period E results in these tables are identical to the OCR regime results in Tables 5.21, 5.22 and 5.23.

Except for the heteroscedasticity tests in periods B and C, the regressions pass all diagnostic tests reported in Table 5.24. The test statistics and p-values (in brackets) of the H-λ^2 and H-F tests for period B were 5.152 (0.023) and 5.248 (0.023) and those for period C were 8.498 (0.004) and 8.731 (0.003) respectively. These results are all highly significant. However, any widening of the confidence intervals around the parameter estimates as a result of heteroscedasticity does not appear to be a serious problem as the results are consistent with those obtained for periods A and D. For example, the $NZ90_{t-1}$, ISC_t and ODM_t coefficients have similar values in periods A and B and all are highly significant. The period C results are also directly comparable with those of period D.

The changing value of the FX_t coefficient is the most interesting feature of Table 5.24. It is highly significant in periods C and D with values of -14.709 and -14.874 respectively. The coefficient is insignificant in periods A, B and E. Periods C and D together comprise the interval covered by the MCI regime and also represent different phases of the interest rate cycle. Thus it was the MCI regime itself rather than any volatility in financial markets that generated the inverse relationship between the FX

Table 5.24 Parameter Estimates for the NZ90 Models Across the Interest Rate Cycle

Dependent Variable is NZ90[#]					
Variable	Period				
	A: Rising Rates[a]	B: Falling Rates[b]	C: Volatile Rates[c]	D: Falling Rates[d]	E: Rising Rates[e]
$NZ90_{t-1}$	0.670 (0.000)***	0.705 (0.000)***	0.562 (0.000)***	0.911 (0.000) ***	0.927 (0.000)***
$NZ90_{t-2}$	-0.035 (0.686)		0.135 (0.027)**		
$NZ90_{t-3}$	0.118 (0.063)*				
$FX_t^{‡}$	-1.273 (0.201)	-0.208 (0.158)	-14.709 (0.000)***	-14.874 (0.000)***	-0.456 (0.118)
$FX_{t-1}^{‡}$			9.598 (0.000)***	14.811 (0.000)***	
$FX_{t-2}^{‡}$			3.963 (0.012)**		
$US90_t^{‡}$	-0.109 (0.099)*	0.245 (0.016)**	0.001 (0.910)	0.006 (0.925)	0.022 (0.260)
$TBS_t^{†}$	0.000 (0.742)	0.000 (0.548)	0.000 (0.743)	0.000 (0.882)	0.000 (0.536)
$LO_t^{†‡}$	0.000 (0.391)	0.000 (0.252)	0.000 (0.717)	0.000 (0.312)	0.000 (0.887)
$ISC_t^{□}$	1.651 (0.000)***	1.664 (0.000)***	1.187 (0.000)***	0.044 (0.001)***	
$ISC_{t-1}^{□}$		-0.249 (0.000)***	0.247 (0.120)	-0.032 (0.000)***	
$ODM_t^{□}$	-1.105 (0.000)***	-1.210 (0.000)***	-0.816 (0.000) ***	0.001 (0.887)	
$ODM_{t-1}^{□}$	-0.099 (0.000)***		-0.290 (0.028)**		
$ODM_{t-2}^{□}$			-0.012 (0.691)		
$ODM_{t-3}^{□}$			-0.067 (0.004)***		
$ODMG_t$					-0.047 (0.244)
$ODMP_t$					0.031 (0.022)**
LFV_t	0.000 (0.764)	0.000 (0.305)	0.000 (0.128)	0.000 (0.925)	0.000 (0.241)
Intercept	7.649 (0.000)***	5.026 (0.000)***	6.246 (0.000)***	0.411 (0.567)	0.532 (0.041)**
Trend	0.000 (0.320)	0.002 (0.000)***	0.001 (0.192)	0.000 (0.708)	0.000 (0.134)
Dummy Variable					
DVN					-0.056***
Test Statistics and Diagnostic Tests					
$\overline{R}^2$	0.989	0.990	0.983	0.992	0.986
SER	0.062	0.072	0.085	0.112	0.025
RSS	0.706	0.844	1.666	2.104	0.094
F-statistic	F(12, 183) 1526.7 (0.000)	F(12, 161) 1480.3 (0.000)	F(16, 229) 890.535 (0.000)	F(11, 167) 1979.6 (0.000)	F (10, 148) 1081 (0.000)
AR-λ^2	0.025 (0.876)	0.710 (0.399)	0.629 (0.428)	0.183 (0.669)	0.411 (0.522)
AR-F	F(1, 182) 0.023 (0.880)	F(1, 160) 0.655 (0.419)	F(1, 228) 0.584 (0.445)	F(1, 166) 0.170 (0.680)	F (1, 147) 0.381 (0.538)
Durbin-*h*		-0.651 (0.515)		-0.361 (0.718)	0.626 (0.532)
RESET-λ^2	2.373 (0.123)	0.426 (0.514)	0.441 (0.507)	0.125 (0.723)	0.611 (0.434)
RESET-F	F(1, 182) 2.230 (0.137)	F(1, 160) 0.392 (0.532)	F(1, 228) 0.410 (0.523)	F(1, 166) 0.116 (0.733)	F (1, 147) 0.567 (0.453)
H-λ^2	0.224 (0.636)	5.152 (0.023)	8.498 (0.004)	0.033 (0.854)	0.806 (0.369)
H-F	F(1, 194) 0.222 (0.638)	F(1, 172) 5.248 (0.023)	F(1, 244) 8.731 (0.003)	F(1, 177) 0.033 (0.855)	F (1, 157) 0.799 (0.373)

Notes:

*, **, *** indicate the 10%, 5% and 1% levels of significance respectively.

[#] The p-value of each test statistic is given in brackets.

[a] The ARDL model has a lag structure of (3, 0, 0, 0, 0, 0, 1, 0) based on the AIC.

[b] The ARDL model has a lag structure of (1, 0, 0, 0, 0, 1, 0, 0) based on the SBC.

[c] The ARDL model has a lag structure of (2, 2, 0, 0, 0, 1, 3, 0) based on the AIC.

[d] The ARDL model has a lag structure of (1, 1, 0, 0, 0, 1, 0, 0) based on the AIC.

[e] The ARDL model has a lag structure of (1, 0, 0, 0, 0, 0, 0, 0) based on the SBC.

† Indicates a variable that was entered into the regression equation as a squared term in period A.

‡ Indicates a variable that was entered into the regression equation as a squared term in period C.

□ Indicates a variable that was entered into the regression equation as a squared term in period D.

Table 5.25 NZ90 Error Correction Estimates Across the Interest Rate Cycle

Dependent Variable is ΔNZ90[#]					
Variable	Period				
	A. Rising Rates[a]	B. Falling Rates[b]	C. Volatile Rates[c]	D. Falling Rates[d]	E. Rising Rates[e]
$\Delta NZ90_1$	-0.083 (0.194)		-0.135 (0.027)**		
$\Delta NZ90_2$	-0.118 (0.063)*				
ΔFX[‡]	-1.273 (0.201)	-0.208 (0.875)	-14.709 (0.000)***	-14.874 (0.000)***	-0.456 (0.118)
ΔFX_1[‡]			-3.963 (0.012)**		
ΔTrend	0.000 (0.320)	-0.002 (0.000)***	-0.001 (0.192)	0.000 (0.708)	0.000 (0.134)
ΔIntercept	7.649 (0.000)***	5.026 (0.000)***	6.246 (0.000) ***	0.4107 (0.567)	0.532 (0.041)**
ΔUS90[‡]	-0.109 (0.099)*	0.245 (0.016)**	-0.001 (0.910)	0.006 (0.925)	0.022 (0.260)
ΔODM	-1.105 (0.000)***	-1.210 (0.000)***	-0.816 (0.000)***	0.001 (0.567)	
ΔODM_1			0.079 (0.006) ***		
ΔODM_2			0.067 (0.004)***		
ΔODMG					-0.047 (0.244)
ΔODMP					0.031 (0.022)**
ΔISC	1.651 (0.000)***	1.664 (0.000)***	1.187 (0.000) ***	0.044 (0.001)***	
ΔLFV	0.000 (0.764)	0.000 (0.305)	0.000 (0.128)	0.000 (0.925)	0.000 (0.241)
ΔLO[†‡]	0.000 (0.391)	0.000 (0.252)	0.000 (0.717)	0.000 (0.312)	0.000 (0.887)
ΔTBS[†]	0.000 (0.742)	0.000 (0.548)	0.000 (0.743)	0.000 (0.882)	0.000 (0.536)
ΔDVN					-0.056 (0.001)***
EC_{t-1}	-0.247 (0.000)***	-0.295 (0.000)***	-0.303 (0.000)***	-0.089 (0.008)***	-0.073 (0.012)**
Test Statistics and Diagnostic Tests					
$\bar{R}^2$	0.270	0.486	0699	0.421	0.135
SER	0.062	0.072	0.085	.0.112	0.025
RSS	0.706	0.844	1.666	2.104	0.094
F-statistic	F(11, 184) 7.632 (0.000)	F(11, 162) 15.942 (0.000)	F(13, 232) 44.990 (0.000)	F(9, 169) 15.615 (0.000)	F(10, 148) 3.474 (0.000)

Additional Temporary Variables Created

ΔNZ90 = NZ90 – NZ90(-1)
ΔODMP = ODMP – ODMP(-1)
ΔISC = ISC – ISC(-1)
ΔLO = LO – LO(-1)
ΔFX_1 = FX(-1) – FX(-2)
ΔUS90 = US90 – US90(-1)

$\Delta NZ90_1$ = NZ90(-1) – NZ90(-2)
ΔODM_1 = ODM(-1) – ODM(-2)
ΔODMG = ODMG – ODMG(-1)
ΔLFV = LFV – LFV(-1)
ΔTBS = TBS – TBS(-1)
ΔIntercept = Intercept – Intercept(-1)

$\Delta NZ90_2$ = NZ90(-2) – NZ90(-3)
ΔODM_2 = ODM(-2) – ODM(-3)
ΔTrend = Trend – Trend(-1)
ΔDVN = DVN – DVN(-1)
ΔFX = FX – FX(-1)

Period A
EC = NZ90 + (5.147*FX) + (0.439*US90) – (0.00000004TBS) + (0.000000002*LO) – (6.675*ISC) – (5.677*ODM) + (0.0002*LFV) – (30.924*Intercept) – (0.001*Trend)

Period B
EC = NZ90 + (0.706*FX) – (0.833*US90) – (4.802*ISC) + (4.106*ODM) – (0.001*LFV) – (0.0007*LO) + (0.00002*TBS) – (17.057*Intercept) + (0.0006*Trend)

Period C
EC = NZ90 + (3.787*FX) – (0.00000006*LO) + (3.906*ODM) – (4.725*ISC) + (0.001*LFV) – (0.003*US90) + (0.00002*TBS) – (6.246*Intercept) + (0.0005*Trend)

Period D
EC = NZ90 + (0.715*FX) – (0.071*US90) – (0.00004*TBS) + (0.0003*LO) – (0.138*ISC) + (0.006*ODM) – (0.0004*LFV) – (4.627*Intercept) + (0.003*Trend)

Period E
EC = NZ90 + (6.218*FX) – (0.00004*LO) + (0.642*ODMG) – (0.418*ODMP) – (0.0005*LFV) – (0.296US90) + (0.00005*TBS) – (7.246*Intercept) – (0.004*Trend) + (0.764*DVN)

Notes: See Table 5.24

Table 5.26 Estimated Long-Run Coefficients for the NZ90 Models Across the Interest Rate Cycle

Dependent Variable is NZ90[#]					
Variable	Period				
	A. Rising Rates[a]	B. Falling Rates[b]	C. Volatile Rates[c]	D. Falling Rates[d]	E. Rising Rates[e]
Intercept	30.925 (0.000)***	17.057 (0.000)***	20.581 (0.000)***	4.626 (0.553)	7.246 (0.085)*
FX[‡]	-5.147 (0.192)	-0.706 (0.875)	-3.787 (0.062)*	-0.715 (0.945)	-6.218 (0.181)
US90[‡]	-0.439 (0.124)	0.833 (0.013)**	0.003 (0.910)	0.071 (0.925)	0.296 (0.202)
TBS[†]	0.000 (0.743)	0.000 (0.550)	0.000 (0.744)	0.000 (0.882)	0.000 (0.550)
LO[†‡]	0.000 (0.387)	0.000 (0.266)	0.000 (0.717)	0.000 (0.336)	0.000 (0.887)
ISC	6.675 (0.000)***	4.802 (0.000)***	4.725 (0.000)***	0.138 (0.173)	
ODM	-5.677 (0.000)***	-4.106 (0.000)***	-3.906 (0.000)***	-0.006 (0.885)	
ODMG					-0.642 (0.310)
ODMP					0.418 (0.036)**
LFV	0.000 (0.764)	0.001 (0.312)	-0.001 (0.137)	0.000 (0.925)	0.001 (0.299)
Trend	0.001 (0.312)	-0.006 (0.000)***	-0.002 (0.189)	-0.003 (0.702)	1.596 (0.113)
Dummy Variables					
DVN					-0.764 (0.058)*

Notes: See Table 5.24.

and NZ90. The FX_{t-1} coefficient has a highly significant positive value in periods C and D. This is consistent with replies to questions 18, 19 and 20 of the survey[31], which indicated that the MCI target became less rigid over time as new information came to hand. Financial market participants appeared willing to accept some downward movement in interest rates after an initial upward movement associated with a fall in the exchange rate.

The ISC, ODM and ODMP variables are the only statistically significant policy instruments in Table 5.24. The most noticeable impact of the interest rate cycle on these policy variables was in period D when interest rates declined sharply. The size of the ISC_t coefficient fell substantially (from 1.187 in period C to 0.044 in period D) and the ODM variable became insignificant.

[31] See sections 5.1.2 and 5.1.3.

The EC_{t-1} coefficients in Table 5.25 are all highly significant and have the correct sign. The larger the coefficient (in absolute value) the faster is the system's return to equilibrium, once shocked. The coefficients suggest a reasonably fast speed of convergence to equilibrium in periods A, B and C with the respective values being -0.247, -0.295 and -0.303. The adjustment mechanism was weaker during periods D and E with the coefficient having values of only -0.089 and -0.073.

The ISC and ODM are the only statistically significant policy instruments in Table 5.26. Their long-run coefficients are all reasonably large and pass the one-percent significance level in periods A, B and C. However, they are insignificant in period D when the NZ90 declined sharply. The US90 coefficient in period B had a value of 0.833 and a p-value of 0.013. This may indicate that money markets had a heightened sensitivity to external factors, however the presence of heteroscedasticity means that this test result should be treated with caution.

5.4 The VAR Results

Nonstationarity can be a serious problem when analysing time series data[32]. Non-stationary variables can be analysed using a co-integrating VAR or they can be made stationary by differencing and then analysed with an unrestricted VAR. This analysis used block Granger causality tests, FEV decompositions and IR functions derived from an unrestricted VAR to learn more about how the NZ90 and FX were affected by the ISC and ODM policy variables. The other policy variables (LO, LFV and TBS) were not included in the VAR analysis because the ARDL results showed that there was no relationship between them and the two components of the MCI. Long-run information is lost when data is differenced, however this was not a problem here as the analysis focused on the short-run links between variables. Subsection 5.4.1 reports the results obtained from block Granger causality tests, subsection 5.4.2 discusses the FEV decompositions and subsection 5.4.3 contains tables and graphs from the IR functions.

[32] Nonstationarity is discussed in section 2.5.1 and the differencing of data is discussed in section 4.3.1.

5.4.1 *Block Granger causality results*

Block Granger causality tests were undertaken to determine how the MCI regime affected the correlation between movements in the FX and NZ90, and innovations in the ISC and ODM. Two trivariate VARs were constructed. The first VAR contained the FX, ISC and ODM; the second VAR contained the NZ90, ISC and ODM. Each VAR was applied to the pre-MCI and MCI periods. The results are presented in Table 5.27.

Table 5.27 Block Granger Causality Test Results

Variable Caused	Operating Framework	LR-statistic	p-value
FX	Pre-MCI Period MCI Regime	10.303 7.526	0.112 0.275
NZ90	Pre-MCI Period MCI Regime	16.166 4.071	0.040** 0.851

Note:
** significant at the five-percent level.

Granger causality is an indicator of predictability and does not necessarily imply a cause-effect relationship (Griffiths *et al.*, 1993, pp. 695-696). The LR statistic for the NZ90 in the pre-MCI sample is the only significant result in Table 5.27. It has a value of 16.166, which is significant at the 5-percent level. This suggests that the ISC and ODM had a role in explaining movements of the NZ90 during the pre-MCI regime. There was no significant causality for the FX under either operating framework or for the NZ90 during the MCI period. These results are consistent with those obtained from the ARDL analysis in section 5.3. For example, all the ISC and ODM coefficients in Table 5.18 were insignificant indicating that there was no statistical relationship between them and the exchange rate. The ODM coefficient in Table 5.21 was also insignificant during the MCI period. This may explain why, in Table 5.27, the LR statistic for the NZ90 was insignificant (the p-value is 0.851) during the MCI period.

5.4.2 *FEV decompositions*

The VAR model was used to calculate FEV decompositions for the NZ90 and FX variables. Results obtained from the orthogonalized and generalised decompositions did not differ significantly. Table 5.28 shows the relative proportions of changes in FX and NZ90 that can be accounted for by other variables. The variables were differenced once and their order was NZ90, FX, US90, ODM, ODMG, ODMP, LFV, ISC, LO and TBS. The results from other orderings differed from those in Table 5.28 by less than a percentage point.

Table 5.28 Orthogonalized Forecast Error Variance Decompositions

Variable	Forecast Period (days)	Per cent of forecast variance explained by									
		NZ90	FX	US90	ODM	ODMG	ODMP	LFV	ISC	LO	TBS
Pre-MCI Regime											
NZ-90	1	0.9725	0.0000	0.0015	0.0209			0.0000	0.0044	0.0000	0.0006
	5	0.9668	0.0000	0.0015	0.0226			0.0000	0.0082	0.0002	0.0007
	10	0.9668	0.0000	0.0015	0.0226			0.0000	0.0082	0.0002	0.0007
FX	1	0.0017	0.9891	0.0029	0.0004			0.0013	0.0000	0.0031	0.0015
	5	0.0017	0.9876	0.0029	0.0004			0.0015	0.0003	0.0032	0.0023
	10	0.0017	0.9876	0.0029	0.0004			0.0015	0.0003	0.0032	0.0023
MCI Regime											
NZ-90	1	0.9908	0.0024	0.0029	0.0006			0.0002	0.0007	0.0000	0.0023
	5	0.9899	0.0024	0.0030	0.0008			0.0003	0.0010	0.0000	0.0027
	10	0.9899	0.0024	0.0030	0.0008			0.0002	0.0010	0.0000	0.0027
FX	1	0.0047	0.9811	0.0001	0.0070			0.0008	0.0036	0.0000	0.0026
	5	0.0053	0.9773	0.0001	0.0072			0.0013	0.0048	0.0000	0.0040
	10	0.0053	0.9773	0.0001	0.0072			0.0013	0.0048	0.0000	0.0040
OCR Regime											
NZ-90	1	0.9676	0.0006	0.0157		0.0000	0.0067	0.0015		0.0006	0.0072
	5	0.9617	0.0006	0.0173		0.0000	0.0070	0.0055		0.0006	0.0073
	10	0.9617	0.0006	0.0173		0.0000	0.0070	0.0055		0.0006	0.0073
FX	1	0.0364	0.9456	0.0093		0.0028	0.0020	0.0000		0.0003	0.0034
	5	0.0371	0.9435	0.0106		0.0028	0.0020	0.0002		0.0005	0.0033
	10	0.0371	0.9435	0.0106		0.0028	0.0020	0.0002		0.0005	0.0033

The results in Table 5.28 reveal an extremely weak statistical connection between the RBNZ's policy tools and the two MCI components. Innovations in the ODM and ISC had at most a one or two-percentage point effect on the FX and the NZ90 during the pre-MCI and OCR periods. There was no significant effect during the MCI period itself. Other policy instruments had no effect at all. Almost all the explainable forecast variation of the dependent variables was accounted for by their own lagged values. This implies that simple autoregressive processes largely capture the forecast variation in FX and NZ90.

5.4.3 IR functions

Having determined the level of influence the independent variables have on the NZ90 and FX, it is of interest to determine the nature of the relationship between them. IR functions using differenced data were used to obtain information about the impact of one standard deviation shocks in the ISC and ODM on the NZ90 and FX. The system's dynamic properties in the pre-MCI period were compared with those in the MCI period. The orthogonalised and generalised IR functions gave identical results and changes in the variable ordering affected the results by less than one percentage point. Table 5.29 provides the IR results to shocks in the ISC at time zero and Table 5.30 does the same for shocks in the ODM. Figures 5.4 and 5.5 describe the relationship between the shocked variables and NZ90 and FX in the four days following the shock.

Table 5.29 Generalised Impulse Responses for the ISC.

Operating Framework	Variable Shocked	Response Variables		
		ISC	NZ90	FX
Pre-MCI Period	ISC	0.1109	0.0396	0.0002
MCI Period	ISC	0.2476	0.0729	-0.0013

Table 5.30 Generalised Impulse Responses for the ODM.

Operating Framework	Variable Shocked	Response Variables		
		ODM	NZ90	FX
Pre-MCI Period	ODM	0.1276	0.0323	0.0003
MCI Period	ODM	0.2996	0.0575	-0.0010

It can be seen in Table 5.29 that a positive innovation in the ISC has a small positive impact on the ISC and a negligible impact on the FX. The change in operating framework did not alter this relationship significantly. Similar results were obtained for the ODM in Table 5.30.

Figure 5.4 Generalised Impulse Responses to a One Standard Deviation Shock in the ISC.

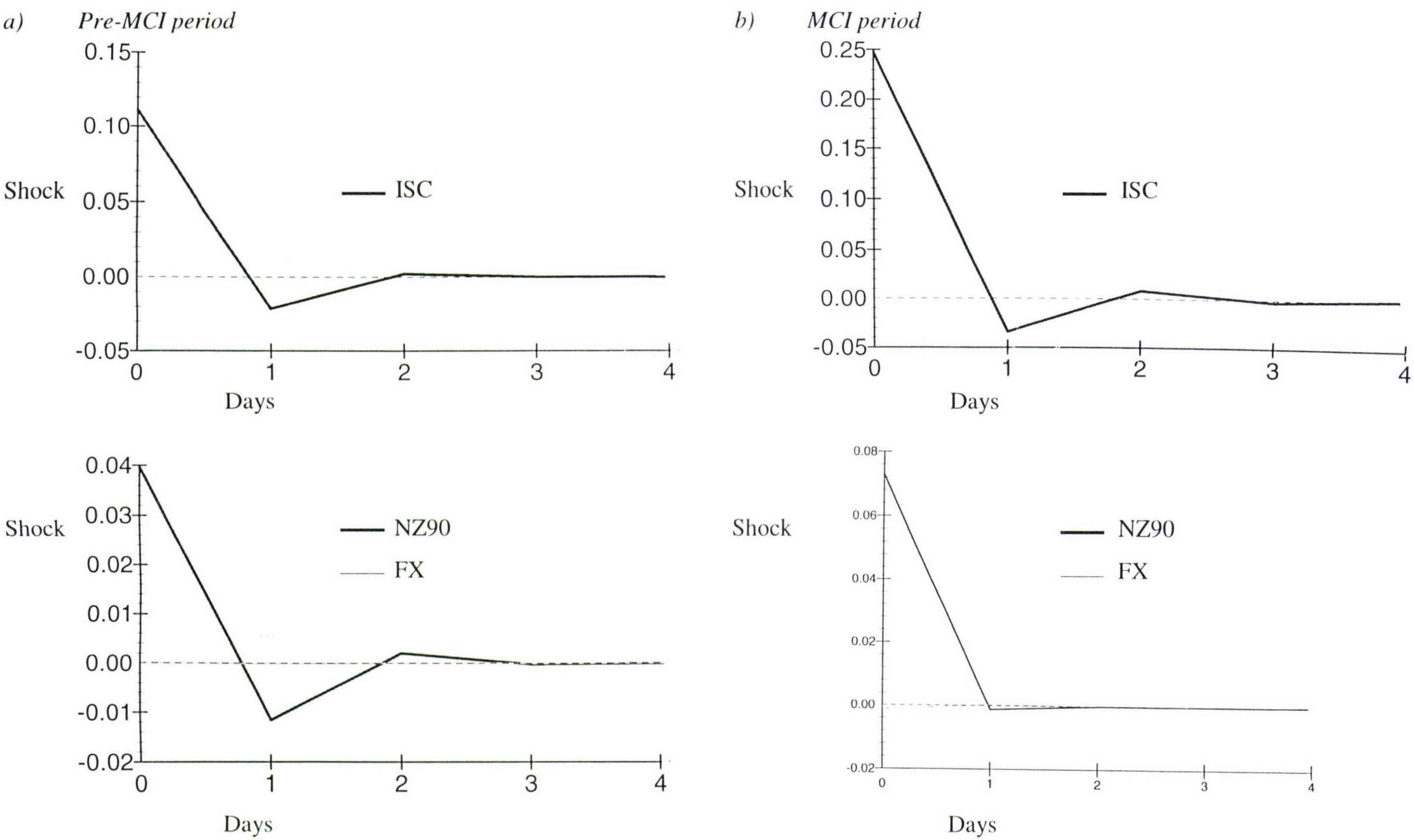
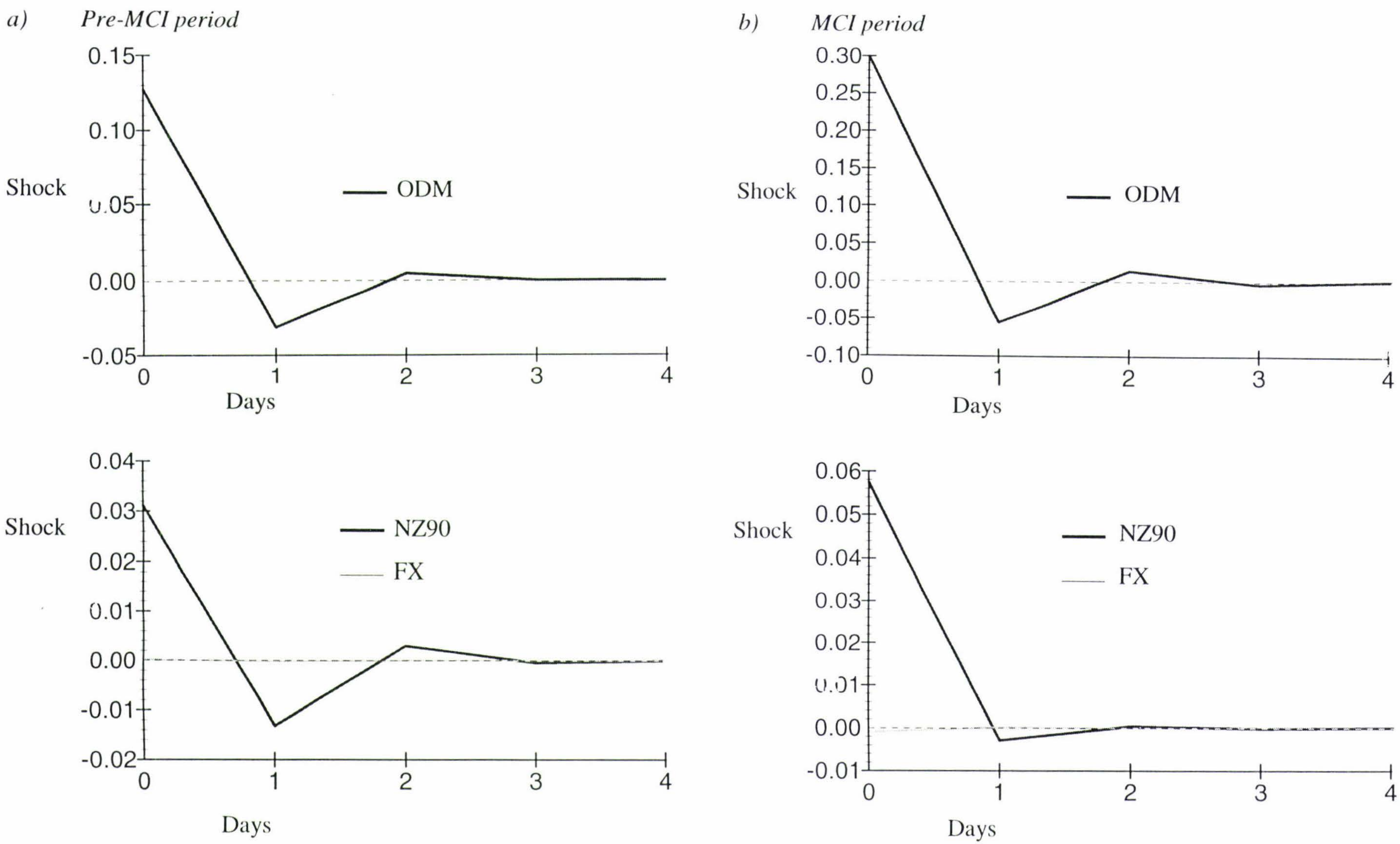


Figure 5.5 Generalised Impulse Responses to a One Standard Deviation Shock in the ODM.



Figures 5.4 and 5.5 show that innovations in the ODM and ISC had impacts on the NZ90 that were largely complete within a couple of days following the shock. In both cases, the impact of the innovation appeared to die out more rapidly during the MCI regime.

5.5 Concluding Comments

This chapter presented results from the four methodologies described in chapter four. The questionnaire was given to a small number of people and so it was not possible to subject the results to a rigorous statistical analysis. However, the respondents are assumed to have had a good understanding of the issues involved and so their views should be generally representative of those prevailing in financial markets. The survey results indicated that the MCI regime failed to improve the communication of the RBNZ's policy stance to financial markets. The opinion that the target MCI was too rigid and that this raised interest rates during the 1998 recession is particularly interesting because it is consistent with results obtained from the rolling regressions and the ARDL analysis. Both methodologies demonstrated that a statistically significant inverse relationship existed between the FX and NZ90 during the MCI regime. The ARDL analysis also showed that this phenomenon was not due to changes in the interest rate cycle.

None of the RBNZ's policy instruments were found to have a statistically significant relationship with either the MCI itself or the exchange rate in any of the operating frameworks. However, innovations in the ISC, ODM and ODMP were correlated with changes in the NZ90. The introduction of the MCI regime did not appear to affect these relationships greatly; indeed the interest rate cycle seems to have been responsible for any observed changes. Finally, block Granger causality tests, orthogonalized FEV decompositions and generalised IR functions derived from a VAR framework were used to show how the ISC and ODM influenced the NZ90 and FX. The two policy instruments had a minor impact on the NZ90 and none at all on the FX. The introduction of the MCI regime did not appear to affect these relationships significantly.

6 CONCLUSION

This study used four methodologies to investigate the effect of the MCI regime on the implementation of monetary policy in New Zealand.

The first methodology was a survey. Its results suggested that the MCI regime failed to reduce uncertainty and improve the communication of the RBNZ's monetary policy stance to financial markets. For example, some respondents were confused by such things as changes to the bandwidth around the target MCI. The MCI regime also produced new transactions that influenced monetary conditions through exchange rate changes but their overall impact is uncertain. Answers received to questions 16 and 17 of the survey are particularly interesting. All respondents believed that the MCI target was too rigid. Such perceived rigidity would have placed upward pressure on interest rates if the RBNZ had underestimated the extent by which changes in external factors were pushing down the value of the currency. These factors included such things as unit labour costs, international inflation differentials and fiscal policy. This explains the prolonged increase in interest rates, which began when the MCI regime was introduced in mid-1997 and continued until mid-1998 when the economy went into recession following the Asian financial crisis. This development was associated with a large fall in the value of the currency.

The second methodology, the 10-week rolling regressions, demonstrated that there was a systematic negative relationship between short-term interest rates and the exchange rate from mid-1997 until November 1998. A similar inverse relationship in Australia lasted for only five months in 1998 when the Asian financial crisis was at its worst. Both countries had a similar exposure to the world economy and so these different outcomes are most likely due to their different approaches to monetary policy. The OCR system used by the RBA was relatively straightforward to operate and did not rely on market perceptions of the central bank's monetary policy stance in the same way that the MCI regime did. This explains the different time patterns of the exchange rate coefficients in Figures 5.1 and 5.2. The New Zealand results are consistent with the perceived rigidity of the MCI target mentioned by respondents to the survey. This perception was perhaps due to the desired MCI remaining above the actual MCI for so long, which implied that the RBNZ wanted interest rates kept high so that its inflation goals would not be jeopardised by the depreciating exchange rate[33]. The short duration of the statistically significant negative coefficients in Figure 5.2 indicates that market participants in Australia were better able to anticipate the RBA's policy response to portfolio shocks. Hence political and economic uncertainties in mid-1998 caused short-term interest rates to change in a way that offset exchange rate changes without hindering the implementation of monetary policy over the long-run.

The ARDL procedure was the third methodology. It produced results that were consistent with those obtained from the 10-week rolling regressions. For example, in Table 5.21a, the FX_t coefficient in the model for the MCI period is very large and significantly negative. This indicates that the large fall in the value of the currency at that time was correlated with a rise in New Zealand interest rates. There was no inverse relationship in the pre-MCI and OCR periods. Re-estimation of the NZ90 models after partitioning the data on the basis of the interest rate cycle showed that this inverse relationship was not caused by changes in the volatility of financial markets. It appeared to have been caused by the MCI regime itself.

These results support the arguments advanced by Gerlach and Smets (2000) in their investigation into the use of MCIs in monetary policy[34]. They maintained that it is inappropriate to use an MCI as an operational target if the central bank cannot identify the causes of exchange rate changes. In such circumstances, the optimal MCI weight is likely to be smaller than that implied by the elasticities of aggregate demand. Respondents, in their answers to questions 16 and 17 of the survey, claimed that the RBNZ did not take into account the changing external environment, which was pushing the currency lower. This indicates that the MCI was used inappropriately as an operational target for monetary policy and that the optimal weight was smaller than that calculated by the RBNZ. The inverse relationship between the exchange rate and interest rates described in this study can therefore be considered as the unfortunate consequence of an inappropriate use of the MCI. It is the reason why interest rates

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[33] See Figure 3.4, p. 50.

[34] The study by Gerlach and Smets (2000) is described in section 2.7.

reached almost 10-percent in mid-1998 and exacerbated the recession, which hit the New Zealand economy at that time[35].

The VAR analysis was the fourth methodology. It and the ARDL procedure showed that the MCI regime did not affect the RBNZ's ability to implement monetary policy through its policy instruments. None of those instruments had any discernible influence on the exchange rate or the MCI itself under any of the operating frameworks. The ISC and ODM were the only policy instruments that had a statistically significant relationship with movements in the NZ90. However, their impact was small and the RBNZ was unable to use them to set the MCI to a desired target level on a daily basis. Indeed, the FEV decompositions suggest that the policy tools were more appropriately applied to smoothing out daily fluctuations in money markets than to implementing long-term policies. Nevertheless the high statistical significance of the ISC and ODM variables suggests that it might have been possible for the RBNZ to exert a degree of influence over the MCI through short-term interest rates when the economy was not being buffeted by external influences. This is supported by the fact that some of the daily data used in the analysis were highly volatile, and so the RBNZ's operations may have accounted for only a small proportion of their movement.

These findings are consistent with answers given by two respondents to question 15 in the survey when they claimed that the RBNZ intervened in financial markets by jawboning. They are also consistent with the study by Bonato *et al.* (1999), which uncovered a relationship between the RBNZ's "open mouth operations" and public expectations. Threatened rather than actual changes to the ISC and the ODM have therefore been the primary means by which the RBNZ has influenced monetary conditions. The MCI regime affected the implementation of monetary policy by impacting on the way financial market participants perceived the RBNZ's public announcements on the appropriate level of monetary conditions.

This study also supports the claim by Mayes and Virén (2000) that MCIs do not take account of all factors affecting prices and so need to be used in combination with other information when analysing inflationary pressure in one particular period or when

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[35] The article by the *Economist* (1999), which describes how interest rates peaked at the time of the 1998 recession, is described in section 3.7.

comparing time periods[36]. Too little is understood of how perceptions are developed and influenced in financial markets for it to be used as an operational target as was done in New Zealand, especially when one considers the uncertainty surrounding the concept. An MCI is best used by a central bank as an indicator of monetary conditions when formulating policies. Future research should be directed towards determining its reliability as such an indicator.

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[36] The study by Mayes and Virén (2000) is described in section 2.7.

APPENDIX 1

Section 8, Reserve Bank of New Zealand Act 1964.

8. Primary functions of Bank

(1) The primary functions of the Bank shall be:

(a) To act as the central bank for New Zealand; and

(b) To advise the Government on matters relating to monetary policy, banking, and overseas exchange; and

(c) Within the limits of its powers, to give effect to the monetary policy of the Government as communicated in writing to the Bank under subsection (2) of this section, and to any resolution of Parliament in relation to that monetary policy.

(2) For the purposes of this Act, the Minister may from time to time communicate to the Bank the monetary policy of the Government, which shall be directed to the maintenance and promotion of economic and social welfare in New Zealand having regard to the desirability of promoting the highest degree of production, trade, and employment and of maintaining a stable internal price level.

(3) The Bank may on behalf of the Government, regulate and control:

(a) Money, banking, banking transactions, credit, and currency,

(b) Rates of interest in respect of such classes of transactions as may from time to time be prescribed.

(c) Overseas exchange, and overseas exchange transactions.

(New Zealand Government, 1964, pp. 1017-1018)

APPENDIX 2

Part II of the Reserve Bank of New Zealand Act 1989

FUNCTIONS AND POWERS OF RESERVE BANK

Central Bank

7. Bank to act as central bank—The Bank shall act as the central bank for New Zealand.

Cf. 1964, No. 134, s. 8 (1) (a); 1973, No. 16, s. 5

Monetary Policy

8. Primary function of Bank—The primary function of the Bank is to formulate and implement monetary policy directed to the economic objective of achieving and maintaining stability in the general level of prices.

9. Policy targets—(1) The Minister shall, before appointing, or reappointing, any person as Governor, fix, in agreement with that person, policy targets for the carrying out by the Bank of its primary function during that person's term of office, or next term of office, as Governor.

(2) In the case of a person who is deemed to have been appointed as Governor under section 191 (1) of this Act, policy targets for that person's term of office shall be fixed by the Minister, in agreement with the Governor, within 30 days after the commencement of this Act.

(3) Policy targets may be fixed for the term of office of the Governor, or for specified periods during the term of office of the Governor, or for both.

(4) The Minister and the Governor may, from time to time,—

(a) Review or alter any policy targets fixed under this section; or

(b) Substitute new policy targets for targets fixed under this section.

(5) Where policy targets are fixed under this section,—

(a) The Minister shall ensure that they are recorded in writing; and

(b) The Governor shall ensure that they are tabled at the first Board meeting held after the date on which they are fixed; and

(c) The Minister shall, as soon as practicable after they are fixed, publish them in the *Gazette* and lay a copy of them before the House of Representatives.

10. Formulation and implementation of monetary policy—In formulating and implementing monetary policy the Bank shall—

(a) Have regard to the efficiency and soundness of the financial system:

(b) Consult with, and give advice to, the Government and such persons or organisations as the Bank considers can assist it to achieve and maintain the economic objective of monetary policy.

11. Governor to ensure policy targets followed—It is the duty of the Governor to ensure that the actions of the Bank in implementing monetary policy are consistent with the policy targets fixed under section 9 of this Act.

12. Bank may be directed to formulate and implement monetary policy for different economic objective—(1) The Governor-General may, from time to time, by Order in Council, on the advice of the Minister, direct the Bank to formulate and implement monetary policy for any economic objective, other than the economic objective specified in section 8 of this Act, for such period not exceeding 12 months as shall be specified in the order.

(2) Notwithstanding anything in section 8 of this Act, the Bank shall formulate and implement monetary policy in accordance with any economic objective specified in an Order in Council in force under subsection (1) of this section.

(3) The Governor-General may, by Order in Council, on the advice of the Minister, before the period specified in an Order in Council made under subsection (1) of this section expires, extend the period specified in that order for a period, which shall be specified in the order, not exceeding 12 months, and may in the same manner extend that period on successive occasions.

(4) Every Order in Council made under subsection (1) of this section shall expire with the close of the last day of the period specified in the order or any extension of that period.

(5) An Order in Council made under subsection (1) of this section may be revoked.

(6) The Minister shall, as soon as practicable after the making of an Order in Council under this section, publish a copy of the order in the *Gazette* and lay a copy of the order before the House of Representatives.

(7) While an Order in Council made under subsection (1) of this section remains in force,—

(a) The policy targets fixed under section 9 of this Act shall cease to have effect; and

(b) The Minister and the Governor shall,—

(i) Within 30 days of the making of the order, or the making of an Order in Council under subsection (3) of this section, as the case may be, fix new policy targets for the period that the order remains in force; and

(ii) Within 30 days of the expiry or revocation of the order, fix new policy targets for the carrying out by the Bank of its primary function.

(8) Subsections (4) and (5) of section 9 of this Act shall apply in relation to any policy targets fixed under subsection (7) (b) of this section.

13. Bank's primary function not affected—Except as provided in sections 9 to 12 of this Act, nothing in this Act or in any other Act whether passed before or after the commencement of this Act limits or affects the obligation of the Bank to carry out its primary function.

14. Advice concerning effects of monetary policy—Where the Bank gives advice to the Minister under any provision of this Act and the Governor considers that giving effect to that advice would, or would be likely to, affect the monetary policy of the Bank, the Governor shall advise the Minister of—

(a) The effect, or likely effects, on monetary policy; and

(b) Any action that may be taken by the Bank in implementing the Bank's monetary policy if effect is given to that advice.

15. Policy statements—

"(1) The Bank shall deliver to the Minister and publish, in accordance with subsection (1A) of this section, policy statements for the period of 6 months from and after the date of publication.

(1A) The Bank shall deliver and publish a policy statement on or before the 1st day of October 1990 and thereafter at intervals not exceeding 6 months from the date of publication of each preceding statement.

(1B) The Bank shall, if directed to do so by the Minister, in addition to its obligation under subsection (1) of this section, deliver to the Minister and publish policy statements at such intervals and for such periods as may be specified in the direction."

(2) The policy statement shall be signed by the Governor and shall—

(a) Specify the policies and means by which the Bank intends to achieve the policy targets fixed under section 9 of this Act:

(b) State the reasons for adopting those policies and means:

(c) Contain a statement of how the Bank proposes monetary policy might be formulated and implemented during the next 5 years:

(d) Contain a review and assessment of the implementation by the Bank of monetary policy during the period to which the preceding policy statement relates.

(3) Every policy statement shall, by virtue of this section, stand referred to—

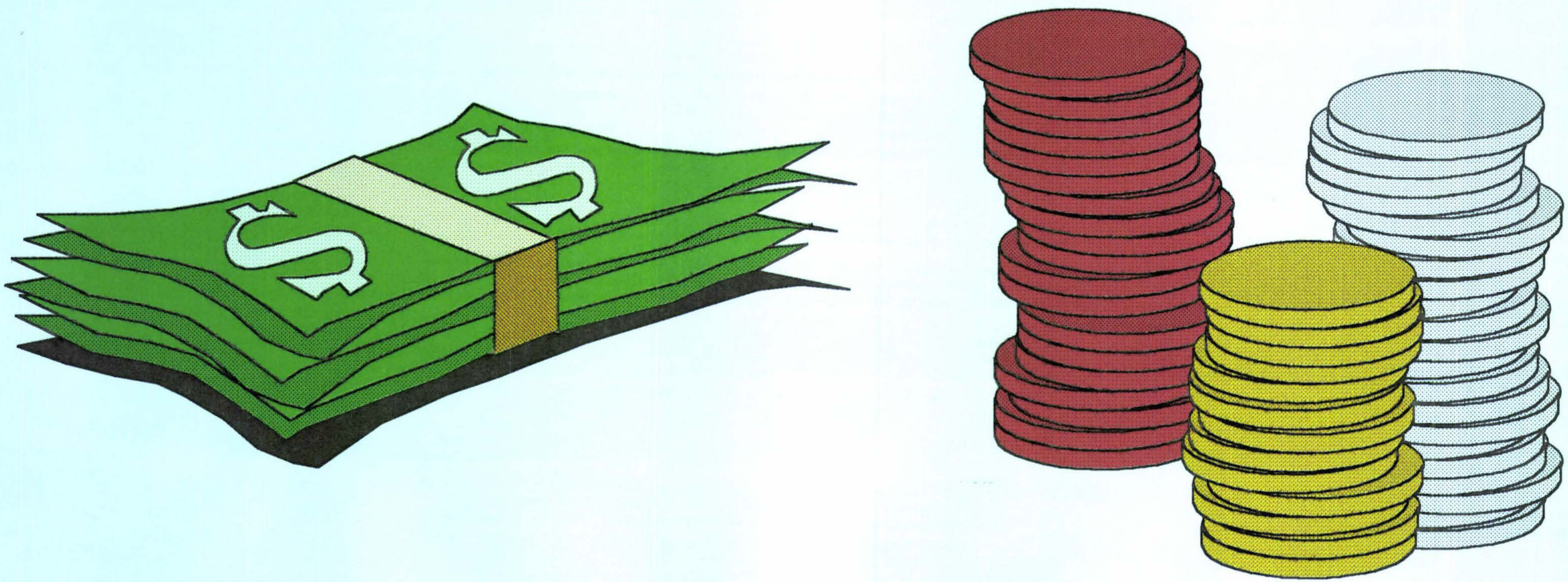
(a) The House of Representatives; and

(b) Any committee of the House of Representatives responsible for the overall review of financial management in government departments and other public bodies.

(New Zealand Government, 1992, pp. 2550-2553)

APPENDIX 3 The Survey

THE MONETARY CONDITIONS INDEX



AN INVESTIGATION OF THE MCI

INFORMATION SHEET

MASSEY UNIVERSITY
Private Bag 11222
Palmerston North
New Zealand
Telephone +64-6-356 9099
Facsimile +64-6-350 5660

COLLEGE OF BUSINESS

DEPARTMENT OF APPLIED AND INTERNATIONAL ECONOMICS

The Chief Economist
The Bank of New Zealand
P.O. BOX 335
WELLINGTON

Dear Sir or Madam:

Greetings, my name is Robin Loomes. I am currently researching the Monetary Conditions Index (MCI) under the supervision of Dr Hans-Jürgen Engelbrecht and Dr Claudio Michelini at Massey University.

The Reserve Bank of New Zealand used the MCI as an operational target for monetary policy from June 1997 until March 1999. There has been a lot of debate about this experiment. You may be aware of and perhaps have even taken part in discussions on the matter. The purpose of my study is to determine whether the Reserve Bank's focus on the MCI hindered or improved policy implementation.

I am inviting you and economists from other banks to provide information on your experience with the MCI. If you are willing to participate in this survey, which should take about 15 minutes to complete, please return it in the freepost envelope provided. I would be grateful if you would pass the survey on to someone else at your bank if you prefer not to fill it out.

You do not have to fill out this questionnaire and have the right not to answer any questions. Filling out this questionnaire implies consent.

Completed surveys will be destroyed once they have been collated and your answers will be held in complete confidence. Your name will not be used or any clues provided as to your identity without your express permission.

I am happy to answer any questions you may have. Please write or call.

Thank you for your assistance.

Sincerely,

R. A. Loomes,

Robin Loomes
Graduate Student
ROBIN.LOOMES.1@uni.massey.ac.nz

Dr Hans-Jürgen Engelbrecht
Supervisor
(06) 350-5968

Background

The Reserve Bank of New Zealand Act 1989 was designed to improve the credibility and transparency of monetary policy. It created an environment in which financial markets tended to implement policy on behalf of the Reserve Bank. They adjusted interest rates along paths indicated by the Bank's published statements to an extent that central bank intervention was rarely required. On most occasions when the Reserve Bank released its statements it was merely confirming and validating adjustments in monetary conditions that had already occurred.

However, a communication problem emerged. It proved impossible to give markets unambiguous messages that related simultaneously to movements in interest rates and the exchange rate. In other words, the Reserve Bank was unable to control the mix of monetary conditions. Thus attempts at signaling were occasionally unsuccessful and moved monetary conditions in unintended ways.

The Reserve Bank decided to use the Monetary Conditions Index (MCI) as an operational target for monetary policy in an effort to cure this problem. If inflation appeared likely to increase, then the Reserve Bank used the MCI to tell markets that a particular level of the MCI was required if the inflation target was to be met. Daily movements in interest rates and the exchange rate were thus translated into MCI terms and compared with the 'desired' level of the MCI estimated by the Reserve Bank.

Your answers to the following questions will be treated as strictly confidential. Your name will not be used in connection with the results of this study except with your express permission.

1. **Did you use the MCI throughout the period that it was employed as an operational target for monetary policy?** *(Please circle).*

Yes No

2. **If your answer to question 1 was (No), then between which dates did you use it?**

____

3. **Which of the following statements best describes how the MCI affected your understanding of what the Reserve Bank wanted monetary policy to do?** *(Please circle).*

A. The MCI made it harder for me to understand what the Reserve Bank wanted monetary policy to do.

B. The MCI made it easier for me to understand what the Reserve bank wanted monetary policy to do.

C. The MCI did not affect my understanding of what the Reserve Bank wanted monetary policy to do.

4. **The main purpose of the MCI was to identify desired monetary conditions when interest rates and the exchange rate changed relative to each other. Was that your understanding?** *(Please circle).*

Yes No

5. **If your answer to question 4 was (No), then what did you think the purpose of the MCI was.**

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6. **The actual MCI often deviated significantly from the Reserve Bank's announced target, but the Reserve Bank did not always indicate that it was unhappy with the deviation. Did you find this confusing?** *(Please circle)*.

Yes No Sometimes

7. **Please give a reason for your answer to question 6.**

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8. **Did the MCI cause banks to produce new types of transactions?** *(Please circle)*

Yes No Don't know

9. **If your answered yes to question 8, then please list those transactions and their effects.**

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10. **If any transactions occurred, how do you think they might have impacted on monetary conditions?**

11. **Did you believe that the MCI affected the New Zealand dollar versus the exchange rates of other countries?** *(Please circle)*

Yes No Don't know

12. **Please give reasons for your answer to question 11.**

In June 1997, when the MCI was formally introduced, the Bank announced +/- 50-point tolerance bands to prevent actual conditions deviating too much from the desired path.

Between early July 1997 and early May 1998 a 12% depreciation caused monetary conditions to fall by about 400 index points. At the same time, short-term interest rates rose by over 200 basis points, peaking at around 10%. Short-term interest rate differentials with the United States and Australia widened and so New Zealand rates were relatively high.

Questions 12 to 15 deal specifically with the period from early July 1997 to early May 1998. I want to know your opinion about the affect of the MCI on interest rates.

13. **Which of the following statements best describes the way the MCI affected your overall approach to adjusting interest rates during this period?** *(Please circle)*

A. It made you more reluctant to raise interest rates

B. It made you more reluctant to lower interest rates.

C. It did not affect your approach to changing interest rates.

D. You are unsure if it affected your approach to changing interest rates.

14. Which of the following statements best describes your opinion about the likelihood of the Reserve Bank intervening to keep the exchange rate stable during this period? *(Please circle)*

A. The Reserve Bank became less likely to intervene.

B. The Reserve Bank became more likely to intervene.

C. You did not believe that the Reserve Bank would intervene at any stage.

D. You always believed that intervention was likely.

E. You had no opinion about the Reserve Bank intervening.

15. Which of the following statements best describes your opinion during that period about the likelihood of the Reserve Bank intervening to adjust interest rates if the MCI exceeded the +/- 50-point tolerance band? *(Please circle)***.**

A. You thought that the Reserve Bank was becoming less likely to intervene.

B. You thought that the Reserve Bank was becoming more likely to intervene.

C. You did not believe that the Reserve Bank would intervene at any stage.

D. You always believed that intervention was likely.

E. You had no opinion about the Reserve Bank intervening

16. Which of the following statements best describes your belief about the rigidity of the target MCI during this period? *(Please circle)*

A. The MCI target was too rigid throughout this period.

B. The MCI target was not rigid enough during this period.

C. The Reserve Bank used the MCI target with the correct degree of flexibility.

D. Not possible to tell if the MCI target was too rigid.

17. Given your answer in question 16, what do you think were the consequences for short-term interest rates?

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18. **Which statement best describes your opinion about how the rigidity of the MCI target might have changed during this period?** ***(Please circle)***

A. The MCI target became less rigid as time went by.

B. The MCI target became more rigid as time went by.

C. The rigidity of the MCI target did not change.

The MCI was increasingly allowed to drift from its projected path during the second half of 1998. The Reserve Bank formally acknowledged the removal of an explicit MCI band in its November 1998 Monetary Policy Statement (MPS).

19. Did you believe, prior to the November 1998 MPS, that the Reserve Bank had changed its tolerance band without informing the market? *(Please circle)*

Yes No Didn't know

20. If you answered yes to question 19 then when do you think the Bank changed its tolerance band and by how much?

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20. Did you start ignoring the tolerance bands set by the Reserve Bank before they were removed? If so, when?

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Finally, I would like to ask a few questions about you to help interpret the questionnaire.

21. **What was your job (e.g. financial analyst) during the period that the Reserve Bank used the MCI as an operational target for monetary policy?**

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22. **What type of employer (e.g. a trading bank) did you have during that period?**

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THANK YOU FOR YOUR TIME

Your response to this questionnaire is strictly confidential and your name will not be connected to any work done with your answers except with your express permission.

You have the right to withdraw from this study at any time and to decline to answer any particular questions. Please contact us if there are any aspects of the survey that you want clarified.

We are grateful to you for answering these questions. Please mail the questionnaire in the stamped addressed envelope provided as soon as possible.

There might be something else you want to tell us about the MCI. If so, please use the rest of this page for that purpose.

Your contribution to this effort is greatly appreciated. Thank you.

PILOT STUDY QUESTIONS

1. **Please indicate below any questions that you thought were ambiguous and need to be reworded. Give reasons if possible.**

2. **Were there any unnecessary questions?**

3. **Can you think of any questions that should have been asked but weren't?**

4. **How long did it take you to answer the questions in this survey?**

____

5. **Do you have any other suggestions for improving this survey?**

APPENDIX 4 The Operation of Australian Monetary Policy

Monetary policy in Australia is currently regulated by the Reserve Bank Act 1959, which sets out the objectives of monetary policy as being:

(a) The stability of the currency of Australia;

(b) The maintenance of full employment in Australia; and

(c) The economic prosperity and welfare of the people of Australia.

(Reserve Bank Act of Australia, 1959, section 10(2)).

The RBA has recently tended to focus on the inflation objective and the 'Statement of the Conduct of Monetary Policy, 1996' provides an agreement between the RBA and the Government as to the target inflation.

The RBA enjoys relative freedom in the way it implements monetary policy and has used an OCR to achieve its inflation objective. The OCR is the interest rate on overnight loans made between lending institutions (primarily banks) in the money market and is determined by the demand for and supply of overnight funds. The RBA determines the level of the OCR through its control over the supply of funds banks have to settle transactions amongst themselves – called exchange settlement funds (ESF). For example, the RBA can increase the OCR by decreasing the amount of ESFs available. This puts pressure on banks to borrow from the money market in order to meet their settlement obligations and so puts upward pressure on the OCR. Conversely, the RBA can decrease the OCR by increasing the supply of ESFs. This encourages banks to lend surplus funds to the money market, thus putting downward pressure on the OCR. This process of changing the supply of ESFs is referred to as the RBAs domestic market operations and involves the buying and selling of Government securities, usually in the form of repurchase agreements.

The OCR affects banks' cost of funds and so there is a direct link between changes in the OCR and other short-term money market rates, especially the 90-day bank bill rate. The RBA can tighten monetary conditions by increasing the OCR, thereby increasing the cost of funds and forcing banks to increase their commercial interest rates. Conversely, looser monetary conditions can be achieved by lowering the OCR.

This method of implementing monetary policy provides for considerable transparency and accountability. The actions and intentions of the RBA with respect to current monetary policy stance are made unambiguous by the use of an explicit cash rate target accompanied by clear, public statements by the RBA at the time changes are made to the targeted cash rate.

(Reserve Bank of Australia, 1999, Online)

APPENDIX 5 Dummy Variables

Table A5 Dummy Variables Used in the ARDL Analysis.

DVM1	20 May 1997 to 30 June 1997	The TWI rises to 68.7 after the Australian dollar undergoes a large appreciation.
DVM2	1 August 1996 to 7 August 1996	The TWI falls when the $US weakens against the Japanese yen.
DVM3	4 March 1997 to 7 March 1997	Australian interest rates fall causing the $NZ to appreciate. New Zealand bank bills rise due to overseas investors buying NZ government stocks.
DVX1	4 October 1996 to 8 October 1996	The $NZ falls in value following the release of figures showing higher than expected inflation, a large current account deficit and high economic growth.
DVX2	21 January 1997 to 30 January 1997	The $NZ falls in value following comments by the RBNZ governor that the currency is overvalued.
DVX3	6 December 1996 to 13 December 1996	The $NZ falls in value following the formation of a new coalition government and the appointment of Mr Peters as treasurer.
DVX4	11 March 1996 to 18 March 1996	The NZ90 rises to over 9-percent after a big slump on the American share market on 8 March. The $NZ rises in value following a $250 million government stock tender on 13 March.
DVX5	7 October 1998 to 15 October 1998	The RBNZ signals that the exchange rate and interest rates need to fall if its inflation target is not to be breached.
DVX6	23 August 1999 to 27 August 1999	The New Zealand dollar falls in value after the release of figures showing that the labour cost index rose by only 1.4% over the preceding twelve months. This translated into a big reduction in inflation pressures.
DVX7	20 May 1999 to 8 June 1999	The June MPS predicts a breach of the 0-2% inflation target during the September quarter.
DVX8	30 August 1999 to 14 September 1999	The $NZ falls in value after the RBNZ governor warns that New Zealand might get a credit downgrade.
DVN	22 September 1999 to 24 September 1999	The NZ90 falls sharply after it is announced that the current account deficit is $6.3 billion, which is the worst result in thirteen years.

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