

EFFECTS OF CHANGES IN THE OFFICIAL INTEREST RATE IN AN INFLATION-TARGETING REGIME

James Obben¹

Department of Economics and Finance
Massey University
Palmerston North
New Zealand

ABSTRACT

Despite the increasing number of countries adopting inflation targeting since New Zealand led the way in 1989, there is relative obscurity surrounding the magnitudes, direction and duration of changes in the variables instrumental in the monetary transmission mechanism through which interest rate changes enable central banks to control inflation. A greater awareness of the ramifications can help economic agents to put into perspective undesirable side-effects that have the potential to undermine public support for monetary policy. Using cointegrating vector autoregression, the paper estimates the dynamic responses of key macroeconomic variables to a sudden increase in the official cash rate for New Zealand – the country with the longest history of inflation targeting.

JEL Classification Numbers: C32, E42, E52, E58

Keywords: inflation targeting, monetary transmission mechanism, New Zealand, vector error correction model.

1. INTRODUCTION

Within the last two decades, no less than two dozen industrial and developing/emerging market countries² have adopted inflation targeting as the framework for conducting their monetary policy. New Zealand was the pioneer in 1989 followed in later years by countries such as Canada in 1991, UK in 1992, Sweden in 1993, Finland in 1993, Australia in 1993 and Spain in 1995. Adopting the inflation targeting framework (ITF) means corresponding changes have had to be made with respect to the goals, intermediate targets and instruments in the conduct of monetary policy in those countries. ITF requires the central bank laws to be amended to give the institution greater autonomy and its multi-goal mission is pared to make price stability the primary monetary policy objective; other objectives are subordinated to the inflation control objective. Rather than targeting monetary aggregates or exchange rates as intermediate targets or nominal anchor, some low

¹ Contact details: Email: J.Obben@massey.ac.nz, Ph: 64 6 350 5799 Ext 2671; Fax: 64 6 350 5660.

² As of May 2007 the countries included Australia, Brazil, Canada, Chile, Colombia, Czech Republic, Hungary, Iceland, Indonesia, Israel, Republic of Korea, Mexico, New Zealand, Norway, Peru, Philippines, Poland, Romania, Slovakia, South Africa, Sweden, Thailand, Turkey and United Kingdom. Members of the European Union come under the monetary policy of the European Central Bank.

inflation targets are set, the sustained achievement of which would indicate successful inflation control. The instruments of choice are short-term market interest rates.

Various commentators have noted that inflation targeting has largely been a success (Roger and Stone, 2005; Portugal, 2007). To explain how the central bank is able to affect inflation through setting the official interest rate, economists usually invoke the monetary transmission mechanism which encompasses other variables. However, the theory of the monetary transmission mechanism indicates only the directions of the responses and not the magnitudes and duration or lag lengths. Most of the studies evaluating inflation targeting regimes have tended to focus on comparative governance structures and inflation performances of the central banks without highlighting the dynamic responses of those other variables. Having an idea of the magnitudes and duration of responses of the other key macroeconomic variables to changes in interest rates can help deepen the public's understanding of how monetary policy works and enhance the credibility of the central bank's decisions. To that end, this paper showcases the ITF of New Zealand (the first country to adopt inflation targeting) and fleshes out the transmission mechanism of monetary policy by conducting a time series/econometric analysis of the responsiveness of key macroeconomic variables to changes in the official interest rate. The research examines data from the inception of the inflation targeting regime to the most recent time period. By way of categorisation, the study comes somewhere between the central bank's highly technical general-equilibrium forecasting reports and the periodic accountability/transparency bulletins aimed at explaining the central bank's actions. The estimates of short-run and long-run responses should be of benefit not only to economic agents in New Zealand but to those in other countries whether they are old, new or potential adopters of inflation targeting.

The paper reports that in response to developments, the original 1989 Parliamentary Act that made price stability the sole objective of monetary policy has been modified to require the Reserve Bank of New Zealand (RBNZ) to avoid causing unnecessary instability in other economic indicators in the pursuit of the price stability objective. After the initial disinflation, the target band has been revised twice. The dynamic analysis indicates that responses of the key macroeconomic variables in the transmission mechanism are largely consistent with theory and the lag lengths are in harmony with RBNZ's target horizon of 18 to 24 months. The rest of the paper is structured as follows. Section 2 gives an overview of the literature on the theory and practice of monetary policy and traces the structure and performance of New Zealand's ITF over time. The methodology and data used are described in Section 3. Section 4 presents the analytical results and Section 5 concludes the paper.

2. LITERATURE REVIEW

2.1 Implementation of Monetary Policy

The ultimate issue in economic policy is stabilisation – reducing the volatility in output inflation and unemployment – and its potential benefits. Both fiscal policy and monetary policy can be used but because policy actions affect the economy with a lag that makes stabilising the economy quite difficult. For example, following a positive aggregate demand shock, the government could dampen aggregate demand by

increasing taxes or decreasing government expenditure or increasing interest rates to stabilise the economy. Fiscal policy is not flexible enough and its impact too uncertain to be extensively used for stabilisation purposes, hence monetary policy has become the main vehicle for effecting stabilisation.

Central banks are the institutions responsible for implementing monetary policy. To attain the ultimate economic goals stipulated for monetary policy, central banks have at their disposal operational instruments (e.g., short-term market interest rates, reserve requirements) they can manipulate in order to control some intermediate targets (e.g., money supply, exchange rate and inflation forecast) that enable the central banks to achieve the ultimate targets. Up until the 1980s monetary policy in virtually all countries was targeted at multiple goals including keeping inflation low, maximising employment and growth and maintaining an external balance. The popular intermediate targets were money supply growth and exchange rates. Owing to the incompatibility of some of the goals, difficulties with achieving and maintaining the money and exchange rate targets, political interference in monetary policy implementation, high inflation experiences in the 1960s and 1970s and financial innovations in the 1980s that undermined the connection between monetary aggregates and output and inflation forecasts, the literature on the theory and practice of monetary policy in the 1970s and 1980s increasingly drew attention to the superior inflation outcomes of independent/autonomous inflation-targeting central banks with the mandated single/over-riding goal of controlling inflation. In an inflation targeting regime, the intermediate target is some inflation forecast and the operational instruments of choice are short term interest rates.

But how are interest rates set by an inflation targeting central bank and how does that allow the central bank to control inflation? In the scheme of things, central banks set monetary policy by firstly analysing the economy and then consider how best to set the policy instruments they have, usually the short-term money market interest rates. The best known rule for setting interest rates is the Taylor rule (Taylor, 1993). It suggests that central bankers translate the various messages conveyed by a wide range of macroeconomic variables into movements in the *output gap* and *inflation relative to a target* and adjust interest rate accordingly. Output gap is expressed as positive and negative percentage deviations from trend (the long-run average or the natural rate).

Because of lags in the responses to policy action, the central bank has to be forward-looking. The Taylor rule says that if within its target horizon the central bank's forecast of inflation (π) is above the target level (π^*) and/or if the forecast of output (Y) is above its natural rate (Y_n), the central bank will attempt to cool off the economy by increasing the targeted nominal interest rate, i , by an amount such that the real interest rate ($r = i - \pi$) is above its long-run equilibrium level or the neutral real interest rate (r_N); the converse is tenable. According to the rule, monetary policy responds directly to inflation and the output gap ($\ln Y/Y_n$). Algebraically, the Taylor rule³ may be expressed as:

³ Obviously, the adequacy of the central bank's forecasting model(s) is crucial to the success of the inflation targeting regime. Modelling issues that need to be sorted out include the measurement of the neutral real interest rate (the real interest rate consistent with output being equal to the natural rate) and whether it is constant or time-varying, the target inflation rate and the natural rate of output itself. Some versions of the Taylor rule use the gap between current inflation and the target inflation; some others

$$i - \pi = r_N + \beta(\pi - \pi^*) + \gamma(\ln Y/Y_n) \quad (1a)$$

$$i = r_N + \pi + \beta(\pi - \pi^*) + \gamma(\ln Y/Y_n) \quad (1b)$$

The positive response coefficients, β and γ , reflect the sensitivity of inflation and output, respectively, to changes in interest rate. If inflation is very sensitive to interest rate then, *ceteris paribus*, β will be small; similarly, if output is very sensitive to interest rate then, *ceteris paribus*, γ will be small. If the central bank will not tolerate much volatility in inflation, then β will be large; similarly, if the central bank will not tolerate much volatility in output, then γ will also be large.⁴

The central bank is able to control short term interest rates because of a peculiar monopoly power it has in the financial system. One of the functions of a central bank is to serve as the clearing-house for inter-bank payments. For this, each commercial bank is expected to have a *settlement account* with the central bank. The settlement accounts are subject to rules about overdrafts; each central bank has its own rules. Some central banks prohibit overdrafts at the end of each day; other central banks specify that each account must have a positive balance on average over some specified period known as a ‘reserve period’. Banks that contravene the overdraft regulation are penalised. To make good a shortfall, an overdrawn bank can escape the penalty by either borrowing the required amount from another commercial bank that has excess reserves or directly from the central bank. The central bank is the only institution that can provide settlement balances. And the rate at which the central bank lends money is chosen by the central bank itself. That rate is the so-called official interest rate: the interest rate that financial institutions have to pay the central bank to borrow cash (or equivalently, the financial system’s ‘base rate’). The central bank also controls the other terms under which it lends money. Most of the time commercial banks have to turn to the central bank to clear their overdrafts. The interest rates commercial banks charge their customers reflect the margins and risk premia added to that basic cost of cash.

As mentioned in the previous section, both advanced and developing countries have adopted inflation targeting. Studies evaluating inflation targeting have focused largely on governance structures and inflation performances of the adopting central banks. As experience has accumulated both the structures and performances have evolved. Those studies examining governance structures look at the roles and inter-relationships between the policy, supervisory and management boards of the central banks and report considerable differences (e.g., Tuladhar, 2005; Heenan *et al.*, 2006). Those studies looking at inflation performance scrutinise how often inflation outcomes exceed or fall below the targets and how often they hit the target or target bands. Reports indicate that inflation targets are missed about 40% of the time (e.g., Roger and Stone, 2005). Some differences in performance have been noted between advanced countries and the emerging market countries. Because of their relatively greater vulnerabilities to supply shocks and less developed financial markets,

include lagged interest rate in order to smooth the changes in interest rates, something that central banks appear to do. In forward looking models, the rule uses the gap between expected future inflation and the target inflation.

⁴ Popular estimates of β and γ for many countries centre around 0.5%.

developing/emerging market countries have had less success in achieving their targets than industrial countries. Early adopters have softened their laws to reflect greater consideration for volatility in other macroeconomic variables.

Whereas inflation targeting has been relatively successful in the industrial countries, it has not been an unmitigated success in the developing/emerging-market countries. In assessing why it has been a success in the former group of countries but problematic in the latter group, Masson *et al.* (1997) surmised that a country needs to satisfy a couple of prerequisites and the inflation targeting framework it sets up must have four essential elements. The first prerequisite is that the country must have a well-functioning financial system and the central bank should have a considerable degree of independence with a minimal burden of financing government budgets (i.e., no fiscal dominance). Second, the authorities should give a clear priority to inflation control over the other objectives of monetary policy. If the preconditions are satisfied, the monetary policy framework the authorities set up should have the following essential elements: (i) explicit inflation target for some period or periods ahead; (ii) clear and unambiguous indications that attaining those inflation targets is the overriding objective of monetary policy; (iii) a model for forecasting inflation that uses relevant variables and information indicators; and (iv) a forward-looking operating procedure in which the setting of policy instruments depends on assessing inflationary pressures and where inflation forecasts are used as the main intermediate target of monetary policy. Absence or breaches of those conditions underlie conduct of monetary policy inconsistent with inflation targeting.

2.2 A Short History of New Zealand's Inflation Targeting Framework

Reflecting the liberalisation and deregulation ethos that permeated economic thinking at the time and as part of on-going economic reforms began in 1984, New Zealand enacted legislation in 1989 to confer independence on its central bank, the Reserve Bank of New Zealand (RBNZ).⁵ Prior to 1989, monetary policy was targeted at a range of economic goals including maximising employment and growth. That was also a period of significant government regulation and a fixed or pegged exchange rate. For instance, in the earlier RBNZ Act of 1964, monetary policy was obliged to have regard 'to the desirability of promoting the highest level of production and trade and full employment and of maintaining a stable internal price level'. The RBNZ Act of 1989 conferred instrument independence on the RBNZ and the legislation defined the normal objective of monetary policy to be the single goal of 'achieving and maintaining stability in the general level of prices'. The specifics were set out in a contract between the Governor of the RBNZ and the Minister of Finance known as Policy Targets Agreements (PTA). A new set of PTA must be signed each time a Governor is appointed or re-appointed for the five year term; seven PTAs have been signed since 1990.⁶ The first PTA signed in 1990 called for a reduction of inflation to 0-2% in the consumer price index (CPI) by 1992; this was achieved ahead of schedule. The immediate backdrop was the twelve-year period preceding 1989 when CPI-inflation had averaged 13% per annum. By 1992 inflation had been stabilised,

⁵ The material in this section borrows heavily from RBNZ (2007). More on the RBNZ can be gleaned from the URL: <http://www.rbnz.govt.nz>.

⁶ For more on the governance structure and the inflation targeting framework of New Zealand, see: <http://www.rbnz.govt.nz/monpol/about/2851362.html>.

and over the next twelve years inflation averaged just 1.8%, exceeding 3% only in 1994/95.

Over time and with experience, parts of the RBNZ Act and the PTA have been revised. In December 1996 the target range was revised to 0-3% per annum because the initial range was deemed to be too restrictive. Also the first paragraph in the Act was amended to emphasise that the purpose of price stability was ‘so that monetary policy can make its maximum contribution to sustainable economic growth, employment and development opportunities within New Zealand’. In 1999 the fourth paragraph in the Act was amended to require RBNZ to ‘seek to avoid unnecessary instability in output, interest rates and the exchange rate’ as it pursued its price-stability objective. Further, the PTA signed in September 2002 contained a revision that declared that ‘the policy target shall be to keep future CPI inflation outcomes between 1% and 3% on average over the medium term’.⁷ This was ostensibly to afford the RBNZ greater flexibility in dealing with transient shocks.

Before 1999, RBNZ used a variety of instruments to control inflation including targeting money supply and signalling desired monetary conditions to the financial markets via the monetary conditions index (MCI). These were all indirect mechanisms which were not well understood by the public. It could be said that RBNZ implemented monetary policy by controlling the aggregate amounts of settlement cash available to the financial system. On 17th March 1999 it switched to controlling the price of settlement cash or the official interest rate known as the official cash rate (OCR).

In New Zealand’s *Exchange Settlement Account System*, commercial banks’ settlement-account deposits at RBNZ are not allowed to be negative. The RBNZ pays interest on settlement account balances and charges interest on overnight borrowing at rates related to the OCR. RBNZ sets no limit on the amount of cash it will borrow or lend at these rates, hence, inter-bank lending rates or market interest rates are generally held around the RBNZ’s OCR level. Assume Bank A runs a deficit and Bank B runs a surplus. Bank A can borrow what it requires overnight from RBNZ at the rate of the OCR *plus* 0.25%. Bank B can save its surplus with RBNZ’s deposit facility at the rate of the OCR *minus* 0.25%. Or, for a better outcome for both banks, Bank B can side-step the RBNZ and lend directly to Bank A in the inter-bank cash market at any rate within the OCR \pm 0.25% band. Most of the trade in the overnight money market (between banks) is done this way. The interest rates banks charge their customers reflect the risk premia and margins they put on this basic cost of cash. The RBNZ’s power to control the money supply and interest rates derives from its monopoly power to set the OCR (plus other activities).

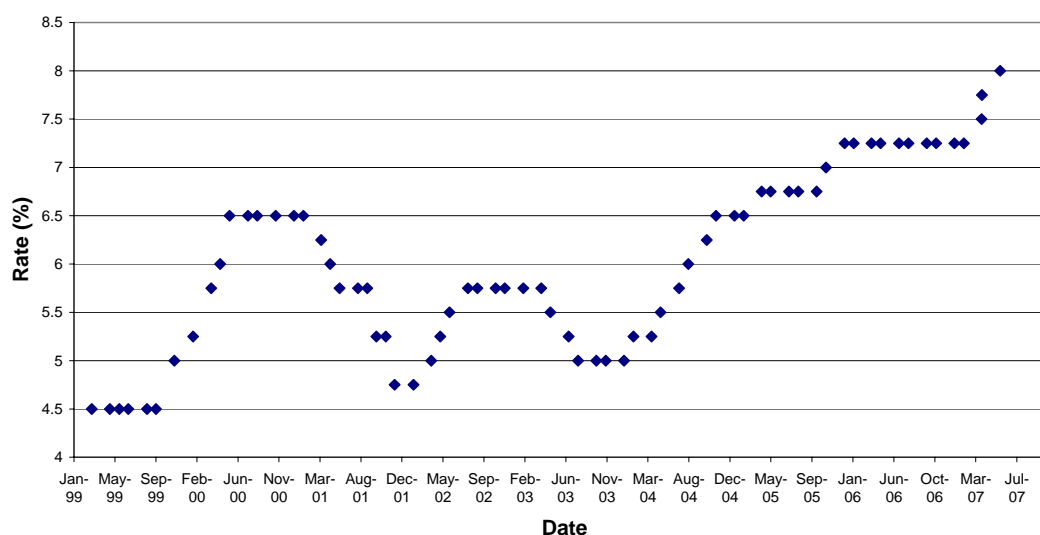
In consonance with the forward-looking nature of the inflation targeting regime, the RBNZ reviews its forecasts for inflation and output gap every six weeks (or eight times a year)⁸ and makes announcements about the level of the OCR. Monetary

⁷ This is interpreted to mean that RBNZ’s setting of the official cash rate should be such that projected inflation should be comfortably inside the target range in the latter half of a three year forward horizon.

⁸ The announcements on the level of the OCR are made once in each month except in February, May, August and November.

Policy Statements⁹ are issued with the OCR on four of those occasions. Starting at 4.5% in March 1999, the OCR was revised up and down above that level over the next four years. However, since September 2003 no downward revision has been made. In subsequent announcements either the level has been kept constant or revised upwards, usually by 0.25% or 25 basis points. By September 2007 it had reached 8.25%, the highest in the developed world. Figure 1 shows the dates and the levels of the OCR from inception in March 1999 to the present. Unscheduled adjustments to the OCR may occur at other times in response to unexpected or sudden developments, but to date this has occurred only once, following the 11th September 2001 attacks on the World Trade Center in New York. If the RBNZ judges that above-target inflation or above-trend output is imminent, it increases the OCR in the hope of dampening total spending within the economy to reduce inflation. Conversely, if it judges that below-target inflation or a recession is imminent, it does the opposite to stimulate economic activity. That is, if $\pi > \pi^*$ and/or $Y > Y_n$, the RBNZ increases the OCR; if $\pi < \pi^*$ and/or $Y < Y_n$, the RBNZ decreases the OCR. However, the OCR is not the only factor influencing New Zealand's market interest rates. Since New Zealand banks are net borrowers in overseas financial markets, movements in offshore rates can lead to changes in the domestic interest rates even if the OCR has not changed. In the conduct of monetary policy, changes in policy take time to affect the economy and so the RBNZ must act on its *expectations* for the economy rather than what is happening at the moment. This explains why the RBNZ acts on its forecasts for inflation and the output gaps.

Figure 1: The OCR Levels and Announcement Dates: March 1999 to July 2007

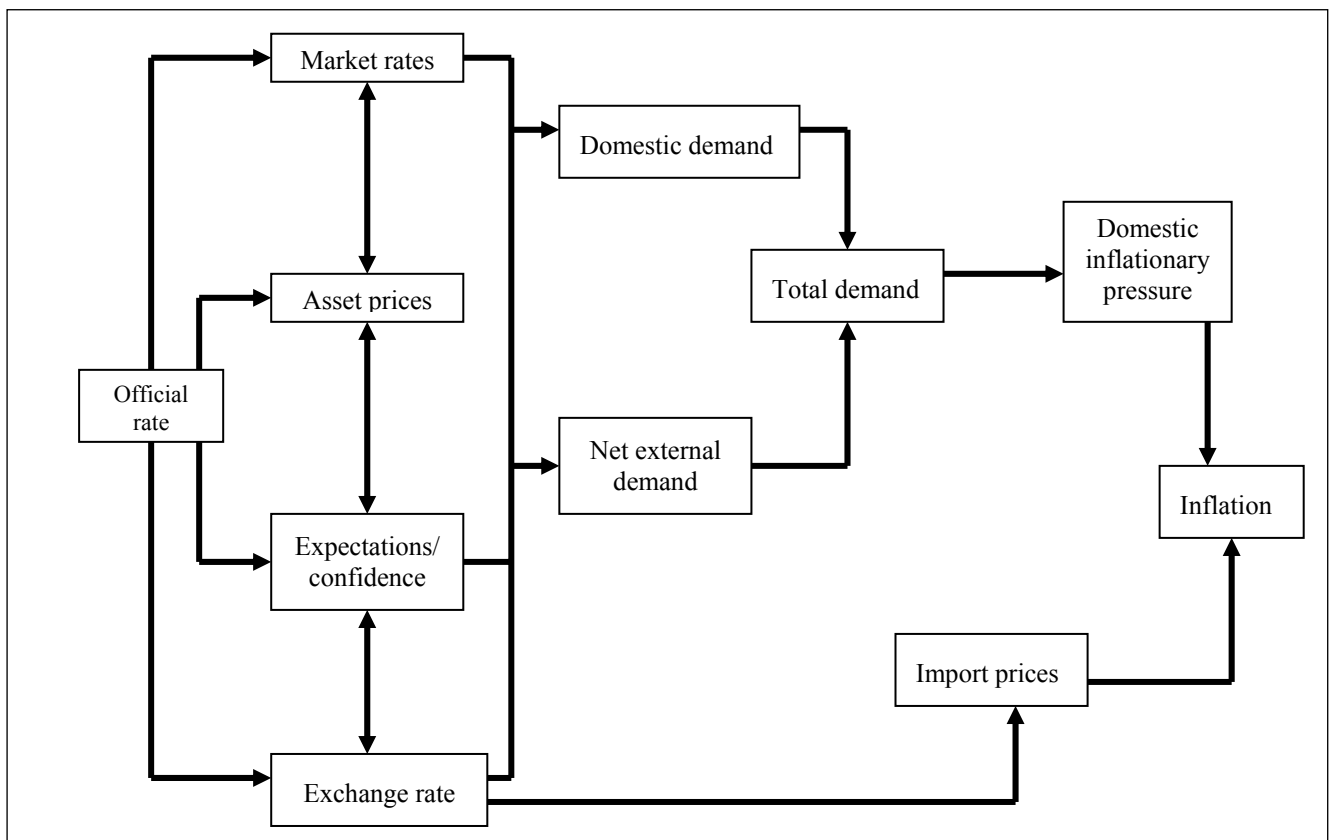


⁹ The Monetary Policy Statements can be downloaded from the RBNZ website: <http://www.rbnz.govt.nz/monpol/statements>.

2.3 How Monetary Policy Affects the Economy

The transmission mechanism of monetary policy depicts how changes in interest rates affect output and inflation. With an increase in the official nominal interest rate, other things being equal, all interest rates are expected to rise. Theory predicts that the resulting higher real interest rate will lead to: (a) an increase in saving and a corresponding decrease in consumption; (b) a decrease in investment as cost of borrowing increases; (c) expectations about inflation are dampened because people interpret the interest rate hike as a commitment of the central bank to fighting inflation; (d) share prices fall and shareholders feeling less wealthy will cut back on consumption and investment; (e) in international transactions the domestic currency appreciates as the relatively higher domestic interest rate attracts foreign capital escalating the nominal and real exchange rates and reducing net exports. All these have the combined effect of reducing aggregate demand and inflation (Miles and Scott, 2005, pp. 398-405). The channels through which official interest rates affect output and inflation can also be outlined diagrammatically with Figure 2.

Figure 2: The Monetary Policy Transmission Mechanism



Source: Bank of England, cited in Miles and Scott (2005).

In addition to the channels indicated above, sometimes a different channel – the credit channel – is specified. The credit channel focuses on how the *quantity* of bank credit or loans affects the economy. An increase in the official interest rate leads to a reduction in real estate prices and equity prices which reduce the value of the collateral firms can offer banks. In response, banks reduce the amount of collateralised loans (repos) they extend. This leads to a contraction in consumption and investment expenditure and thus national output.

The foregoing implies the principal macroeconomic variables that are affected by changes in the official interest rate are: (i) market interest rates, (ii) output growth rate, (iii) inflation, (iv) expected inflation, (v) bank credit, (vi) share/asset prices, (vii) exchange rates, and (viii) current account. Therefore, the empirical exercise will be to estimate the dynamic inter-relationships among that nominated set of variables. It is clear that the presence of reverse causations among the variables precludes a neat dichotomy of the variables into endogenous and exogenous varieties required to rationalise a structural model. Hence resort will be made to an atheoretical model – the vector autoregression (VAR) model. The next section describes the VAR model.

3. METHODOLOGY AND DATA

The review of the literature helped to identify a system of at least nine inter-related variables relevant in this investigation. The quest is to exploit the outlined channels through which official interest rates affect output and inflation and generate estimates of the magnitudes and durations of the impacts. This would require system estimation – structural or non-structural. The reverse causations among the variables would make the specification of structural relationships in a system estimation rather tenuous and so this study adopts the alternative non-structural vector autoregression (VAR) approach in which all variables are assumed to be endogenous.

In the VAR methodology, each of the variables in the system is regressed on its own lags and the lags of the other variables. The optimal number of lags can be decided based on statistical selection criteria such as the Akaike Information Criterion (AIC), the Schwartz Criterion (SC) or the Hannon-Quinn (HQ) criterion. Assume \mathbf{X}_t is a vector of k -jointly determined endogenous variables and \mathbf{W}_t is a vector of m exogenous variables. A p^{th} order VAR model of the inter-related time series, VAR(p), can be written as:

$$X_t = \sum_{i=1}^p \Phi_i X_{t-i} + \Psi W_t + \varepsilon_t \quad (2)$$

where Φ_i and Ψ are matrices of coefficients to be estimated, and ε_t is a vector of independent and identically distributed disturbances. This version of the model may be referred to as unrestricted VAR (UVAR). If the endogenous variables are each I(1) we can write the VAR(p) model as a vector error correction model (VECM):

$$\Delta X_t = \Pi X_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + \Psi W_t + \varepsilon_t \quad (3)$$

$$\text{where } \Pi = \sum_{i=1}^p \Phi_i - I, \text{ and } \Gamma_i = - \sum_{j=i+1}^p \Phi_j$$

Granger's Representation Theorem asserts that if the coefficient matrix Π has reduced rank (i.e., $\text{rank}(\Pi) = r < k$) then there exist k -by- r matrices α and β each with rank r such that Π is equal to $\alpha\beta'$ and $\beta'X_t$ is integrated of order zero, $I(0)$. The rank r is the number of cointegrating or long-run relations among the variables and each column of β is a cointegrating vector. The Johansen maximum likelihood estimation procedure (Johansen, 1988, 1991, 1995a; Johansen and Juselius, 1990) can be used to estimate the two matrices α and β and to test for the number of distinct cointegrating vectors. Restrictions on the elements of β help to determine which variables are relevant in the long-run relations; economic theory may have to be invoked to decide on the restrictions to impose on each cointegrating vector (Johansen, 1995b). The elements of α are known as the adjustment parameters in the VECM. When appropriate and binding restrictions are imposed on the identified cointegrating vectors, the VECM becomes a restricted VAR and is also called cointegrating VAR (CVAR).

As the coefficients of the VECM only reveal the direct effects, the VAR analysis relies a great deal on impulse response functions (IRFs) that capture the direct and indirect effects. IRFs trace out the time paths of the effect of a shock in a nominated variable on each of the other variables in the system. From them we can determine the extent to which an exogenous shock causes short-run and long-run changes in the respective variables. Two types of IRFs can be generated: orthogonalised and generalised IRFs. Whereas orthogonalised IRFs depend on the order in which the variables are arranged in a VAR model, generalised IRFs are invariant to the ordering of variables (Pesaran and Shin, 1998). For that reason, generalised IRFs are preferable. These concepts are amply described in time-series oriented econometrics texts such as Hamilton (1994), Harris (1995), Charemza and Deadman (1997), Johnston and Di Nardo (1997), Patterson (2000) and Enders (2004).

For our modelling purposes the names of the variables to be analysed are listed as follows: (i) **OCR** (the official cash rate); (ii) **NBB** (90-day bank bill rate to represent market interest rates); (iii) **GDP** (to represent the annual growth rate in the real GDP); (iv) **INF** (to represent annual rate of CPI inflation); (v) **EXI** (to represent expected annual CPI inflation); (vi) **BCR** (to represent annual growth rate in bank credit); (vii) **SHP** (to represent annual growth rate in the share market index); (viii) **TWI** (to represent the annual growth rate in the trade weighted index of the New Zealand dollar foreign exchange rates); and (ix) **CAC** (to represent current account expressed as a percentage of GDP). Quarterly data on these variables were sourced from the websites of RBNZ and Global Financial Data. Availability of data restricted the sample period to the 1999Q1–2007Q2 interval. The start date was dictated by the date of introduction of the OCR (March 1999); the end date was the latest date data could be obtained for analysis at the commencement of the empirical exercise; and quarterly data were used because of frequency constraint in the New Zealand macroeconomic data series. The time series of the variables are presented in Appendix 1 and graphed in Figure 3. Table 1 reports the strength of correlation between pairs of variables.

Figure 3: The Sample Data: 1999Q1-2007Q2

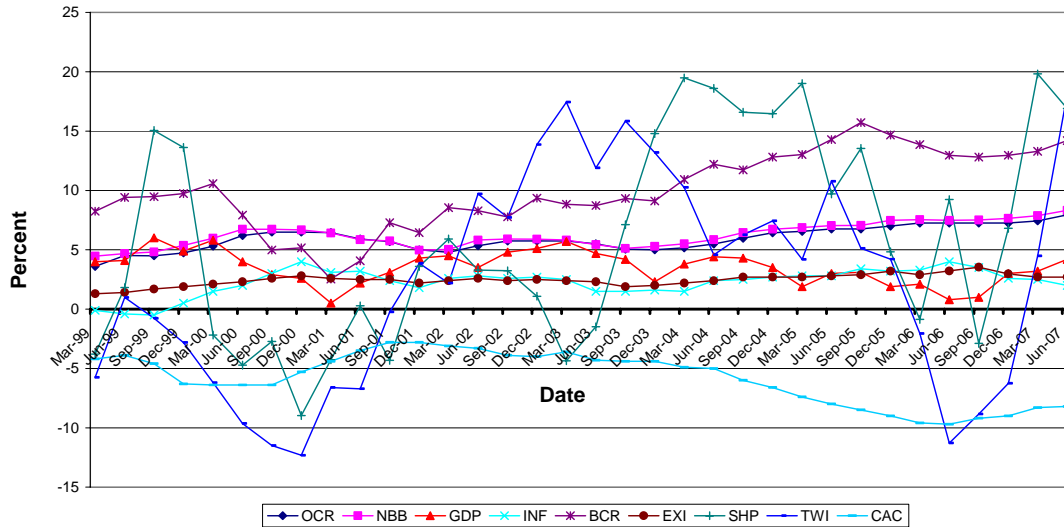


Table 1
Correlation Matrix of the Variables

Variable	OCR	NBB	CAC	EXI	BCR	INF	TWI	GDP	SHP
OCR	1.000								
NBB	0.978	1.000							
CAC	-0.774	-0.848	1.000						
EXI	0.874	0.842	-0.646	1.000					
BCR	0.457	0.542	-0.745	0.398	1.000				
INF	0.740	0.679	-0.397	0.893	0.114	1.000			
TWI	-0.106	-0.141	0.239	-0.145	0.293	-0.165	1.000		
GDP	-0.561	-0.523	0.462	-0.608	-0.059	-0.614	0.406	1.000	
SHP	0.093	0.143	-0.268	0.015	0.590	-0.144	0.430	0.085	1.000

The strongest estimated correlation is between OCR and NBB (0.978) followed by that between INF and EXI (0.893) and that between OCR and EXI (0.874); the weakest correlation is between SHP and EXI (0.015). With reference to the coefficient of variation statistics in Appendix 1, TWI is the most volatile variable, followed by SHP; and NBB is the least volatile, followed by OCR and EXI. BCR, CAC, GDP and INF exhibit intermediate volatility. During the study period, INF averaged 2.28% and EXI averaged 2.47% per annum (both averages being well within the 1%–3% target band). A noteworthy result is that EXI exceeded INF by an average of 0.2 percentage point per annum, suggesting that there was an upward bias in inflation expectations over the study period. Traversing between a peak at 5.7% in 2003Q1 and a trough at 0.5% in 2001Q1, GDP averaged 3.51% per annum. CAC is in the negative throughout the study period and averaged negative 5.81%. NBB tracks OCR very closely and exceeded it by an average of 0.3% or 30 basis points; OCR surpassed NBB only in 4 out of the 34 instances.

As far as the New Zealand inflation targeting performance is concerned, between 1999Q1 and 2007Q2 actual inflation exceeded the upper limit of the target band in 8 out of the 34 quarters (or 23.5% of the time), fell within the target band in 22 out of the 34 quarters (or 64.7% of the time) and dropped below the lower limit of the target band in 4 out of the 34 quarters (or 11.8% of the time). These translate into a record of 65% success rate and 35% failure rate which compares favourably with the global average of 40% failure rate reported by Roger and Stone (2005).

4. ANALYTICAL RESULTS AND INTERPRETATION

4.1 Pre-modelling Tests: Unit Root, VAR Lag Order, Cointegration Test

The unit root test results are reported in Table 2. At the 5% level both the Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) test indicate all the variables are integrated of order 1, that is, I(1). On the lag order of the VAR model, the Akaike Information Criterion (AIC), the Schwartz Criterion (SC) and the Hannon-Quinn (HQ) criterion all suggested [unrestricted] VAR(2) with trend. To ascertain the existence of long-run relationships among the variables, the Johansen cointegration test was implemented. The estimated trace (λ_{trace}) and maximal eigenvalue (λ_{max}) test statistics and their corresponding 5% critical values are reported in Table 3. The trace statistic tests the null hypothesis that the number of cointegrating vectors, or rank(Π), is less than or equal to r (where $r = 0, 1, \dots, k-1$, for k endogenous variables) against the general alternative that the number of cointegrating vectors is greater than r (i.e., $\lambda_{\text{trace}} \Rightarrow H_0: \text{rank}(\Pi) \leq r; H_1: \text{rank}(\Pi) \geq r+1$). The maximal eigenvalue statistic tests the same null hypothesis against the alternative that the number of cointegrating vectors is equal to $r+1$ (i.e., $\lambda_{\text{max}} \Rightarrow H_0: \text{rank}(\Pi) \leq r; H_1: \text{rank}(\Pi) = r+1$). Whereas the maximal eigenvalue test suggests there are four cointegrating relationships among the variables, the trace test indicates there are five cointegrating relationships among the variables. When there is a conflict between the λ_{trace} and λ_{max} results, both Johansen and Juselius (1990) and Maddala and Kim (1998, p. 211) suggest that the result of λ_{max} may be better.

Table 2
Results of the Unit Root Tests

Variable	ADF		PP	
	Levels	1 st Differences	Levels	1 st Differences
OCR	-0.8748	-3.6138	-1.7096	-3.5772
NBB	-1.2435	-3.3123	-1.0907	-3.3454
INF	-2.3805	-3.5478	-2.4253	-4.5004
GDP	-2.5012	-6.0327	-2.5422	-6.1775
EXI	-2.6032	-4.9113	-2.6004	-4.9131
BCR	-0.6615	-4.3340	-1.0828	-5.3406
TWI	-1.6252	-3.2763	-1.7609	-4.3739
CAC	-1.3879	-3.1696	-1.0536	-3.3454
SHP	-2.4153	-3.4485	-2.5794	-5.9056

Notes: The critical values are: 1%, -3.6537; 5%, -2.9571; and 10%, -2.6174.

Table 3
The Johansen Cointegration Test Results

Eigenvalue	Null Hypothesis	Maximal Eigenvalue (λ_{\max})		Trace Test (λ_{trace})	
		Test stat	5% CV	Test stat	5% CV
0.959810	$r = 0$	102.8520	58.43354	399.8726	197.3709
0.935781	$r \leq 1$	87.85454	52.36261	297.0206	159.5297
0.920344	$r \leq 2$	80.96117	46.23142	209.1660	125.6154
0.790429	$r \leq 3$	50.00623	40.07757	128.2049	95.75366
0.643921	$r \leq 4$	33.04333	33.87687	78.19864	69.81889
0.492461	$r \leq 5$	21.70182	27.58434	45.15532	47.85613
0.376619	$r \leq 6$	15.12312	21.13162	23.45350	29.79707
0.192855	$r \leq 7$	6.856080	14.26460	8.330379	15.49471
0.045027	$r \leq 8$	1.474299	3.841466	1.474299	3.841466

To operationalise the cointegrating relationships, it is helpful to recall that in an inflation targeting regime, monetary policy is conducted principally to control inflation, contain inflationary pressure (proxied with the output gap) and influence expectations about inflation to be anchored around the official target. From this viewpoint, the first three variables to be selected for normalisation are INF, GDP and EXI. In New Zealand since the central bank is required to avoid causing unnecessary instability in output, interest rates and the exchange rate, it can be argued that the responsive behaviour of those variables to changes in the OCR is also of great concern. Therefore, two additional variables can be considered for normalisation: the exchange rate variable (TWI) and the market interest rate variable (NBB). And so the five candidate variables to match the five potential cointegrating relations are INF, GDP, EXI, TWI and NBB. In implementing the VECM, four cointegrating vectors with their attendant restrictions normalised on INF, GDP, EXI and TWI yielded consistent and plausible coefficients and impulse responses but the four cointegrating vectors normalised on INF, GDP, EXI and NBB and five cointegrating vectors normalised on INF, GDP, EXI, TWI and NBB yielded some counter-intuitive and implausible coefficients and impulse responses. Hence, we report the VECM results for four cointegrating vectors normalised on INF, GDP, EXI and TWI. In doing so, we have implicitly accepted the maximal eigenvalue test result of four cointegrating vectors and rejected the trace test result of five cointegrating vectors. This result vindicates the recommendation by Johansen and Juselius (1990) and Maddala and Kim (1998) that when λ_{trace} and λ_{\max} give different results, that of λ_{\max} may be preferred.

4.2 The Long-Run Relationships and Short-Run Models

The four estimated long-run relationships are reported as equations (4) to (7); the figures in parentheses below the coefficients are t-ratios of the estimated parameters. The results suggest that within the set of variables, the long-run behaviour of inflation (equation 4) hinges significantly on OCR, TWI and SHP; increases in these variables decrease inflation. INF is estimated to be trending upward. Equation (5) suggests that

the upward trending GDP has strong negative correlation with NBB and INF in the long run. The cointegrating equation for EXI (equation 6) indicates that INF and BCR boost expected inflation but TWI and OCR dampen expected inflation. On the exchange rate front, equation (7) denotes that an increase in EXI leads to a depreciation and increases in OCR, CAC and SHP lead to appreciation of the New Zealand dollar. However, the estimated negative trend in TWI, albeit insignificant, is hard to reconcile with recent developments in the foreign exchange market.

$$\begin{aligned} \text{INF} = & 13.5176 + 0.5407 \text{TREND} - 0.2399 \text{TWI} - 2.8308 \text{OCR} \\ & (5.28) \qquad \qquad (-3.46) \qquad \qquad (-2.72) \\ & - 0.5509 \text{SHP} \\ & (-6.23) \end{aligned} \tag{4}$$

$$\begin{aligned} \text{GDP} = & 14.6712 + 0.1428 \text{TREND} - 0.9933 \text{INF} - 1.8218 \text{NBB} \\ & (7.26) \qquad \qquad (-6.01) \qquad \qquad (-8.49) \end{aligned} \tag{5}$$

$$\begin{aligned} \text{EXI} = & 2.7670 - 0.0106 \text{TREND} + 0.4906 \text{INF} - 0.0178 \text{TWI} \\ & (-1.78) \qquad \qquad (11.4) \qquad \qquad (-5.29) \\ & - 0.6128 \text{OCR} + 0.2461 \text{BCR} \\ & (-8.86) \qquad \qquad (18.7) \end{aligned} \tag{6}$$

$$\begin{aligned} \text{TWI} = & -202.5657 - 0.3255 \text{TREND} - 72.5708 \text{EXI} + 88.1968 \text{OCR} \\ & (-1.12) \qquad \qquad (-9.47) \qquad \qquad (18.3) \\ & + 23.7838 \text{CAC} + 0.6031 \text{SHP} \\ & (22.4) \qquad \qquad (3.18) \end{aligned} \tag{7}$$

The short-run results from the VECM are reported in Table 4. Discussion of the short-run model will focus first on the error correction terms before dealing with the other coefficients. Interest lies principally in the coefficients of $\text{ECT1}_{(-1)}$ in the equation for ΔINF , $\text{ECT2}_{(-1)}$ in the equation for ΔGDP , $\text{ECT3}_{(-1)}$ in the equation for ΔEXI and $\text{ECT4}_{(-1)}$ in the equation for ΔTWI . Those adjustment parameters measure the responses of the respective dependent variables to previous-period imbalance in the relevant long-run relation; a negative sign implies a response to restore the equilibrium and a positive sign implies a response that increases the imbalance. The relevant error correction terms in the equations for ΔINF , ΔGDP and ΔEXI take the expected negative sign, suggesting that the INF, GDP and EXI relationships are error correcting and dynamically stable. Following a shock, 58% and 47.5% of the disequilibrium in the GDP and EXI relationships, respectively, are corrected in the subsequent quarter. The 3.8% adjustment coefficient in the INF equation is not significant. The positive adjustment parameter of the ΔTWI equation suggests that the TWI relationship is not stable and strong. With respect to the other coefficients that show the short-run direct (but not indirect) effects between variables, it would be noted that previous-period changes in other variables do not impact significantly on current-period changes in GDP and SHP. In the short run, the significant determinants of changes in INF are GDP, CAC and BCR; those of EXI are INF, GDP, CAC and

BCR. TWI is influenced significantly in the short term only by BCR and SHP. What influences the rest of the variables may be inferred from the coefficients in bold fonts in Table 4. It will be noted that the only variable OCR influences significantly in the short term is CAC. Definitely, the configuration of short-run impacts is different from that of long-run impacts.

Table 4
Regression Results of the VECM (Short-run Models)

Regressor	Dependent Variable								
	Δ INF	Δ GDP	Δ EXI	Δ TWI	Δ NBB	Δ OCR	Δ CAC	Δ BCR	Δ SHP
ECT1 ₍₋₁₎	-0.0381 (-0.67)	-0.0207 (-0.17)	-0.0131 (-1.05)	-0.2777 (-0.53)	0.0361 (1.60)	0.0314 (1.72)	-0.0414 (-1.03)	0.1850 (2.05)	-0.9521 (-1.64)
ECT2 ₍₋₁₎	-0.1904 (-1.54)	-0.5804 (-2.25)	-0.0822 (-3.02)	1.5031 (1.31)	0.0299 (0.61)	0.0387 (0.97)	0.0189 (0.21)	-0.6795 (-3.46)	-2.1401 (-1.69)
ECT3 ₍₋₁₎	-0.3280 (-0.62)	1.3766 (1.25)	-0.4752 (-4.09)	5.9025 (1.20)	0.1210 (0.57)	0.0886 (0.52)	1.6808 (4.48)	2.2577 (2.69)	-2.2522 (-0.41)
ECT4 ₍₋₁₎	-0.0140 (-1.24)	-0.0033 (-0.14)	-0.0081 (-3.24)	0.0162 (0.15)	0.0115 (2.53)	0.0082 (2.25)	0.0128 (1.58)	0.0053 (0.29)	-0.0601 (-0.51)
Δ INF ₍₋₁₎	0.4033 (1.30)	0.1185 (0.18)	0.2761 (4.03)	-0.2300 (-0.08)	0.2328 (1.87)	0.2057 (2.05)	0.8046 (3.64)	0.6750 (1.37)	-2.0714 (-0.65)
Δ GDP ₍₋₁₎	0.2571 (2.24)	0.0749 (0.31)	0.0761 (3.00)	-0.7392 (-0.69)	0.0712 (1.55)	0.0471 (1.27)	-0.0872 (-1.07)	0.4979 (2.72)	1.0476 (0.89)
Δ EXI ₍₋₁₎	0.3479 (0.52)	1.0166 (0.72)	0.0897 (0.61)	-1.3777 (-0.22)	-0.4730 (-1.76)	-0.4690 (-2.16)	-1.1608 (-2.43)	-0.9279 (-0.87)	-6.8160 (-0.99)
Δ TWI ₍₋₁₎	0.0213 (0.75)	0.0502 (0.85)	0.0027 (0.45)	-0.1291 (-0.49)	-0.0037 (-0.33)	-0.0040 (-0.45)	-0.0101 (-0.50)	0.0141 (0.31)	0.1640 (0.56)
Δ NBB ₍₋₁₎	0.4173 (0.59)	0.7127 (0.48)	-0.0881 (-0.56)	5.1850 (0.78)	0.1538 (0.54)	0.5605 (2.44)	-0.5272 (-1.04)	-1.2335 (-1.09)	0.7452 (0.10)
Δ OCR ₍₋₁₎	-0.3309 (-0.46)	0.6130 (0.41)	-0.0038 (-0.02)	-0.9630 (-0.14)	0.1745 (0.61)	0.0201 (0.09)	0.8600 (1.69)	0.6332 (0.56)	5.8303 (0.79)
Δ CAC ₍₋₁₎	-0.9550 (-2.50)	-0.2049 (-0.26)	-0.1641 (-1.95)	0.4948 (0.14)	0.2460 (1.61)	0.2290 (1.85)	0.0574 (0.21)	-0.7659 (-1.26)	0.8259 (0.21)
Δ BCR ₍₋₁₎	-0.2955 (-2.23)	0.1647 (0.59)	-0.1216 (-4.16)	3.0627 (2.48)	0.0032 (0.06)	-0.0129 (-0.30)	0.2916 (3.09)	-0.0388 (-0.18)	-0.3017 (-0.22)
Δ SHP ₍₋₁₎	-0.0056 (-0.28)	-0.0058 (-0.14)	0.0017 (0.40)	0.5459 (2.94)	0.0156 (1.95)	0.0072 (1.12)	0.0201 (1.41)	-0.0372 (-1.17)	-0.1782 (-0.87)
INTPT	-0.0498 (-0.39)	-0.2628 (-0.99)	0.0220 (0.79)	-0.6261 (-0.53)	0.1006 (1.99)	0.0772 (1.89)	-0.2482 (-2.76)	0.1343 (0.67)	0.4177 (0.32)
R ²	0.6075	0.5696	0.8800	0.5708	0.8259	0.8749	0.8152	0.8140	0.7113
Adj. R ²	0.3240	0.2587	0.7933	0.2609	0.7002	0.7846	0.6817	0.6797	0.5028
S.E. eqn	0.4848	1.0146	0.1069	4.5074	0.1938	0.1565	0.3447	0.7719	4.9813

Notes: Figures in parentheses below the coefficients are t-ratios. Bold fonts indicate significance at the 10% level, at least.

The results of the Granger noncausality and weak exogeneity tests are reported in Table 5. The block Granger noncausality test is done to check whether a nominated variable Granger-causes the others in the set without it being block Granger-caused by them. If a variable in a system influences the long-run development of the other variables but is itself not influenced by them, then the variable is said to be weakly exogenous (Ericsson, 1992). According to the results in Table 5, only GDP and SHP are characterised by Granger noncausality and none of the variables is weakly exogenous and therefore none is strongly exogenous. This observation implies that the VAR assumption of endogenous variables may be questionable in the cases of GDP and SHP. This inference, although valid, does not devalue the chosen methodology inasmuch as the VAR is not being applied to identify the determinants of, for instance, output growth (as may be done in Solow-type or endogenous growth models) or share prices but rather to identify the impact of OCR on growth and other variables instrumental in the monetary transmission mechanism.

Table 5
Results of the Block Granger Non-causality and Weak Exogeneity Tests

Variable	H ₀ : Variable is not Granger-caused by the others		H ₀ : Variable is weakly exogenous		Exogeneity status
	$\chi^2_{(8)}$	p-value	$\chi^2_{(11)}$	p-value	
OCR	31.53	0.0001	102.13	0.0000	Not weakly exogenous
NBB	22.73	0.0037	108.40	0.0000	Not weakly exogenous
CAC	27.94	0.0005	96.27	0.0000	Not weakly exogenous
EXI	68.02	0.0000	115.39	0.0000	Not weakly exogenous
BCR	18.88	0.0155	119.35	0.0000	Not weakly exogenous
INF	17.22	0.0279	94.33	0.0000	Not weakly exogenous
TWI	15.98	0.0427	104.82	0.0000	Not weakly exogenous
GDP	8.42	0.3939*	100.97	0.0000	Not weakly exogenous
SHP	11.31	0.1848*	102.71	0.0000	Not weakly exogenous

* Variable is characterised by Granger noncausality.

4.3 The Generalised Impulse Response Functions

To avoid too much clutter in a single diagram, the graphs of the GIRFs from the CVAR are reported in Figures 4, 5 and 6. Figure 4 shows the GIRFs for OCR, INF, GDP and EXI; Figure 5 shows the GIRFs for OCR, NBB, CAC and BCR; and Figure 6 shows the GIRFs for OCR, TWI and SHP.

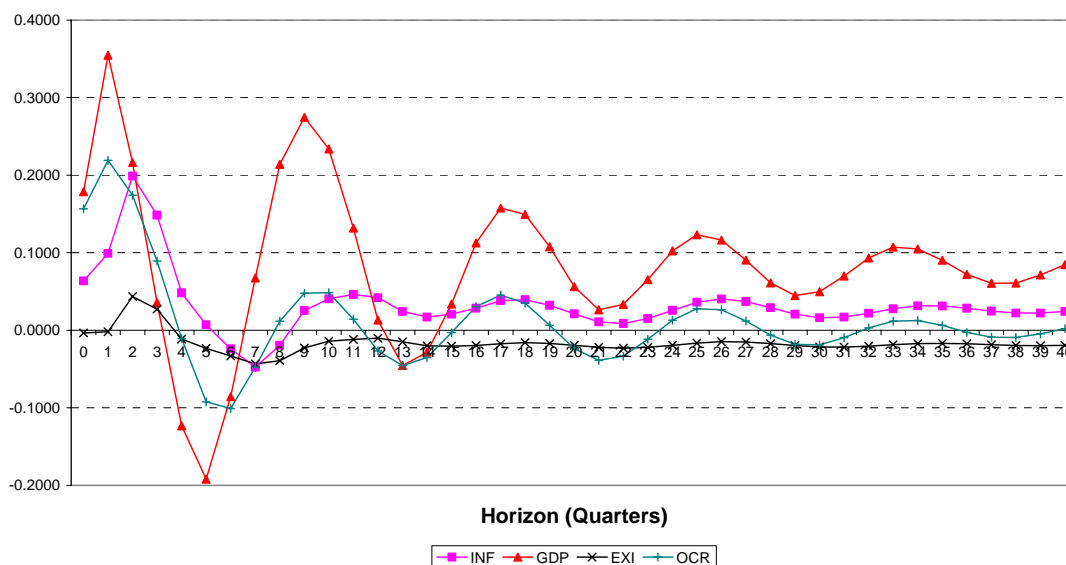
OCR: Historically, no increase in the OCR has ever been followed immediately by a decrease; either the level is kept constant or hiked further at the next announcement. VAR captures this remarkably in the GIRF of the OCR. The initial positive one standard deviation shock (equivalent to about 16 basis points) is invariably followed by a non-negative change the next quarter and a continuous fall that bottoms out in the 5th and 6th quarters. Thereafter the OCR rises and fluctuates around the pre-shock level in dampening oscillations.

INF: After the positive impact effect, which is less than the magnitude of the shock in the OCR, INF increases for two consecutive quarters before dropping steadily past the pre-shock level and hitting a trough of negative 0.05% in the 7th quarter. Subsequently INF picks up and hovers just above the pre-shock level starting from the 9th quarter. *The maximum impact on inflation is observed in the 7th quarter after the OCR shock.*

GDP: There is a positive impact effect (slightly greater than the magnitude of the shock in the OCR) followed by a further increase in the first quarter before a steady decline sets in to hit a trough of negative 0.19% in the 5th quarter. Thereafter, GDP exhibits a series of dampening fluctuations above the pre-shock level around the value of 0.07%.

EXI: The increase of 16 basis points in the OCR induces no contemporaneous effect and no measurable change in expected inflation even after one quarter. However, EXI rises slightly above the pre-shock level in the 2nd quarter and dips past the pre-shock level in the 4th quarter to reach its nadir in the 7th quarter at negative 0.04%. After that EXI rises slightly and stabilises just below the pre-shock level. The effect of the OCR shock on EXI peaks in the 7th quarter, the same period as for INF but beyond that it would be noticed that INF stabilises slightly above the pre-shock level whilst EXI stabilises slightly below it. These predicted relative long-run positions seem to contradict the historical record which shows that in the past EXI has exceeded INF by an average of 0.2 percentage points. This may be construed to mean that perhaps because of the prevailing nominal anchor, economic agents have become overoptimistic about inflation and tend to underestimate both inflation and deflation.

Figure 4: Generalised Impulse Responses to 1 Std Dev Shock in OCR: OCR, INF, GDP and EXI

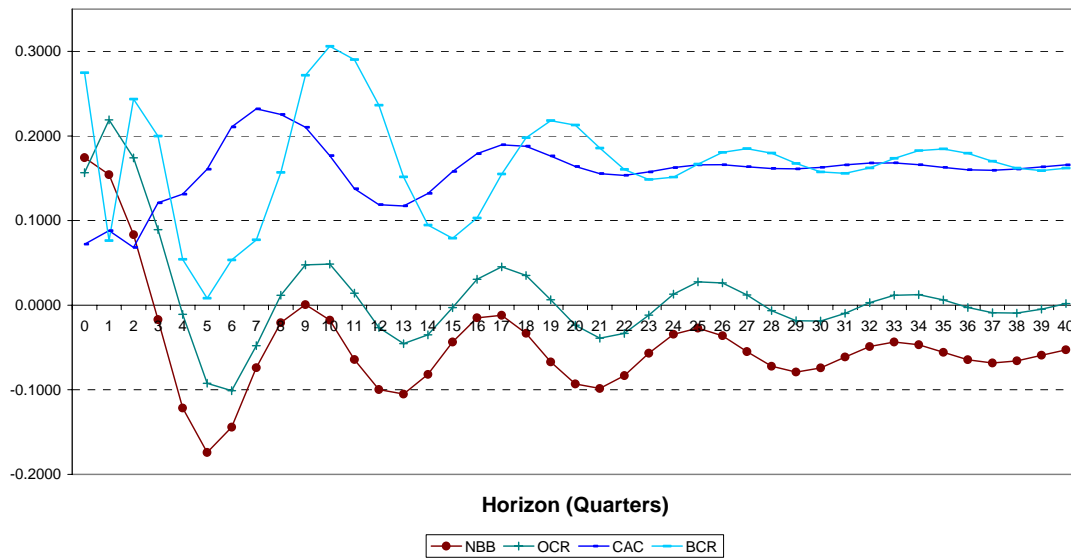


NBB: The positive impact effect exceeds the magnitude of the shock in the OCR by about 2 basis points. In subsequent quarters, NBB drops below OCR and falls continuously hitting a trough in the 5th quarter before rising and mimicking the dampening fluctuations of the OCR but remaining below it.

CAC: After a positive impact effect that is smaller than the magnitude of the shock in the OCR, CAC rises continually peaking in the 7th quarter. Thereafter CAC fluctuates and stabilises well above the pre-shock level. The effect of OCR increase is unambiguously positive (CAC never falls below the pre-shock level).

BCR: The impact effect of OCR on BCR is positive and greater than the magnitude of the shock in the OCR. This is followed by explosive gyrations before the fluctuations die down and BCR stabilises well above the pre-shock level after about six years. The lowest level in BCR occurs in the 5th quarter after the OCR shock. It must also be noted that BCR never falls below the pre-shock level.

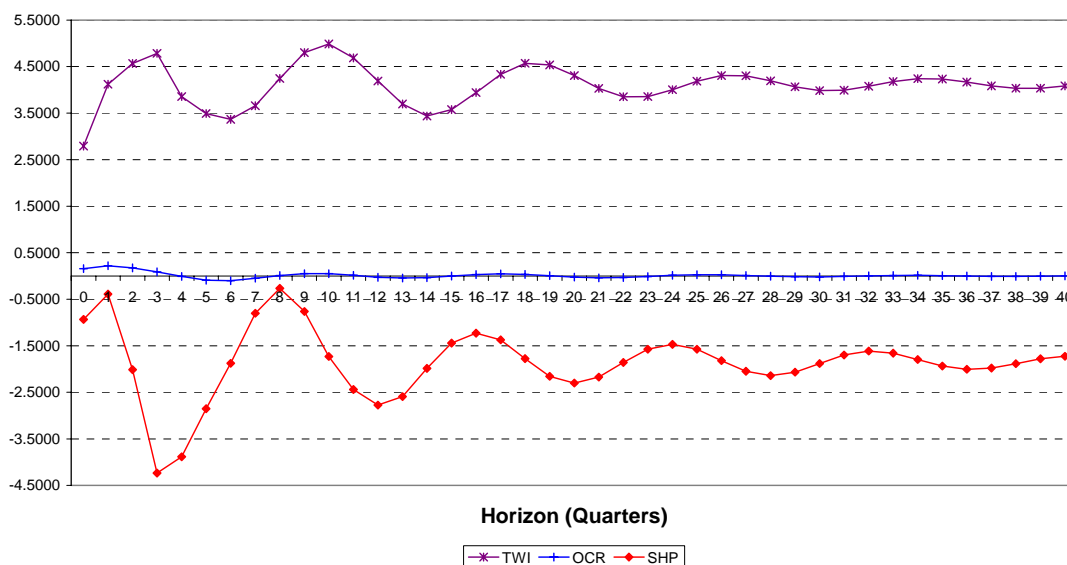
Figure 5: Generalised Impulse Responses to 1 Std Dev Shock in OCR: OCR, NBB, CAC and BCR



TWI: A 2.8% appreciation of the New Zealand dollar (NZD) occurs contemporaneously with the 16 basis point increase in the OCR. The NZD appreciates further for three more quarters before experiencing some depreciation which is partially reversed later on. The effective exchange rate continues on a roller coaster ride at levels well above the pre-shock level. The theory of uncovered interest parity (UIP) implies that when interest rates increase, currencies should appreciate immediately but that, over time, high-interest-rate currencies should experience some depreciation. The impulse response of TWI is consistent with the UIP.

SHP: A negative impact effect is followed by dampening fluctuations that stay below the pre-shock level; the percentage change in the share price index never becomes positive. The persistent negative impact and long-run effects are consistent with the theoretical inverse relationship between interest rates and share prices.

Figure 6: Generalised Impulse Responses to 1 Std Dev Shock in OCR: OCR, TWI and SHP



In general, the analysis shows that following a shock increase in the OCR, the other variables involved in the monetary transmission mechanism manifest their maximum responses within three to seven quarters. The estimated directions of response are consistent with *a priori* expectations. The maximum negative effects on inflation and expected inflation occur in the 7th quarter, but that on output growth is greater and also occurs sooner in the 5th quarter. This finding accords with the RBNZ policy of operating with a horizon of 18 to 24 months. If nothing else is done after the OCR shock, the simulation results indicate that the OCR will eventually settle back to its pre-shock equilibrium level but inflation, output growth, the current account:GDP ratio, the bank credit growth rate and the nominal effective exchange rate will stabilise at higher equilibrium levels; and expected inflation, the 90-day bank bill rate and the share price index will stabilise at lower equilibrium levels, albeit with different time lags and magnitudes.

5. SUMMARY AND CONCLUSIONS

Since New Zealand took the lead in adopting inflation targeting as the framework for conducting monetary policy in 1989, about two dozen countries comprising both developed and emerging markets have joined the bandwagon to date. The inflation targeting framework entails revising the central bank laws to make price stability the overriding objective of monetary policy and modifying the governance structure to confer greater autonomy on the central bank. To attain the objective of price stability, the central bank fixes the official interest rate in response to economic conditions and hopes that through the working of the monetary transmission mechanism inflation will hit the target point or fall within the target band. And despite the fact that globally success rate is only about 60% no country that has adopted the framework has abandoned it on account of difficulties with it. Prospects are that more countries will adopt it in the future as the benefits become more widely known.

An important outcome for the economy is when inflation expectations are anchored on the target. In this the credibility of the central bank's decisions and the public's understanding of the monetary transmission mechanism can be vital. Whereas the transparency and accountability requirements direct the central bank to engage the public through various bulletins and publications aimed at explaining the basis of its actions the magnitudes and duration of impacts of interest rate changes on other macroeconomic variables are not given sufficient publicity. Most empirical work has focussed on comparing governance structures and inflation performances of countries that have adopted the framework without highlighting the dynamic responses of the various variables. This study set out to fill the perceived gap in knowledge of those ramifications by providing estimates of the dynamic responses of variables in the monetary transmission mechanism for the country with the longest history of inflation targeting – New Zealand.

In a scrutiny of the data, eight variables in addition to the official cash rate (OCR) were identified as the key macroeconomic variables to be modelled: inflation, output growth, expected inflation, exchange rate, market interest rate, current account, bank credit and share prices. Because the variables influence one another in knock-on and feedback interactions the vector autoregression (VAR) methodology was employed. In particular, the cointegrating VAR and vector error correction model (VECM) approach was taken. Over the long term the variables are related in four important ways. The dynamic analysis shows that following a shock increase in the OCR, the other variables involved in the monetary transmission mechanism manifest their maximum responses within three to seven quarters. This finding accords with the policy of the Reserve Bank of New Zealand of operating with a horizon of 18 to 24 months. The estimated directions of response of all the variables are consistent with *a priori* expectations. Those of three variables are of central importance in an inflation targeting regime. Specifically, following one positive standard deviation shock in OCR of 16 basis points, output growth rises initially and then falls by a maximum of 0.19 percentage points in the 5th quarter. Inflation also initially rises and then falls by a maximum of 0.05 percentage points in the 7th quarter. After reaching their respective nadirs, these two variables rise and show some volatility before stabilising in later quarters at 0.02 and 0.07 percentage points, respectively, above their previous equilibrium levels. The third variable, expected inflation, rises only in the 2nd quarter and falls by a maximum of 0.05 percentage points in the 7th quarter before stabilising at 0.02 percentage points below the pre-shock level. The positive OCR shock creates a persistent reduction in expected inflation in the medium term and long term.

REFERENCES

- Charemza, W. C. and Deadman, D. F. (1997) **New Directions in Econometric Practice: General to Specific Modelling, Cointegration and Vector Autoregression, 2nd edition**, Edward Elgar Publishing Ltd., Cheltenham, UK.
- Enders, W. (2004) **Applied Econometric Time Series, 2nd edition**, John Wiley & Sons, Inc., New York.
- Ericsson, N. R. (1992) Cointegration, Exogeneity, and Policy Analysis: An Overview. *Journal of Policy Modeling*, Vol 14, No. 3, pp. 251-280.
- Global Financial Data, URL: <http://www.globalfinancialdata.com>.
- Granger, C. W. J. (1988) Some Recent Developments in a Concept of Causality, *Journal of Monetary Economics*, Vol 39, pp. 199-206.
- Hamilton, J. D. (1994) **Time Series Analysis**, Princeton University Press.
- Harris, R. (1995) **Using Cointegration Analysis in Economic Modelling**, Prentice Hall, Essex, England.
- Heenan, G., Peter, M. and Roger, S. (2006) Implementing Inflation Targeting: Institutional Arrangements, Target Design and Communications, IMF Working Paper, No. 06/278, International Monetary Fund, Washington DC.
- Johansen, S. (1988) Statistical Analysis of Co-integration Vectors, *Journal of Economic Dynamics and Control*, Vol 12, pp. 231-254.
- Johansen, S. (1991) Estimation and Hypothesis Testing of Cointegrating Vectors in Gaussian Vector Autoregressive Models, *Econometrica*, Vol 59, pp. 1551-1580.
- Johansen, S. (1995a) **Likelihood-Based Inference in Cointegrated Vector Autoregressive Models**, Oxford University Press, Oxford.
- Johansen, S. (1995b) Identifying Restrictions of Linear Equations with Applications to Simultaneous Equations and Cointegration, *Journal of Econometrics*, Vol 69, pp. 111-132.
- Johansen, S. and Juselius, K. (1990) Maximum Likelihood Estimation and Inference on Cointegration With Applications to the Demand for Money, *Oxford Bulletin of Economics and Statistics*, Vol 52, pp. 169-210.
- Johnston, S. and Di Nardo, J. (1997) **Econometric Methods, 4th edition**, McGraw-Hill, Singapore.
- Maddala, G. S. and Kim, In-Moo (1998) **Unit Roots, Cointegration and Structural Change**, Cambridge University Press, Cambridge, UK.
- Masson, P. R., Savastano, M. A. and Sharma, S. (1997) The Scope for Inflation Targeting in Developing Countries, IMF Working Paper, No. 97/130, International Monetary Fund, Washington DC.
- Miles, D. and Scott, A. (2005) **Macroeconomics: Understanding the Wealth of Nations, 2nd edition**, John Wiley & Sons, Inc., West Sussex, England.
- Patterson, K. (2000) **An Introduction to Applied Econometrics: A Time Series Approach**, Macmillan Press Ltd., London.
- Pesaran, M. H. and Shin, H. (1998) Generalised Impulse Response Analysis in Linear Multivariate Models, *Economic Letters*, Vol 58, No. 1, pp. 17-29.
- Portugal, M. (2007) Perspectives and Lessons from Country Experiences with Inflation Targeting, Remarks at a Panel on Inflation Targeting, <http://www.imf.org/external/np/speeches/2007/051707.htm>, International Monetary Fund, Washington DC.
- RBNZ (Reserve Bank of New Zealand), URL: <http://www.rbnz.govt.nz/statistics>.

- RBNZ (2007) Explaining New Zealand's Monetary Policy, Reserve Bank of New Zealand, Wellington, New Zealand.
- Roger, S. and Stone, M. (2005) On Target? The International Experience with Achieving Inflation Targets, IMF Working Paper, No. 05/163, International Monetary Fund, Washington DC.
- Taylor, J. B. (1993) Discretion Versus Policy Rules in Practice, *Carnegie-Rochester Conference Series on Public Policy*, Vol 39, pp. 195-214.
- Tuladhar, A. (2005) Governance Structures and Decision-Making Roles in Inflation Targeting Central Banks, IMF Working Paper, No. 05/183, International Monetary Fund, Washington DC.

Appendix Table A1: The Sample Data

Date	OCR	NBB	GDP	INF	BCR	EXI	SHP	TWI	CAC
Mar-99	3.6	4.46	4	-0.1	8.25	1.3	-3.79	-5.75	-4.2
Jun-99	4.51	4.68	4.1	-0.4	9.42	1.4	1.81	0.98	-3.9
Sep-99	4.5	4.81	6	-0.5	9.48	1.7	15.05	-0.78	-4.6
Dec-99	4.74	5.37	4.9	0.5	9.74	1.9	13.62	-2.81	-6.3
Mar-00	5.31	5.98	5.8	1.5	10.57	2.1	-2.19	-6.19	-6.4
Jun-00	6.21	6.73	4	2	7.92	2.3	-4.72	-9.64	-6.4
Sep-00	6.5	6.74	2.9	3	4.98	2.6	-2.73	-11.49	-6.4
Dec-00	6.5	6.67	2.6	4	5.16	2.8	-8.97	-12.32	-5.3
Mar-01	6.45	6.42	0.5	3.1	2.53	2.6	-4.26	-6.61	-4.4
Jun-01	5.92	5.85	2.2	3.2	4.07	2.5	0.28	-6.71	-3.5
Sep-01	5.69	5.74	3.1	2.4	7.29	2.5	-4.32	-0.24	-2.8
Dec-01	5	4.97	4.3	1.8	6.44	2.2	3.6	3.86	-2.8
Mar-02	4.79	5.03	4.5	2.6	8.55	2.4	5.92	2.19	-3.1
Jun-02	5.33	5.82	3.5	2.8	8.29	2.6	3.3	9.71	-3.3
Sep-02	5.74	5.91	4.8	2.6	7.77	2.4	3.23	7.73	-3.9
Dec-02	5.75	5.9	5.1	2.7	9.36	2.5	1.08	13.86	-4
Mar-03	5.75	5.83	5.7	2.5	8.84	2.4	-4.35	17.44	-3.6
Jun-03	5.5	5.44	4.7	1.5	8.73	2.3	-1.49	11.9	-4.3
Sep-03	5.06	5.12	4.2	1.5	9.32	1.9	7.12	15.84	-4.4
Dec-03	5	5.29	2.3	1.6	9.12	2	14.8	13.19	-4.4
Mar-04	5.17	5.5	3.8	1.5	10.92	2.2	19.49	10.25	-4.9
Jun-04	5.48	5.86	4.4	2.4	12.2	2.4	18.61	4.58	-5
Sep-04	5.98	6.44	4.3	2.5	11.73	2.7	16.59	6.27	-6
Dec-04	6.43	6.73	3.5	2.7	12.81	2.7	16.47	7.44	-6.6
Mar-05	6.56	6.87	1.9	2.8	13.02	2.7	19.01	4.19	-7.4
Jun-05	6.75	7.04	3	2.8	14.29	2.8	9.71	10.77	-8
Sep-05	6.75	7.05	3.1	3.4	15.73	2.9	13.54	5.12	-8.5
Dec-05	7	7.49	1.9	3.2	14.68	3.2	4.83	4.21	-9
Mar-06	7.25	7.55	2.1	3.3	13.86	2.9	-0.86	-2.05	-9.6
Jun-06	7.25	7.48	0.8	4	12.96	3.22	9.23	-11.29	-9.7
Sep-06	7.25	7.51	1	3.5	12.82	3.54	-2.89	-8.85	-9.2
Dec-06	7.25	7.65	3	2.6	12.97	2.98	6.82	-6.26	-9
Mar-07	7.44	7.88	3.2	2.5	13.3	2.7	19.82	4.48	-8.3
Jun-07	7.94	8.32	4.2	2	14.2	2.7	16.91	18.05	-8.2
Avge	5.95	6.24	3.51	2.28	10.04	2.47	5.89	2.38	-5.81
Min	3.60	4.46	0.50	-0.50	2.53	1.30	-8.97	-12.32	-9.70
Max	7.94	8.32	6.00	4.00	15.73	3.54	19.82	18.05	-2.80
Std Dev	1.01	1.02	1.39	1.12	3.26	0.48	8.73	8.85	2.18
Coef of Var (%)	17.05	16.30	39.62	49.05	32.46	19.60	148.29	371.03	-37.49