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**A measure of
monetary conditions**

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Abstract

This paper explains why the overall stance of monetary policy is effected by both interest rates and the exchange rate, and hence why a Monetary Conditions Indicator can provide useful information about the stance of policy. Three output gap equations estimated in this paper reveal that the real interest rate and the real exchange rate both affect excess demand but that the real interest rate is the more powerful and faster acting policy transmission channel.

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1 Introduction

The phrase “monetary conditions” is increasingly being used as a term encompassing movements in both interest rates and exchange rates, especially in small open economies. Interest rates and exchange rates are both relevant if, as Duguay (1994) argues, monetary policy is transmitted primarily through interest rates and exchange rates rather than through money and credit aggregates. In small open economies, where domestic and foreign assets are highly substitutable, interest rates and exchange rates are tightly interlinked with the domestic/foreign interest rate differential offset by expected exchange rate changes. This close relationship means that shocks are quickly transmitted between bond markets and foreign exchange markets.

Because interest rates and exchange rates are both important channels for monetary policy, Freedman (1995) argues that a combination of interest and exchange rates provides a better indicator of policy stance than either variable alone. A central bank intervention can manifest itself in a whole host of different interest rate/exchange rate combinations, depending on agents’ expectations of the future exchange rate. If expectations of next period’s exchange rate rise sufficiently, then a policy tightening may even lead to a fall in interest rates. Therefore, combining both interest and exchange rates in a single policy indicator, a Monetary Conditions Indicator (MCI), may provide a better indication of the overall policy stance.

Since the Bank of Canada began publishing its MCI (see Freedman (1995)) other central banks have followed suit. Both Sweden and Norway now publish MCIs (see Hansson and Lindberg (1994) and Eika, Ericsson, and Nymoén (1996)), and the IMF, in its World Economic Outlook (1996), recently published MCIs for Italy, Germany, France, the United Kingdom, Japan, and the United States. More recently still, the Reserve Bank of New Zealand (1996) published a Bulletin article illustrating three MCIs for New Zealand, and a paper estimating New Zealand’s MCI ratio (Nadal-De Simone, Dennis, and Redward (1996)).

Methods of building MCIs are discussed in Freedman (1995) and explored further in Eika *et al* (1996). The indicator itself depends on the variables chosen to enter it (usually the real 90 day bank bill rate and the real

effective exchange rate - although nominal rates are also sometimes used) and the weights applied to each variable. The Bank of Canada use weights of three on the interest rate and one on the exchange rate - thus their MCI ratio is 3:1 - indicating that the effect on demand pressure of a one percentage point interest rate increase can be offset by a three percent depreciation of the exchange rate.

In practice, this MCI ratio must be estimated; typically it is derived from the long-run interest rate and exchange rate elasticities estimated from an IS curve equation (Duguay (1994)). In theory, as the economy becomes increasingly open the IS curve's slope should increase and the MCI ratio should fall. Hence, large relatively closed economies should have large MCI ratios compared to small open economies like New Zealand, Australia, and the United Kingdom.

In this paper we build an MCI for New Zealand². We begin in section 2 by discussing the key channels through which monetary policy affects demand and inflation, emphasising the roles of interest and exchange rates. In section 3 we estimate a series of output gap equations that summarise the real interest rate and real exchange rate policy channels into excess demand. From these output gap equations we derive an estimate of New Zealand's MCI ratio. Having estimated an MCI ratio, in section 4 we use this ratio to construct a monetary conditions indicator. We then discuss New Zealand's recent economic history in light of this indicator. Section 5 concludes.

2 Monetary conditions and the IS curve

Our discussion of monetary conditions begins with a standard IS curve, see Parkin and Bade (1990) or Branson and Litvack (1976), specified as follows:

$$Y_t = \alpha + \eta_t + \delta \eta_t + \phi Y_t^f + v_t^d \quad (1)$$

² Initially we attempted to estimate New Zealand's MCI ratio for different policy horizons using a VAR. However, we found that a short lag length was needed to obtain a stable VAR, and this short lag length prevented the interest rate and exchange rate impacts on aggregate demand from being estimated accurately.

where: Y_t = real production GDP
 r_t = the real interest rate
 q_t = the real effective exchange rate
 Y_t^f = real foreign GDP
 v_t^d = a random innovation.

In equilibrium, real GDP, Y_t , will equal potential output, Y_t^p . Similarly, r_t will equal r_t^p (the equilibrium real interest rate), q_t will equal q_t^p (the equilibrium real exchange rate) and Y_t^f will equal Y_t^{fp} (foreign potential output). Therefore we can model the output gap, or demand pressure, as:

$$Y_t - Y_t^p = (\alpha\gamma r_t^p - \delta q_t - q_t^p) + \phi(Y_t^f - Y_t^{fp}) + v_t^d. \quad (2)$$

If we could observe each of the variables in equation (2), then it could be estimated and an MCI formed. In the context of equation (2), the MCI ratio would be γ/δ , which indicates the strength the interest rate has on demand pressure relative to the exchange rate. However, the variables in equation (2) are not generally observed, so estimates of them must be formed.

Filtering techniques (described in section 3.1 below) can be used to form a measure of the output gap, $Y_t - Y_t^p$, and we can proxy $r_t - r_t^p$ and $q_t - q_t^p$ by Δr_t and Δq_t respectively, because neither the real interest rate nor the real exchange rate contain trends. We can also proxy the foreign output gap by foreign output growth, provided that we also add an intercept to the output gap equation.³

During estimation we also allow for the possibility that agents are liquidity constrained. Before the financial market reforms of 1985, government dictated to banks where they could lend, thus agents could not use financial markets to smooth their consumption through time. After the 1985 reforms, financial markets took time to deepen; a lot of reintermediation took place as people transferred funds from accountants'

³ By construction $Y_t^f = Y_t^{pf} + c_t$ (where c_t represents the business cycle). It is c_t that we want entering the output gap equation. Lagging this equation, and noting that $Y_t^{pf} = Y_{t-1}^{pf} + g$ (where g is potential's growth rate) suggests that $c_t = \Delta Y_t^f - g + c_{t-1}$. Hence we can approximate c_t by $\Delta Y_t^f - g$ while recognising that stationary measurement errors are involved.

and lawyers' trust accounts back into the banking system (see Greville (1989)). Similarly, after the reforms it took time for banks to begin lending using market criteria.

In addition, housing loans are often tied to the value of the property being bought rather than to the expected future income stream of the lender (see Greville and Reddell (1992)). Therefore, a nominal interest rate not a real interest rate may be the relevant variable in equation (2). Using the Fisher equation, and the other approximations described above, the form of the output gap equation we estimate is:

$$Y_t - Y_t^p = \alpha + \beta_1 \pi_t + \beta_2 \Delta Y_t^{fp} + v_t^d \quad (3)$$

3 Estimation

In this section we estimate output gap equations according to equation (3). The parameters are freely estimated, but the implied restrictions are tested⁴. Before we can estimate equation (3), however, we need to measure New Zealand's output gap.

3.1 Measuring the output gap

To estimate the output gap we detrend real output. There is no unique way of detrending real output and any estimation results may be sensitive to the exact trend/cycle decomposition method used. Therefore, we use a variety of filters to detrend real output producing four measures of the output gap. These four output gaps are plotted in graph 1 and constructed as follows:

- 1) we regress (logged) real output on an intercept and a time trend and take the residuals as a measure of the output gap, gap1;
- 2) we detrend (logged) real output using the Hodrick-Prescott (1980) filter with λ equal to 1600, gap2;

⁴ Appendix I defines the data series used.

- 3) we detrend (logged) real output using the Hodrick-Prescott filter with λ equal to 1600 before 1985:1 and λ equal to 600 from 1985:1 onward, gap3; and
- 4) we detrend (logged) real output using the Hodrick-Prescott filter with λ equal to 1600 before 1985:1 and λ equal to 200 from 1985:1 onward, gap4.

It is well known that the Hodrick-Prescott (HP) filter renders stationary any variable with four or fewer unit roots (see King and Rebelo (1993)). Hence the output gap measures gap2, gap3, and gap4 should all be stationary. Alternatively, if the real output series we use is trend stationary, then gap1 should be stationary. However, when tested (see table 1), gap1 is found to contain a unit root and thus is not a suitable measure of demand pressure. Because it is not stationary, gap1 is not used in any empirical work.

Detrending real output using the HP filter (with λ equal to 1600) has become common place⁵ despite known problems with the filter (see Cogley and Nason (1995)). However, allowing λ to take on different values over time is reasonably new (see Razzak and Dennis (1995)). We allow λ to take on values smaller than 1600 after 1985 since 1985 represents the beginning of New Zealand's extensive micro- and macro-reforms. These reforms were in part designed to free up the supply side of the New Zealand economy. Interpreting λ as the ratio of demand shock variances to supply shock variances (see Harvey and Jaeger (1991)), reducing λ after 1985 allows for the increased influence of supply shocks on the New Zealand economy.

Real output is detrended over the period 1975:4 through 1996:1, but other data limitations (notably to the real interest rate - financial markets were tightly regulated in New Zealand prior to 1985) mean that the output gap equations we estimate below use a sample period of 1986:1 to 1996:1. The variables in each equation are tested for unit roots (see table 1) but, other than gap1, all variables are found not to contain unit roots. The estimated gap equations are presented in table 2.

⁵ There are many other de-trending techniques other than the Hodrick-Prescott filter, see Lucas (1972) and Beveridge and Nelson (1981).

3.2 Excess demand equations

When estimating equations for gap2 and gap3 (equations A and B respectively) we correct for autocorrelation using interactive Cochrane-Orcutt. We also correct for autocorrelation when gap4 is the dependent variable (equation C) using maximum likelihood estimation. Maximum likelihood is not used to estimate all three equations because those for gap2 and gap3 contain lagged dependent variables. All variables are included in logs, except the real interest rate and the inflation rate. Thus Δq_t represents the quarterly percentage change in the real exchange rate⁶ and $Y_t - Y_t^p$ represents the percent by which real output is above potential output.

Looking at table 2, the first thing we notice is that each of the three equations have a very similar lag structure. The real interest rate effects the gap after three quarters, the real exchange rate after five.⁷ Similarly, foreign output growth effects the gap after three quarters in each equation. Each equation exhibits considerable persistence (shocks take a long time to dissipate), although equation C has less persistence than equations B and A. In fact our results suggest that the level of persistence falls as the value of λ (applied after 1985) in the HP filter falls. This is understandable. Smaller values of λ imply a greater variance of supply shocks (relative to demand shocks). Supply shocks are assumed to permanently affect real output (Harvey and Jaeger (1991)). Thus it is natural for persistence to fall as λ falls because the HP filter assigns more of the variation in real output to supply shocks.

As discussed earlier, we include the change in inflation when we estimate these output gap equations to allow for liquidity constraints. If agents are liquidity constrained, then increases to the nominal interest rate caused by higher inflation will temporarily lower aggregate demand.⁸ In each

⁶ Note that an increase in q_t represents an appreciation of the real exchange rate.

⁷ If real UIP holds, then there is the possibility that collinearity between the (differenced) real interest rate and the (differenced) real exchange rate may cause our MCI ratio to be highly sensitive to small specification changes. The correlation between these two variables, however, is only 0.34, suggesting collinearity between these variables is not a cause for concern.

equation we find that high inflation significantly lowers demand pressure, and that inflation enters with the same lag as the real interest rate. However, Wald tests for whether the real interest rate and inflation rate have the same coefficient (as suggested by equation (3)) can be rejected at the 1% level.⁹

These Wald tests suggests that inflation and the real interest rate do not have the same coefficient. Nevertheless, in each equation the inflation rate is highly significant suggesting that more than just the real interest rate matters. It is possible that our null hypothesis is rejected because the Fisher equation is not holding - perhaps due to our use of actual inflation in place of expected inflation. Therefore, we leave inflation in each equation, but do not impose the restriction that the real interest rate and inflation have the same coefficient.

From these three output gap equations we can gain an estimate of foreign potential output growth. From equation (3) foreign potential output growth, g , can be estimated by dividing each equation's intercept by the sum of the foreign output (growth) coefficients. Taking this approach, we estimate g to be 3.36%pa, 3.45%pa, and 3.76%pa for equations A, B, and C respectively.¹⁰

Comparing the real interest rate coefficient with that of the real exchange rate, in each equation the real interest rate channel has the larger coefficient, implying that the MCI ratio is greater than 1:1. In fact equation A has an MCI ratio of 1.75:1; equation B a ratio of 1.65:1; and equation C a ratio of 1.98:1. Overall these equations suggest New

⁸ This effect occurs because higher nominal interest rates increase borrowers' debt payments as a proportion of their current income. Because borrowers are unable to borrow against their future income this higher debt servicing causes them to save, lowering their consumption.

⁹ The real interest rate is in annual terms whereas inflation is in quarterly terms. We correct for this difference in units when performing the Wald tests by dividing the inflation rate coefficients by four. For equation A we obtain a test-statistic of 23.82; for equation B we get 22.53; and for equation C we get 23.18. With these test statistics (which follow a $\chi^2(1)$ distribution under the null), the null hypothesis of equal inflation and interest rate coefficients can easily be rejected at the 1% level.

¹⁰ To the extent that positive world-wide output gaps have dominated over the sample period, these estimates of g will be over stated. See footnote 2.

Zealand's MCI ratio to be roughly 2:1. Furthermore, the real interest rate channel into demand pressure is not only more powerful than the real exchange rate channel it is also faster acting.

To put this MCI ratio in context, the Bank of Canada estimates the Canadian MCI ratio to be about 3:1; Eika *et al* (1996) report the Swedish and Norwegian MCI ratios to be approximately 2:1; and the IMF (World Economic Outlook, (1996)) use MCI ratios of 3:1 for France, Italy, and the United Kingdom, 4:1 for Germany, and 10:1 for Japan and the United States. New Zealand's MCI ratio of (about) 2:1, therefore, is not dissimilar to those of other small open economies such as Sweden and Norway. Additionally, Gerlach and Smets (1996), using quite different techniques, estimate New Zealand's MCI ratio to be in the range 1.5:1 - 2.7:1.

4 Monetary conditions

In this section we use the MCI ratio estimated in section 3 to produce a graph of New Zealand's monetary policy conditions over the past decade (graph 2). We use an MCI ratio of 2:1 and construct the indicator as follows:

$$MCI_t(gap_t) = \left[\frac{r_t - r_b}{r_t - r_b} - \frac{q_t - q_b}{q_t - q_b} \right] \times 100 + 100 \quad (3)$$

where r_b and q_b are the 1990:1 values of the real interest rate and (logged) real exchange rate respectively.

From graph 2 we observe that monetary conditions rose rapidly over 1985 as financial market regulations were removed allowing interest rates to rise to market levels. Conditions loosened in mid 1986 before firming sharply when the Reserve Bank tightened in early 1987. Monetary policy remained tight through to mid-1988 at which time inflation began to fall rapidly. The MCI rose in 1989 but fell quickly between 1991 and mid-1992 as demand slacked and the economy entered a recession. Monetary conditions reached their lowest point in June 1992. Demand picked up over late 1993 and 1994 while 90 day bank bills were very low (90 day bills were 4.9% in March quarter 1994). Inflation began to rise in mid-

1994 causing monetary conditions to firm sharply in early 1995. Since 1995 monetary conditions have remained firm.

5 Conclusion

In this paper we have suggested that in small open economies monetary policy gets transmitted through both interest rates and the exchange rate. Consequently, incorporating both channels into a single policy indicator, an MCI, may give a better indication of the stance of policy than either the interest rate or exchange rate alone.

Although the nominal exchange rate has a direct effect on prices, it is demand pressure that has the greater effect on medium-term inflation. An MCI focusing on medium-term inflation, therefore, should be based on the effects real interest rate and real exchange rate movements have on excess demand. The excess demand equations we estimate suggest that New Zealand's MCI ratio is approximately 2:1, which is similar to MCI ratios estimated for other small open economies.

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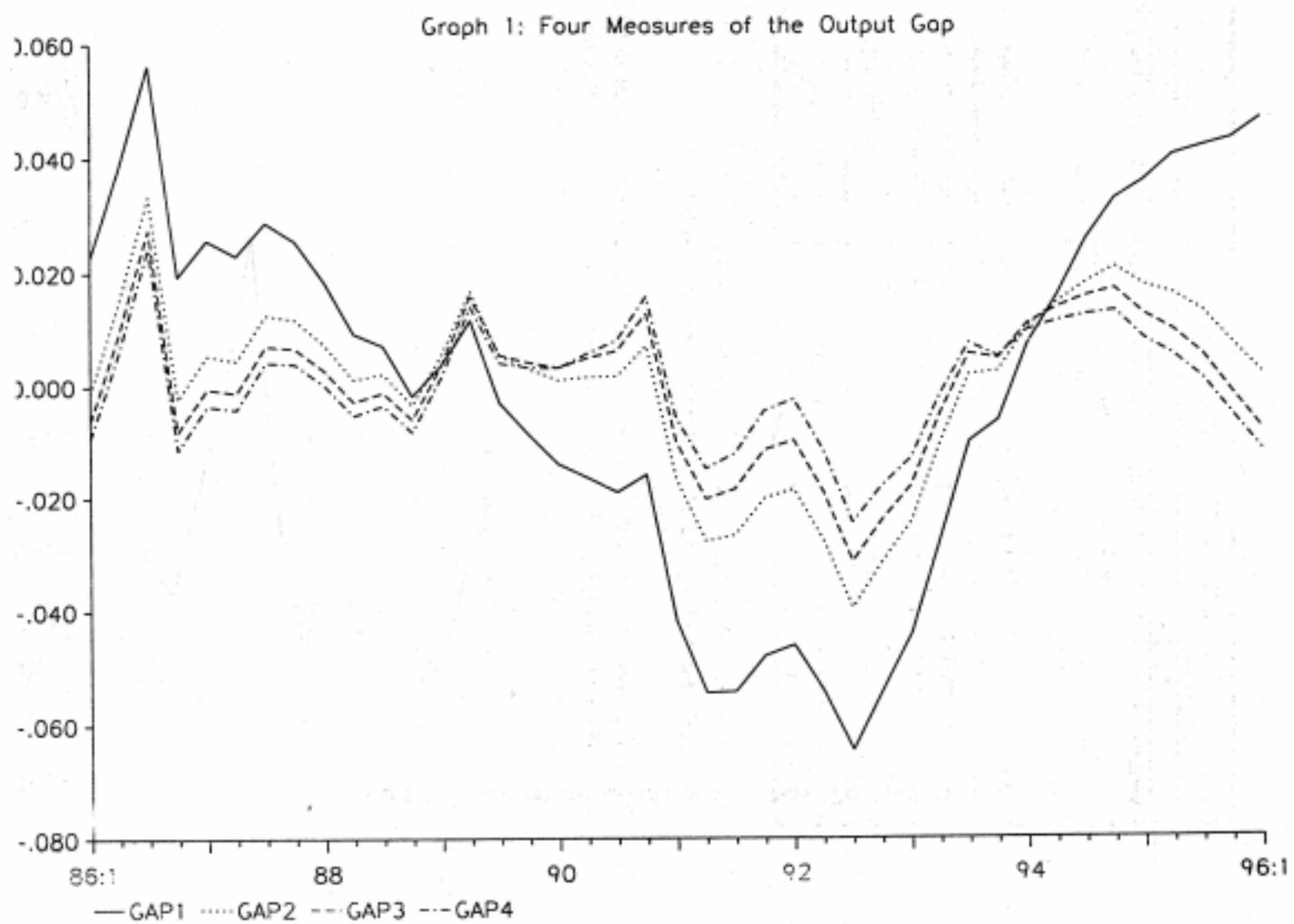
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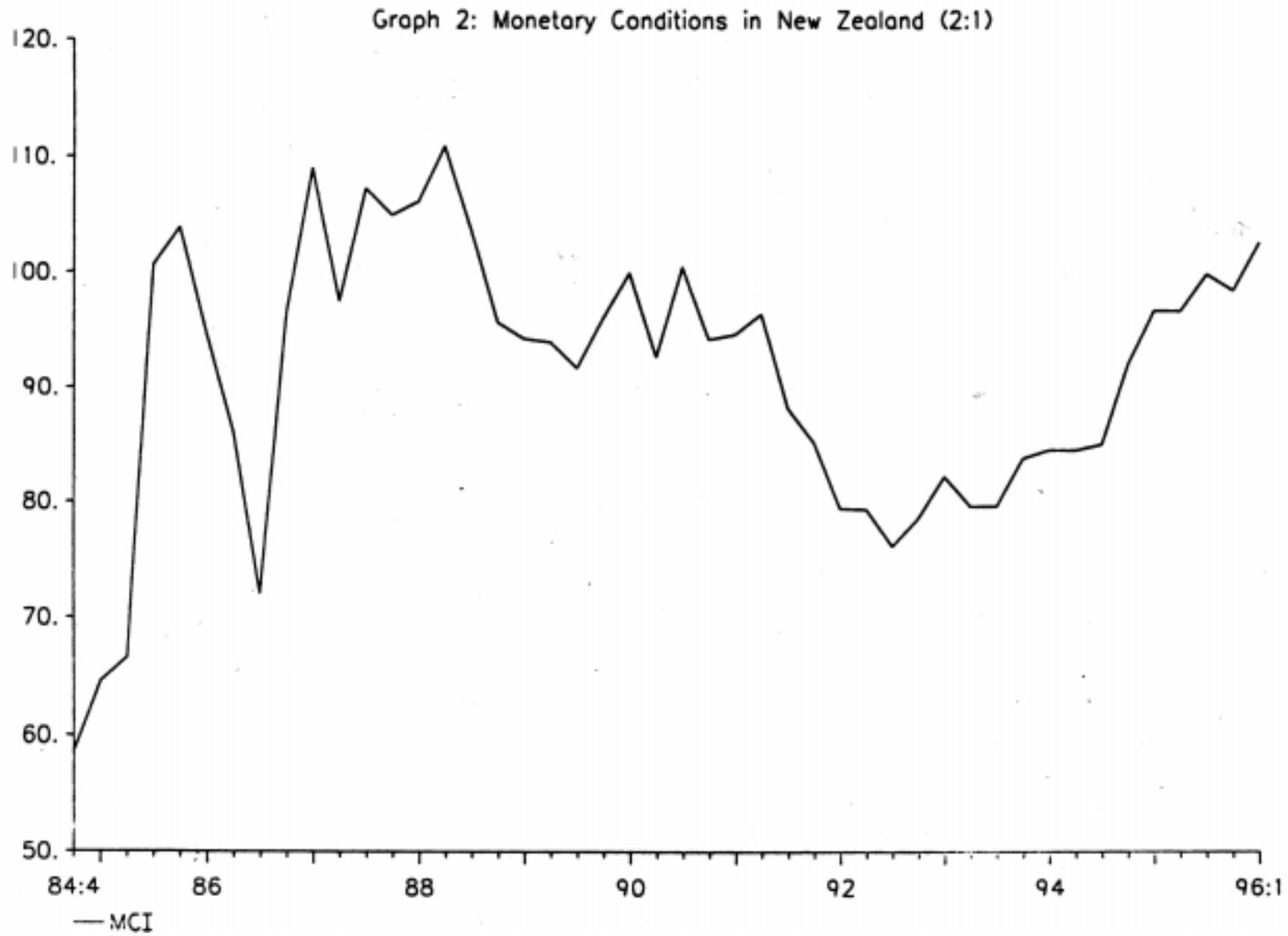
Table 1: Augmented Dickey-Fuller tests (Said and Dickey (1984))			
Variable	P-value	Order of Integration	Observations
Gap1	0.29374	I(1)	79
Gap2	0.00163	I(0)	79
Gap3	0.00011	I(0)	79
Gap4	0.00002	I(0)	79
πt	0.00446	I(0)	43
$\Delta r t$	0.00000	I(0)	42
$\Delta q t$	0.00361	I(0)	65
$\Delta Y t f$	0.04558	I(0)	78

These tests were all augmented with two lags of the dependent variable. The null hypothesis of these tests is that each variable (in column one) contains a unit root. For all but one of these tests (that for gap1) the null hypothesis can be rejected at the 5% level.

Table 2: Output Gap Equations								
Equation A			Equation B			Equation C		
Gap2			Gap3			Gap4		
Variable	Co-efficient	t-stat	Variable	Co-efficient	t-stat	Variable	Co-efficient	t-stat
constant	-0.011	-1.8	constant	-0.012	-2.6	constant	-0.010	-2.2
gap2 _{t-1}	0.3405	2.2	gap3 _{t-1}	0.3245	2.1			
Δr_{t-3}	-0.155	-2.5	Δr_{t-3}	-0.147	-2.4	Δr_{t-3}	-0.126	-2.2
Δq_{t-5}	-0.089	-2.7	Δq_{t-5}	-0.089	-2.8	Δq_{t-5}	-0.064	-2.2
$\Delta \pi_{t-3}$	-1.215	-3.8	$\Delta \pi_{t-3}$	-1.172	-3.7	$\Delta \pi_{t-3}$	-0.990	-3.6
$\Delta \pi_{t-4}$	-0.526	-3.9	$\Delta \pi_{t-4}$	-0.513	-3.8	$\Delta \pi_{t-4}$	-0.539	-4.2
ΔY_{t-3}^f	0.6459	2.8	ΔY_{t-3}^f	0.6445	2.8	ΔY_{t-3}^f	0.556	2.6
ΔY_{t-5}^f	0.7229	3.1	ΔY_{t-5}^f	0.7115	3.2	ΔY_{t-5}^f	0.486	2.4
ρ	0.8153	6.3	ρ	0.7248	4.8	ρ	0.7412	6.8
R ²	0.867		R ²	0.792		R ²	0.674	
se	0.0066		se	0.0064		se	0.0063	
MCI	1.75		MCI	1.65		MCI	1.98	

- * Equation A is based on Gap2. Gap2 is constructed by applying the HP filter to logged real GDP with λ equal to 1600.
- * Equation B is based on Gap3. Gap3 is constructed using the HP filter on real GDP with λ equal to 1600 before 1985q1 and equal to 600 from 1985q1 onward.
- * Equation C is based on Gap4. Gap4 is derived by applying the HP filter to real GDP with λ equal to 1600 before 1985q1 and equal to 200 from 1985q1 onward.





Appendix I – Data

The data set used for estimation contains six variables spanning 1986:1 - 1996:1. Seasonally adjusted (X-11) real production GDP (NGDPP_Z) is used as the measure of output. Real GDP was then detrended using the filters described in the text to form estimates of the output gap.

Domestic prices are measured by consumer prices excluding GST and interest and credit charges (PCPIIG). This price measure is used to construct domestic inflation and is also used in the real exchange rate measure. The bilateral exchange rates between New Zealand and its five main trading partners¹¹ were trade weighted together to form an estimate of New Zealand's effective nominal exchange rate. Similarly, we constructed measures of foreign prices and foreign real output by trade weighting together, respectively, the manufacturing producer price series¹² and the real GDP series¹³ of our five main trading partners.

The real exchange rate equals (logged) domestic prices plus the (logged) nominal effective exchange rate minus (logged) foreign prices. Finally, we construct the real interest rate by subtracting annualised quarterly domestic inflation (PCPIIG inflation) from the nominal 90 day bank bill rate (R90day).

¹¹ These five trading partners are: Australia, Japan, Germany, the U.K., and the U.S.

¹² The five foreign price series were: IAUPPOM.q for Australia, IUSPPOM.q, for the U.S., IJAPPOM.q for Japan, IUKPPOM.q for the U.K., and IGEPPOM.q for Germany. These variables are all official RBNZ series.

¹³ The five foreign GDP series were: IAUQ_.q for Australia, IUSQ_.q, for the U.S., IJAQ_.q for Japan, IUKQ_.q for the U.K., and IGEQ_.q for Germany. These variables are all official RBNZ series.