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The views expressed are those of the authors and do not necessarily reflect the views of the Bank of Finland.

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Abstract

We use the ten years of experience in inflation-targeting in New Zealand since 1989 to test whether monetary policy appears to conform to the simple rules that have been recommended for it in the literature. Of the inflation targeting central banks, the Reserve Bank of New Zealand has both the longest experience and probably the most clearly defined target and policy framework for achieving it. We show that while a Taylor rule with the standard parameters used in the US does indeed describe New Zealand monetary policy quite well, the Reserve Bank has focused rather more strongly on price stability, as required by its Policy Target Agreements. However, while the conduct of New Zealand monetary policy as set out in the Monetary Policy Statements is firmly based on targeting the inflation rate in the future we find, using the Bank's own forecasts, that nevertheless targeting inflation close to the present appears to be a better description of policy. Furthermore, restricting the policy choice to the information available to the Reserve Bank at the actual time of policy settings and ignoring subsequent revisions to published statistics does not result in a much improved explanation of its actions. We find a clear 'smoothing' element to the Bank's policy rather than immediate response to every small fluctuation. We show further that some of the variables that enter the policy rule have slightly asymmetric cycles. From symmetric and asymmetric cointegration tests on the long-run relationship between interest rates, the output gap, and inflation we show that there is insufficient evidence to suggest that monetary policy has been asymmetric in treating upside inflationary pressures differently from those towards deflation.

Key words: monetary policy, Taylor rule, inflation targeting, New Zealand

JEL classification numbers: E52, E58, E65

Rahapolitiikan säännöt käytännössä: Uuden-Seelannin tapaus

Suomen Pankin keskustelualoitteita 18/2001

Angela Huang – Dimitri Margaritis – David Mayes
Tutkimusosasto

Tiivistelmä

Tässä tutkimuksessa testataan, voidaanko rahapolitiikkaa kuvata kirjallisuudessa esitettyjen yksinkertaisten politiikkasääntöjen avulla. Tutkimuskohteena on Uuden-Seelannin inflaatiotavoitteeseen perustuva rahapolitiikka, josta on kymmenen vuoden kokemus. Inflaatiotavoitetta soveltaneista keskuspankeista Uuden-Seelannin keskuspankilla on sekä pisin kokemus tällaisesta politiikasta että selkeimmin määritelty tavoite ja politiikkakehikko. Tutkimuksessa osoitetaan, että vaikka Taylorin sääntö tavanomaisin, Yhdysvalloissa käytetyin parametrein kuvaakin myös Uuden-Seelannin rahapolitiikkaa varsin hyvin, Uuden-Seelannin keskuspankki on painottanut hintavakautta enemmän kuin amerikkalainen malli. Tämä on sopusoinnussa Uuden-Seelannin keskuspankin rahapoliittisia tavoitteita koskevan politiikkasopimuksen kanssa. Vaikka politiikka onkin virallisten lausumien mukaan suunnattu tiukasti tulevaa inflaatiota koskeviin tavoitteisiin, tutkimus osoittaa, että politiikka on paremminkin suuntautunut hyvin lyhyen ajan inflaationäkymän kontrollointiin. Tähän tulokseen päästään vertaamalla politiikkaa pankin omiin inflaatioennusteisiin. Politiikan vertaaminen vain siihen informaatioon, joka on päätöksiä tehtäessä ollut keskuspankin käytettävissä, ei juuri auta selittämään politiikkaa paremmin kuin lopulliset tilastot. Pankin politiikka on ollut selvästi tasoittavaa, eikä se ole reagoinut taustainformaation pieniin vaihteluihin. Tutkimuksessa osoitetaan myös, että jotkin niistä muuttujista, jotka vaikuttavat politiikkasäännössä, vaihtelevat epäsymmetrisesti. Ei kuitenkaan ole näyttöä, että rahapolitiikka reagoisi epäsymmetrisesti eli eri voimakkuudella inflaatiopaineisiin kuin deflaatiopaineisiin.

Asiasanat: rahapolitiikka, Taylorin sääntö, inflaatiotavoite, Uusi-Seelanti

JEL luokittelu: E52, E58, E65

Contents

1 Introduction

In setting monetary policy central banks seek to be consistent in their decision-making. Consistency not merely enables them to learn in a more coherent manner and not to cause perturbations in the economy through their own actions but it helps others understand what they are trying to do. By making themselves more predictable they can reduce the costs of their actions to society as people do not have to take out so much 'insurance' against policy surprises. Since central banks normally have price stability as their primary objective, structuring their behaviour so that they can be more convincing will help anchor price expectations more firmly on the objective of policy and hence reduce its cost.

The simplest way to achieve such predictability would be for central banks to follow some simple rule in setting policy. However, the complexity of the economy and the difficulty in disentangling signals about the likely directions in the future from the mass of data available makes such simplicity unattractive. At best such a rule would only be a guide to policy and central banks have not been keen to appear to be adopting one.

There is, however, an irony, in that ex-post analysis of central banks' behaviour shows that they have indeed been taking policy actions that do not look very dissimilar from simple rules. In the best known example, John Taylor (1993b) suggested that the U.S. federal funds rate can be described as a function of the current or last quarter output gap and inflation based on the output deflator. Taylor's rule has received attention as it describes the actual path of the U.S. federal funds rate quite well. Furthermore he goes on to show that departures from the rule help explain some of the policy 'mistakes' in the U.S. Hence the implication is that following the rule would not be a bad starting point for policy.

Subsequent empirical and theoretical research has shown that more complex rules may be more effective in achieving the objectives of policy (Svensson, 1997) but Taylor-type rules remain reasonably close to the optimum. However, implementation of the rule is hindered by the lack of timely information on the output variable and its price. At the simplest level the data available at the time and that used in estimating ex post rules differ simply because of revision by the statistical authorities (Orphanides, 1997). What central banks do and what they can do are therefore clearly different from the simple rule. In particular, central banks seek to overcome the time lags by forecasting and setting policy on the basis of what they expect to happen rather than just on estimates of the most recent events that have happened. In one respect this is just elementary common sense as monetary policy takes some time to have its effect on inflation. The appropriate horizon for setting policy is thus the period when current actions will have their effect. Orphanides (1997), has shown that simple forward-looking specifications of the Taylor rule using Federal Reserve staff forecasts describe policy better than Taylor rule specifications based on real-time data. However, difficulties remain as McCallum (1993) points out in regard to the need to extrapolate trends in unobservable variables.

Taylor rules present one further difficulty in that they imply some explicit concern for output as well as inflation as objectives for the central bank. This is appropriate for the United States, where this dual responsibility exists. For other central banks such as the Bank of England, European Central Bank (ECB) and the Reserve Bank of New Zealand (RBNZ) the focus is either just on price stability or any responsibility with respect to output is explicitly secondary. In these cases the most appropriate rule might simply be inflation forecast targeting. Namely, set policy so as to maximise the chance of achieving price stability over the policy horizon. While in practice there is likely to be some element of smoothing (the ECB, for example, explicitly targets stability over the medium term) the rule is almost a description of the objective. Output will of course remain relevant to the decision as output gaps are an important contribution to inflationary pressure.

The purpose of the present paper is therefore to explore the nature of the rules that inflation-targeting central banks appear to have been following. We expect to find that if they have been following a Taylor rule then the weight on output should be low or at least lower than in the US. We also expect to find that, if we use the information available at the time rather than the subsequently revised data, we will be able to describe actual policy more closely. Lastly we expect to find that forward-looking rules using forecasts will be better explanations.

Although the number of inflation targeting central banks has been growing steadily in recent years the policy has only been followed for around a decade in the longest case, which is New Zealand. Even that is a very short period to look at. We therefore focus on New Zealand and do not attempt to draw inferences for other inflation targeters. There are two other reasons for focusing on New Zealand. The first is that they are the only central bank that has published data about their forecasts for a significant number of years and therefore permit the forward look. Secondly they are the only central bank that has explicitly tried to summarise their approach to policy in the form of a reaction function. This therefore presents a unique opportunity to see if the observed behaviour seems to fit with simple rules that describe the policy approach ex ante.

Inevitably this has to be highly simplified but we do go on beyond Orphanides' study to explore whether treating the policy rule as symmetric is appropriate. It is widely accepted that inflation is not a symmetric process (Mayes and Virén, 2000). Moreover, the rhetoric of monetary policy in New Zealand has tended to emphasise the importance of nipping inflationary pressures in the bud. Secondly, New Zealand is a very open economy. While ignoring any extra input from outside may make sense for a much more closed economy like the United States it seems appropriate to see whether the exchange rate has an additional role to play. Not only are the time lags for the influence of the exchange rate on inflation likely to be rather different from that purely from demand pressure but the exchange rate has been explicitly cited by the Reserve Bank in its descriptions of policy.

The general approach of this study is to begin with the traditional view of Taylor-type work on policy rules, and examines the operationality of a Taylor-type rule given ex post, real-time and forecast data. Typically, researchers in this area of macroeconomic policy consider policy rules' efficiency or applicability through simulation or modelling, which leaves the long-run relationship between variables in a policy rule unexamined. Given that the instrument in an economy is one of the controllers that stabilize the system, one would postulate that it should have the property of turning non-stationary variables into stationary ones. Unfortunately, this aspect of macroeconomic policy has been largely ignored. Moreover, the presence of asymmetry in data series e.g. inflation and output with regards to policy rules has not been investigated to a large extent. If asymmetry indeed exists, say, in inflation, where policymakers are found to react more and faster to inflationary rather then disinflationary pressures, then there would be important implications in operating monetary policy with a rule as part of the toolkit. Thus, it is the intention of this study to bring in new econometric methods such as cointegration and tests of asymmetry, as an alternative route to explore the possibility of policy rules in the operation of monetary policy in New Zealand.

The structure of this paper is therefore as follows. Section 2 briefly reviews the nature of monetary policy in New Zealand over the period of inflation targeting and sets the analysis in the framework of previous research on monetary policy rules. Section 3 explores how well a Taylor rule describes New Zealand data, while Section 4 compares it with that derived from 'real-time' data and from forward-looking specifications. In Section 5 we examine whether the variables in this study, particularly inflation, show asymmetric processes. We then go on in Section 6 to establish whether there exists (a) a long-run cointegrating relationship between the short-run interest rate, inflation, the output gap (and the exchange rate) and (b) asymmetry in policy adjustments. We draw conclusions in Section 7.

2 New Zealand monetary policy and the framework for analysis

The New Zealand monetary policy regime is particular helpful to use as a test case for examining the operation of monetary policy rules because of the transparency of the monetary policy framework. Not only is the objective for policy spelt out in advance for the next five years[1] in a Policy Targets Agreement between the Governor of the Reserve Bank and the Minister of Finance (more recently Treasurer) but how the Bank expects to achieve that (or its intended actions should it expect to fail) is set out in Monetary Policy Statements that have to be published at least once every 6 months. In practice there have been quarterly statements of intent although until recently not all of these received the official label *Monetary Policy Statement* (Mayes and Razzak, 1998). In order to conduct this forward-looking explanation the Reserve Bank decided to publish its forecasts. There is therefore a unique dataset that can relate the setting of monetary policy to expected outcomes.

In order to fit any single representation to monetary policy it is sensible to pick a period where policy had some coherence. We have therefore chosen to look at the period of inflation targeting. There are some problems in dating this appropriately, as although the Reserve Bank Act of 1989 introduced the official framework from the date of its coming into force with signing of the first Policy Targets Agreement on 2 March 1990, the policy had been followed in practice before that. New Zealand's monetary policy followed a rather chequered history up to the late 1980s (Grimes, 1996). Prior to 1984 monetary policy had been undertaken in a framework of controlling bank lending. Immediately following the election of July 1984 policy switched to a more market-based approach with a focus initially on the targeting of monetary aggregates but it was not until the exchange rate was floated in March 1985 that monetary policy became truly independent. Although monetary aggregates were being managed with a view to achieving price stability during this period, as was common experience elsewhere,

[1] None of these Agreements (PTAs) has actually run its full five years (Mayes, 2000). New ministers have wanted to sign new agreements.

the link between the aggregates and inflation proved rather elusive (Wong and Grimes, 1992). The nature of the targeting procedure evolved and had been effectively abandoned by the end of 1988. We therefore start our period of analysis of the inflation-targeting regime from the beginning of 1989.

However, assuming that the period since the beginning of 1989 can be taken as a single 'regime' for statistical purposes just because it was covered by the same statute could also be erroneous. It is possible to identify at least four subperiods: 1989–1991; 1992–1994; 1995–1996 and 1997–1998. Although the definition of price stability, as the annual rate of inflation lying between zero and 2 percent, was established at the outset, the first two Policy Target Agreements were concerned with the rate at which actual inflation should be reduced to get it within that range. PTA1 (2 March 1990) required stability to be achieved by the end of 1992, whereas PTA2 (19 December 1990) lengthened this to the end of 1993. In practice it was achieved by the end of 1991. One might therefore want to consider reducing inflation and maintaining price stability as separate regimes.

The fourth period is separable because PTA4 (10 December 1996) widened the target to 0 to 3 percent. However since inflation had actually been outside the target range on the upper side for nearly 2 years at that point and never below 1 percent, it is not quite clear how big a change in regime it was. The split in the intervening period between the beginning of 1992 and the end of 1996 is discussed in Mayes and Riches (1996). As a result of the combination of improvements in forecasting and the unpleasant experience in unexpectedly exceeding the target band the Reserve Bank made a major shift in policy setting. Previously, it had set policy so as to avoid going outside the target range a year ahead (Nicholl, 1995). It had made that judgement largely on the basis of the direct transmission effect from foreign prices through the exchange rate onto inflation. Bowden and O'Donovan (1996) interpret this as in effect setting exchange rate bands as an intermediate target. Thereafter it aimed to bring inflation into the middle of the target range 6 to 8 quarters ahead. This difference in both looking further ahead and aiming towards the middle of the road rather trying to keep out of the gutter represented a substantial change in the way policy was set.

The data period we used goes up to the end of 1998. It includes a further revision in the target in PTA5 (17 December 1997), when the Bank was able to move from targeting its own computation of 'underlying inflation' to a new CPIX, published by Statistics New Zealand, that excluded the cost of credit services from the CPI.[2] In 1999 the CPI itself was altered to compute the housing element in a more commonly accepted manner and PTA6 (16 December 1999) incorporated that into the target.

However, PTA6 itself introduced a further change by qualifying the single focus on price stability with the following words: '**In pursuing its price stability objective**, the Bank shall implement monetary policy in a sustainable, consistent and transparent manner **and shall seek to avoid unnecessary instability in output, interest rates and the exchange rate**.' In explaining the change the Treasurer made it clear that this would represent a change in the Bank's behaviour

[2] The New Zealand CPI was unusual in including house prices and mortgage costs in the computation of the index. Clearly the interest rate element had to be stripped out of the inflation target otherwise the Reserve Bank would have been chasing its tail. Namely, every time it tightened monetary policy measured inflation would rise, implying the need for a further tightening.

in setting policy: saying it ‘reflected a concern not to repeat the experience of the mid-1990s, when the export sector was placed under immense pressure by a sharp increase in the value of the dollar.’ Furthermore he argued ‘Since then, the Reserve Bank has introduced a number of changes to the conduct of monetary policy, the effect of which should be to inject more stability into the system. I welcome those changes and consider this latest change another step in the same direction.’ There have been other more detailed changes in the PTAs and in the Reserve Bank’s policy implementation (Amtenbrink and de Haan, 1999; Archer *et al.*, 1999). It is thus difficult to suggest that the whole of inflation-targeting period represents a single regime in a detailed sense of the word.[3] It is therefore interesting to see how well it can be represented by a single Taylor Rule.

Following the lead of Bryant *et al.* (1993) we can set out a monetary policy rule in terms of the deviation of a nominal interest rate, R, from R*, a baseline path, as a linear function of the deviation of the target variable(s), say X, from its target X*, i.e.

$$R - R^* = \theta(X - X^*) \tag{2.1}$$

This will apply even if some definition of the money stock or nominal income is being used as an intermediate target variable (Silverstone, 1978). Since the RBNZ is targeting inflation directly we would expect to find that a simple Taylor rule of the form shown in Taylor (1993b)

$$R = R^* + 0.5y + 0.5(\pi - \pi^*) \tag{2.2}$$

which places equal weights on the deviation of real output from its long-run trend, y, and on the deviation of inflation π from its target π^* would be inappropriate as a description of the intention.

The RBNZ, like all central banks, does not claim to have been following some slavish rule, as there is considerable information that is difficult to quantify exactly to be taken into account in deciding upon the setting of policy. The best *a priori* guess at what the appropriate representation might be would therefore probably be some form of what Svensson (1997) describes as a flexible inflation-forecast-targeting rule. The RBNZ actually assists this process of guesswork by publishing a ‘reaction function’ as part of the model that is used in the forecasting and policy assessment process (Black *et al.* 1997a,b)

$$R_t = \sum_{i=6}^{8} \theta_i \left(\pi^f_{t+i} - \pi^*\right) + R^* \tag{2.3}$$

where the superscript f denotes the RBNZ’s forecast made in quarter t for t + i quarters ahead. θ_i is a weight set at 1.4. The Bank’s aim in setting policy is

[3] Svensson (2001), in his Review of New Zealand’s monetary policy, suggests that the period between July 1997 and March 1999, when the RBNZ used a Monetary Conditions Index (MCI) as a means of communicating its monetary policy requirements, can be regarded as distinct. Since March 1999 the RBNZ has changed its principal instrument of policy from managing the quantity of overnight cash to setting the interest rate for it (OCR). At the same time the frequency of meetings of the Monetary Policy Committee has been substantially reduced to that prevailing in the U.S. We do not report the estimates including this last period as it is rather short and may indicate some change in policy, possibly towards a Taylor rule.

explicitly to get inflation on to its target (described as the middle of the target range laid down by the PTA (Mayes and Razzak, 1998)) six to eight quarters ahead. (By doing that it hopes to achieve the requirements laid down in the PTA, not actually keep inflation in the middle of the target range. The 'rule' is the means to the end.)

Hence we should expect to see three things in practice from fitting a Taylor rule like (2.2). First of all any weight that appears on output should be small because it either represents some form of incompleteness in the specification or only a secondary concern for economic welfare *given the maintenance of price stability* as laid down in the PTA. Secondly using the current value of $(\pi - \pi^*)$ should be inefficient compared with using the forecast value as specified in (2.3). Lastly using the currently published values for either π or y would imply knowledge that the RBNZ did not have (or that it was able to estimate what the Government Statistician would publish subsequently very accurately). Hence using the actual values available to the Bank at the time it made the decision would be more likely to be accurate.

2.1 The discretion vs rules debate

It is not the purpose of this paper to take a stand in the rules versus discretion debate but merely to see which if any rules seem to characterise New Zealand well and whether these conform to the stated objectives of policy. Rules in this context can be defined as 'a reaction function, according to which policy is changed in response to the values of a few key variables' de Brouwer and O'Regan (1997, p. 2). The mechanical adoption of a rigid algebraic formula, would tend to be inadequate, given the complexities of an economy. However, despite the difficulty of interpreting various inputs such as potential output estimates into an encompassing rule Taylor (1993b) argues that rules have significant advantages over discretion in improving economic performance. Clearly, 'in an uncertain world the optimal contingent rule will always dominate the optimal fixed rule' (Buiter, 1981, p. 648). This is because a contingent rule allows new information to be considered when the actual course of the policy instrument is set, whereas a fixed rule only takes into account information available at the beginning of a decision-making period and cannot be altered as new information becomes available. In line with this, Taylor (1993b) advocates the use of policy rules as one of the tools provided for policymakers' decision-making. That is, a policy rule should be set up among other economic indicators and measures, to give policymakers another reference point in their operation of the monetary policy. By viewing a policy rule as a 'policy system', i.e. a methodical, flexible approach in implementation, it is able to be more than a purely mechanical formula (see also the discussion in Bryant *et al.*, 1993, 7–8). This to our mind provides a fairly accurate description of the sort of framework for monetary policy formulation developed and used in New Zealand over the last decade. With a clear numerical target, a published forecast of what is likely to happen, an explanation of how deviations from target are to be handled, a published model and view of how the economy works the New Zealand system is about as transparent a monetary policy as can be studied at present.

As set out by Bryant *et al.* (1993) the main choice for rule based regimes lies among money targeting, exchange rate targeting, nominal GDP targeting and the

Taylor rule we have explored (if we regard inflation forecast targeting as a special case).[4] Opinions are divided on the empirical merits of the various rules, although straightforward money targeting has generally been the most criticised (Svensson, 1997). What matters from our point of view is not so much which rule wins out in particular circumstances but that policy appears to be fairly robust to a range of rules that do not:

1. place a very high weight on hitting narrow inflation or output targets
2. use a time horizon very far different from the main time lags in the transmission mechanism

see Drew and Hunt (1999) and Amano *et al.* (1999) for example. All of these will deliver outcomes in a similar region and hence similar welfare levels. They all avoid volatility in the monetary policy instrument (some through explicit penalties on changing it). New Zealand's approach conforms clearly to the second of these criteria by design and by having a range of 2 or 3 percentage points avoids getting into the extremes under the first criterion even though there is no explicit weight assigned to output. The results from the New Zealand experience should therefore have a substantial level of applicability to other economies.

3 Estimating the Taylor rule in New Zealand

3.1 The simple rule

If we apply a simple Taylor rule to New Zealand data, for the period 1989–1998 we find that it works rather well as a description of recent policy. There is a slight problem with definitions owing to a quirk in the implementation of monetary policy in New Zealand. Unlike most countries New Zealand did not set an interest rate as such during this period. Instead the RBNZ said what it wanted for market conditions by specifying 90-day bank bill rates that would be consistent with price stability – initially in combination with a range for the exchange rate (Nicholl, 1995) and from late 1996 in terms of a Monetary Conditions Index (Mayes and Virén, 2000) that combined the two in a single measure. Although it could achieve any given market rate by use of quantitative controls in the overnight market – it set a 'cash target' for its daily market operations – it did not normally have to use that weapon to achieve the market conditions it wanted. The combination of the threat that it could act and the statements explaining what was required were normally sufficient.

The Bank thus set policy through what have often been described as 'Open Mouth Operations' (Guthrie and Wright, 1997). Normally the quarterly *Monetary Policy Statements* were the vehicle used but in between times if there were shocks or the market moved too far the Governor or other senior members of the bank would issue a brief statement saying what the Bank wanted. From 17th March 1999 the RBNZ has adopted a more conventional Cash Rate instead of the quantitative target. There is thus no equivalent of the Federal Funds Rate to incorporate but it seems sensible to use the rate that the RBNZ itself referred to,

[4] There is of course a conceptual difference as a Taylor rule is an instrument rule not a target rule.

namely, the 90-day bank bill rate, as the best indicator of policy in the context of a Taylor rule. Given the lack of direct central bank control it will tend to have a rather higher variance than its US equivalent. Furthermore, as we have already indicated, since the RBNZ set so much store on the combined values of interest and exchange rates, given that New Zealand is a small open economy we can expect this will be a rather incomplete measure.

In order to apply the Taylor rule we need to make an assumption about the 'equilibrium' real rate of interest for the period, the inflation target and decide how the output gap is to be measured. As this is an illustrative exercise we adopt a simple calibration. Alternative specifications that permitted variation of the target inflation rate are also presented. We assume the equilibrium real rate to be 5 percent, which is close to the average rate that prevailed over the sample period. Admittedly, this is a rate higher than benchmark international rates (e.g., U.S. real interest rates) but consistent with the tight domestic savings market situation in New Zealand. Similarly we assume the inflation target to be 1.5 percent, the midpoint of the current Policy Target Agreement (0 to 3 percent). Although the mid point of the earlier agreements was 1 percent as explained above, inflation remained persistently above the mid-point and policy was not explicitly aimed at the mid point but at keeping inside the range. For comparison purposes, we also present estimates of the Taylor's rule based on the officially announced inflation targets during the sample period. The response coefficient, θ, is the same as Taylor's which is 0.5. By substituting these into (2.2) and collecting terms gives:

$$T = 4.25 + 1.5\pi + 0.5y$$

where T denotes Taylor's interest rate rule, π is the inflation rate over the previous four quarters, and y is the output gap. We apply three versions of the output gap: the first as estimated by the Reserve Bank using ex-post data; the second derived as deviations of GDP from a log-linear trend and the third a real time estimate using the Reserve Bank's methodology to estimate trend output. Figure 1 illustrates Taylor's rule based on ex post data provided by the Reserve Bank of New Zealand, while Figures 2 and 3 display the rules based on ex post (loglinear trend) and real-time data, respectively. (R is the actual interest rate that prevailed.)

The output gap is the most highly debated element of the formulation of the Taylor rule. In Taylor's (1993b) paper, it was simply generated by estimating potential output as the loglinear trend of real output. We do not have a reliable base to build on as although measurements of output gap and potential output have been widely used overseas, these two measures of inflationary pressure are relatively recent in the Reserve Bank of New Zealand's toolkit of monetary policy formulation. Potential output is a series which cannot be directly observed, and a wide range of techniques has been used to infer it from observable macroeconomic data by using univariate time-series methods or purely structural approaches, i.e. decomposing output into trend and cyclical components. Conway and Hunt (1997) at the Bank for example utilise a semi-structural approach that incorporates past inflation, an indicator of labour market conditions and a survey measure of the economy's capacity utilisation rate into a multivariate filter.

Table 1. **Summary statistics, 1989–1998**

	MEAN	SD	MA	MIN	MAX
R	9.05%	2.80	9.05%	4.58%	14.28%
R–R(–1)	–0.23%	0.96	0.77%	–2.30%	1.45%
GAP ex post (RBNZ)	–0.34%	1.81	1.59%	–3.82%	2.22%
GAP ex post loglinear trend	0.01%	2.95	2.43%	–5.94%	6.28%
GAP real-time	–0.49%	1.38	1.11%	–3.10%	2.40%
INFLX	2.91%	1.87	2.91%	1.10%	7.92%

Note: The statistics shown for each variable are: MEAN, the mean; SD, the standard deviation; MA, the mean of the absolute value; and MIN and MAX are the minimum and maximum values.

Figure 1. **Taylor's rule (RBNZ ex post)**

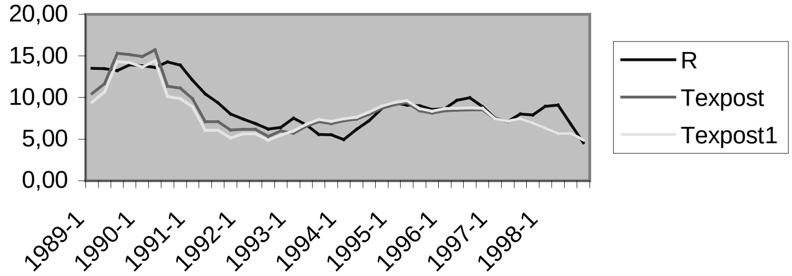


Figure 2. **Taylor's rule (log-linear trend)**

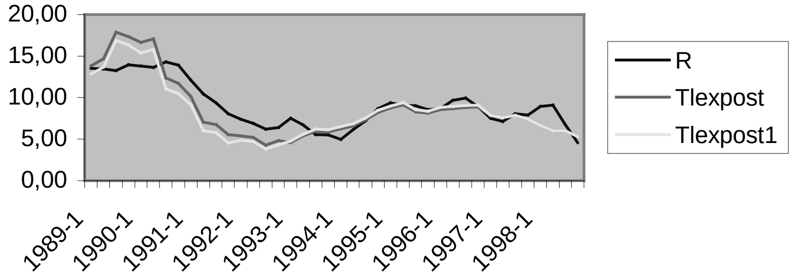
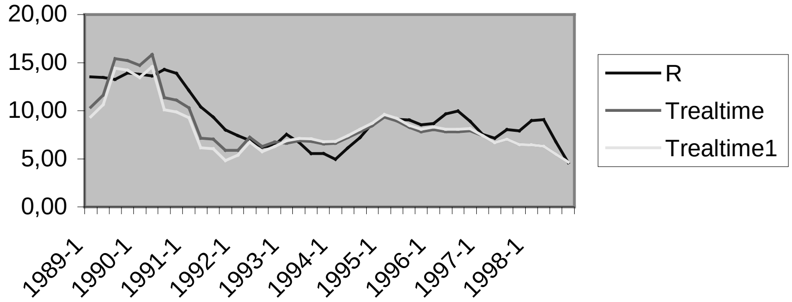


Figure 3. **Taylor's rule (real time)**



However, this does not help us infer what less formal methods might have been applied during this period. Up until the late 1980s the RBNZ used a sequence of large econometric models in their forecasting and simulation (Mayes and Razzak,

1998) but these broke down in the period of substantial structural change after 1984. The FPS published in 1997 was the first full-scale replacement.

The summary statistics of the data series used are shown in Table 1. R is the 90-day bank bill rate, GAP is the real output gap, and INFLX is inflation based on the Consumer Price Index excluding interest costs (CPIX). It is clear that the output gap derived by applying a loglinear trend to GDP is more volatile than the ex post output gap measure provided by the Reserve Bank of New Zealand or the real-time output gap.

Figures 1–3 show that the fit of all versions of the rule is quite reasonable. The alternative (T1) rule in these graphs is generated by altering the inflation target at the mid point of the official target ranges: 4.5–6.5 percent (1989), 3–5 percent (1990), 2.5–4.5 percent (1991), 1.5–3.5 percent (1992), 0–2 percent (1993–1996), 0–3 percent (1997–1998); and using a real rate of interest of 6 percent for 1989.

Table 2. **Descriptive statistics of Taylor's rule in New Zealand, 1989–1998**

	MEAN	SD	MA	MIN	MAX
R–Texpost	0.61%	1.55	1.33%	–2.26%	3.42%
R–Tlexpost	0.44%	1.82	1.43%	–4.61%	3.38%
R–Trealtime	0.66%	1.50	1.32%	–2.20%	3.24%
Texpost–Trealtime	0.05%	0.43	0.34%	–1.08%	0.68%
Tlexpost–Trealtime	0.23%	1.28	0.98%	–2.04%	3.46%

Note: R is 90-day bank bill rate, and T is Taylor's rule as explained in the text. Texpost=rule using the RBNZ output gap data ex post; Tlexpost=rule using a log-linear trend measure of potential output ex post; Trealtime=rule using a real time measure of the output gap.

The errors and differences between the three specifications are shown in Table 2. Although the mean of the difference between the actual 90-day bank bill (R) and the rule (T) based on real time data is the highest at 66 basis points, the standard deviation is actually the lowest at 150 points. The difference between the ex post (Texpost) and the real-time rule (Trealtime) on the other hand is shown to be relatively small, compared to the difference between the ex post rule (Tlexpost, based on loglinear trend for GDP in determining a measure of output gap) and the real-time rule. Note from Table 1 that the standard deviation of the quarterly change in the 90-day interest rate is 96 basis points which suggests that a random walk forecast of the interest rate is more accurate than a forecast derived from the policy rule.

If we describe actual policy compared with the rule, it appears from Figures 1–3 that monetary policy was tight for the period mid 1990 to mid 1993, and around mid 1995 to the end of 1998. In between these two periods, the rule implies that monetary policy was looser than necessary. The looseness in the initial (1989:3–1990:2) period as shown in Figure 1 and 3 (or 1989:1–1990:2 in Figure 2) can (in part) be attributed to the underestimate of the target in our assumptions rather than the looseness of actual policy. This becomes obvious from an inspection of the alternative rule paths (Texpost1 or Trealtime1) in Figures 1 and 3. The tightness of the policy in the 1990–1993 period is consistent with the Bank's aim of achieving credibility at the early stages of the new monetary policy framework and bring about a prompt fall in the public's sluggish inflationary expectations formation process.

Figures 1–3 indicate that the monetary policy since 1995 has been tighter than the path prescribed by the rule. This to some extent is an overreaction to the looseness of policy and ensuing inflationary pressures of the 1994–1995 period. Disinflation is not a simple linear process but rather a process that goes through a phase of initially undershooting the target (as in 1991–1992) that is likely to be followed later by an overshooting of the target (as in 1994–1995). Indeed, the undershooting produces a real exchange depreciation that provides the stimulus to an economy that has been cooled off considerably as a result of monetary tightness during disinflation. Similarly, an overshooting of the inflation target gives rise to a real currency appreciation that can help reduce overheating pressures. More recently policy has clearly been rather tighter than required by the rule. In particular the tightening during the first part of 1996 and again after the Asian crises broke in mid-1997 are not called for. On the rule policy would have eased earlier and further in 1998. To the extent that policy is adequately described by the Taylor rule, the consistent pattern of the deviations of the actual interest rate from any version of the rule shown in Figures 1–3 seems to suggest that policy discrepancies cannot be attributed to the type of informational problems that we have addressed here.

3.2 Estimated reaction functions

We have thus far applied a Taylor rule with conventional parameters. A rather more instructive exercise would be to estimate the parameters of simple reaction functions of the form of Taylor rules, as shown in (2.3)

$$R_t = a_0 + a_\pi \pi + a_y y_t \tag{3.1}$$

where a_0 is a constant, and a_π and a_y are the response parameters for inflation and output gap respectively. Following Orphanides (1997) we extend the analysis to include a partial adjustment process to account for any possible interest smoothing policy. It is argued (Brainard, 1967; Tarkka and Mayes, 1999) that an appropriate response to 'model' or multiplicative uncertainty is for the central bank to be rather cautious in its policy actions. This will result in a lagged adjustment. It is sometimes suggested that central banks actually indulge deliberately in interest rate smoothing (Rudebusch, 2001) so as to increase the stability of the economy. There is no prima facie evidence that the RBNZ has done either of these from its *Monetary Policy Statements*, although the December 1996 *Statement* makes it clear that the Bank did not intend to respond to the very small upward and downward changes to the MCI suggested by its forecast over the coming 6 months. It preferred a more robust approach to policy. If this were the general approach then the appropriate description of the reaction function would become

$$R_t = \rho R_{t-1} + (1-\rho)(a_0 + a_\pi \pi_t + a_y y_t) \tag{3.2}$$

where ρ is the partial adjustment coefficient.

We begin by considering the ex-post data, i.e. the most recent estimates available to us including all revisions that have been made. In practice of course this only applies to the output series as neither the price data nor the interest rate series are revised. The quarterly data series used in the estimation of (3.1) and (3.2) are the 90-day bank bill rate (R), the real output gap (GAP) as estimated by the Reserve Bank of New Zealand using a multivariate filter, and the inflation rate based on the Consumer Price Index excluding interest costs over the previous four quarters (INFLX). The inflation variable was the definition of the target as at the end of the data period. It differs slightly from the Reserve Bank's definition of the target, as 'underlying inflation', that was applied during most of the period, by inclusion of a small range of 'supply shocks'. Following the definition of the target in the early PTAs the Reserve Bank produced its own series for underlying inflation. As Roger (1998) shows, the difference between the two series, mainly reflecting oil prices, is quite small[5] but it may impart a small downward shift to the RBNZ series over the period as the balance of shocks was inflationary. We prefer to use the series published by Statistics New Zealand both because of its current relevance and because of its objectivity. In any case it is not clear that the RBNZ series was used by price setters. The unmodified CPI probably had the greatest influence on expectations. Failure to exclude interest rates, however, has a major effect on the target and would have resulted in policy feeding on itself as we described above. This minimum adustment was therefore essential.

Over the sample period from March 1989 to December 1998 the output gap suggests an increasing slowdown followed by rapid catch-up and then excess pressure from 1994 through to the end of 1997. Inflation after an initial rise fell away rapidly and remained in the top half of the target range or a little above from 1992 onwards. Interest rates start high in nominal terms and never fall below 5 percent except for the very last observation. During the period 1995 to 1997 interest rates were around 9–10 percent in nominal terms giving real rates of 6 to 7 percent and an inverted yield curve.

Table 3 shows the (OLS) results for the simple static and dynamic specifications of the Taylor rule.[6] We observe as expected that while the weight on inflation is similar to that suggested by Taylor (1993a) the weight on output (in the static model) is lower and not significantly different from zero. Thus, the results of the standard (static) Taylor rule model seem to confirm the hypothesis that the RBNZ was generally targeting inflation over the period with a relatively low weight on the output gap.

[5] The technical criteria for excluding supply shocks from the CPI in order to estimate underlying inflation are quite complex and defined in RBNZ (1997). Only identifiable shocks from external prices and administered prices including changes in GST were included with a minimum cut-off that the effect had to be at least a quarter of a percentage point on the index.

[6] Using instrumental variables (IV) to take account of simultaneity, with 4 lags of R, INFLX and GAP as intruments, has little impact on the estimates.

Table 3. **Ex post reaction functions: 1989–1998**
Ordinary least squares estimation

Model	Static	Dynamic
CONST	5.2692 (0.000)*	1.0616 (0.006)*
	0.6845	0.3637
GAP	0.1265 (0.195)	0.2181 (0.000)*
	0.0958	0.0529
INFLX	1.3160 (0.000)*	0.3718 (0.000)*
	0.1502	0.0924
R(–1)	–	0.75066 (0.000)*
		0.0667
R^2 Adjusted	0.74687	0.91645
A: Serial correlation CHSQ(4)	16.5838 (0.002)*	17.9448 (0.001)*
B: Functional form CHSQ(1)	21.6476 (0.000)*	0.0286 (0.866)
C: Normality CHSQ(2)	1.2346 (0.539)	0.3549 (0.837)
D: Heteroscedasticity CHSQ(1)	3.8523 (0.050)	2.0948 (0.148)

Note: Figures under the parameter estimates are standard errors based on the Newey-West heteroscedasticity and serial correlation robust estimator. Figures in parenthesis represent the p-values based on Newey-West adjusted S.E.'s with Parzen weights.
* Reject the null hypothesis at the 5% level of significance.
A: Lagrange multiplier test of residual serial correlation.
B: Ramsey's RESET test using the square of the fitted value.
C: Based on a test of skewness and kurtosis of residuals.
D: Based on the regression of squared residuals on square fitted values.

If we consider the lagged adjustment model (3.1) (labelled 'Dynamic' in the Table) the picture changes. The smoothing parameter is highly significant and around 0.8 in value. However, the statistical significance and magnitude of the output gap coefficients suggests an important role for real output considerations in the policy reaction function.

Plots of cumulative sum of recursive residuals (CUSUM) and cumulative sum of squares of recursive residuals (CUSUMSQ) indicate that the dynamic model appears to be more stable than the static model and that there may be some problem with the static model up to 1994 that was resolved there after. We therefore tested for structural breaks in the relationship but none were detected.

It is interesting to see if the specification of the output gap does matter for the estimation of the Taylor rule. Taylor rule estimates utilising a log-linear trend measure of potential output are shown in Table 4. The results are generally similar to those derived from the (ex post) RBNZ estimate of potential output of Table 3. The main difference is that the Table 4 estimates show the gap coefficient to be significant in both models. Indeed, the long-run values for the output gap and inflation coefficients are fairly close to the respective weights specified in Taylor's rule.

Table 4. **Ex post reaction functions with loglinear GDP trend as potential GDP: 1989–1998 Instrumental variable estimation**

Model	Static	Dynamic
CONST	5.0186 (0.000)*	1.4243 (0.000)*
	0.5064	0.2941
GAP	0.1874 (0.041)*	0.1465 (0.004)*
	0.0883	0.0475
INFLX	1.4745 (0.000)*	0.4243 (0.003)*
	0.1636	0.1321
R(–1)	–	0.6967 (0.000)*
		0.0638
R^2 Adjusted	0.7515	0.8872
A: Serial correlation CHSQ(4)	13.4857 (0.009)*	14.6176 (0.006)*
B: Functional form CHSQ(1)	7.3877 (0.007)*	5.3340 (0.021)*
C: Normality CHSQ(2)	0.7193 (0.698)	0.3953 (0.821)
D: Heteroscedasticity CHSQ(1)	10.5470 (0.001)*	0.5107 (0.475)

Note: See Table 3.

The CUSUM charts indicated that the static model with the loglinear output gap is less stable than the model with the ex post RBNZ gap estimate, while the plots for the dynamic version of the model remain within the critical bounds at the 5 percent significance level.

4 Real-time and forward-looking policy

4.1 Real-time policy rules

For real-time reaction functions, we require estimates of the output gap available at the time of decision-making. That is the estimated output gap for time t available at time t. High frequency (quarterly) consistent data on such forecasts are not available, as the output gap is a recent addition to the Reserve Bank's list of economic indicators. We have generated our own real-time estimates of the output gap by employing the Bank's filtering approach to get an estimate of trend output which in turn is subtracted from the real output data that was actually available at the time of the policy setting.

The results using real time data to obtain an estimate of Taylor's rule are shown in Table 5. They appear to be quite similar to those reported previously for the rule based on RBNZ ex post estimates of the output gap. The estimated weight on the inflation variable is quite robust between the static and dynamic specifications of the policy reaction function and very close to the value hypothesised in Taylor's rule. The weight on the output gap is insignificant in the static model but relatively high (and significant) in the dynamic model specification. Plots of CUSUM and CUSUSQ indicate no evidence of model instability apart from a two quarter blip in 1994 in the static version of the model picked up by the CUSUM test.

Table 5. **Real time reaction functions: 1989–1998**
Instrumental variable estimation

Model	Static	Dynamic
CONST	4.8044 (0.000)*	0.9111 (0.004)*
	0.6597	0.2978
GAP	0.1649 (0.278)*	0.3203 (0.000)*
	0.1618	0.0722
INFLX	1.5585 (0.000)*	0.4544 (0.000)*
	0.1671	0.0894
R(–1)	–	0.7529 (0.000)*
		0.0503
R^2 Adjusted	0.7218	0.89362
A: Serial correlation CHSQ(4)	14.046 (0.007)*	14.9471 (0.005)*
B: Functional form CHSQ(1)	1.341 (0.247)	14.5653 (0.000)*
C: Normality CHSQ(2)	1.162 (0.559)	0.7976 (0.671)
D: Heteroscedasticity CHSQ(1)	6.424 (0.011)*	0.0050 (0.944)

Note: See Table 3.

4.2 Forward-looking policy rules

While policy may have been believed to be forward looking it is a separate question whether it is better represented by a forward-looking version of the Taylor rule. Here we require forecasts of both inflation and the output gap made at the time to be included in a policy reaction function of the form:

$$R_t = \rho R_{t-1} + (1-\rho)(a_0 + a_\pi \pi_{t+i|t} + a_y y_{t+i|t}) \tag{4.1}$$

where i reflects the forward-looking horizon which ranges from 1 to 4 quarters ahead.

The database of Reserve Bank of New Zealand contains quarterly forecasts of real GDP that only go back as far as March 1993. Forecast CPIX figures are also unavailable prior to September 1994, hence underlying inflation figures are used in place of inflation based on CPIX. We use one – to four-quarter and six-quarter ahead RBNZ inflation forecasts and real time output gap forecasts constructed by the authors using data from the RBNZ projections to estimate the forward looking versions of Taylor's rule.

Table 6. **Forward-Looking Reaction Functions: 1990–1998 Instrumental Variable Estimation**

	Horizon relative to decision period (in quarters)						
	–1	0	1	2	3	4	6
CONST	4.8266*	4.8044*	3.5857*	3.8530*	3.9338*	3.6826*	3.1232*
	0.5916	0.6527	0.5334	0.6312	0.5065	0.5163	1.044
GAP	0.3553*	0.1649	0.0847	0.4356	0.6013*	1.0085*	0.8443
	0.1048	0.1627	0.2437	0.2512	0.1704	0.3472	0.5462
INFLX	1.4813*	1.5585*	2.4949*	2.5707*	2.6802*	3.2447*	4.0118*
	0.4344	0.1698	0.2163	0.2990	0.2053	0.1282	0.5189
R^2Adj.	0.7552	0.7218	0.7782	0.7228	0.7746	0.5856	0.2029
CONST	1.2140*	0.9111*	1.2919*	0.8294*	0.9726*	0.7152	0.1763
	0.3327	0.3038	0.4707	0.3942	0.4500	0.6593	0.7691
GAP	0.3771*	0.3203*	0.2403*	0.4039*	0.4728*	0.5945*	0.5764*
	0.0727	0.0716	0.1088	0.0097	0.0947	0.1558	0.1719
INFLX	0.4455*	0.4544*	1.0098*	1.0120*	1.1274*	1.1037*	0.9243*
	0.1164	0.0916	0.2489	0.2349	0.2842	0.4661	0.4651
R(–1)	0.7164*	0.7529*	0.5823*	0.6721*	0.6463*	0.7105*	0.8294*
	0.0670	0.0515	0.1004	0.0834	0.1005	0.1439	0.1335
R^2Adj.	0.9026	0.9076	0.9112	0.9001	0.9178	0.9005	0.8695

Note: Figures under the parameter estimates are standard errors based on the Newey-West heteroscedasticity and serial correlation robust estimator.
*Rejects the null hypothesis of not significantly different from zero at the 5 percent significance level.

Table 6 presents the results from the estimation of the forward-looking policy reaction functions over the period 1990:1 to 1998:4. A backward-looking reaction function is also estimated by regressing the 90-day bank bill on last quarter's real-time output gap data and last quarter's inflation rate based on the CPIX. For completeness of presentation, results obtained over a contemporaneous horizon (t=0) are also reported (i.e. revised Table 5 results due to sample change). Note that the results of the last column are for an output gap forecast of four quarters ahead – when a six quarter ahead forecast was used both the inflation and gap coefficient estimates were insignificant.

The results from Table 6 indicate generally similar patterns for the policy response coefficients. The relative inflation weight of the policy reaction functions rises as the forecast horizon increases from period t–1 to period t+1, a similar pattern to that reported by Orphanides' (1997) for the U.S. Over longer forecast horizons the relative inflation to output gap weights generally follow a declining pattern although their values are higher than the relative weight specified by the Taylor rule. The peak relative weight occurs at the first (t+1) quarter horizon. This suggests contrary to the Bank's stated practice that the Reserve Bank of New Zealand placed more emphasis on short-term inflation forecasts than more distant ahead quarters for current policy settings.

Orphanides (1997) observes that the partial adjustment coefficient estimates under this specification consistently increase as the horizon increases. This is an indication that the lag of the 90-day bank bill rate serves more and more as "a proxy for the imperfectly specified output and inflation variables" (Orphanides, 1997, p. 20). Our results suggest that the adjustment coefficient follows a U-shaped pattern.

5 Symmetry of data series

One of the facets of monetary policy discussed within the RBNZ (Mayes and Razzak, 1997) was whether the behaviour of the economy was symmetric. If the economy itself is asymmetric then policy should also have an offsetting asymmetry (Clark *et al.* 1997). Indeed Laxton *et al.* (1997) argue that as long as the hypothesis of asymmetry cannot be convincingly rejected policy should assume asymmetry because the costs of wrongly assuming symmetry when the economy is asymmetric are greater than from assuming it is asymmetric when it is symmetric (Mayes and Virén, 2000). We therefore have tested for asymmetry in the data series. If the evidence suggests asymmetric adjustment, then asymmetric cointegration and error correction methods should be employed to see how the adjustment occurs.[7] FPS assumes nonlinearity in the Phillips curve in New Zealand and its simulation properties are clearly asymmetric (Black *et al.* 1997b). However, the reaction function as we have noted is symmetric. Whether actual policy has been symmetric is a different matter. A textual or discourse analysis of the RBNZ's *Monetary Policy Statements* could easily give the impression that it has been far more concerned with excess inflation than deflation. Until the very end of the data period there was no real danger of inflation falling below 1 percent a year let alone challenging the lower bound. One might attribute this to an asymmetric distribution of shocks to the economy over the period, although Cassino (1997) suggests that this has not been the case. It might even reflect the opposite worry in macroeconomic policy as a whole leading to strong political action to head off any suspicion of recessions.

The evidence for asymmetry seems quite strong. Harris and Silverstone (1999a) find that Okun's law for New Zealand holds in both the long run and the short run only if an asymmetric approach is taken. In Harris and Silverstone (1999b) they show this is also the case for some other OECD acountries and Mayes and Virén (2000) show this more widely. We therefore explore whether the three variables involved in the Taylor rule also exhibit asymmetric patterns over the cycle. Following the approach of Sichel (1993) a test of skewness is used to determine if asymmetry exists in business cycles. To do this, a 'deepness' and 'steepness' test is conducted on each variable. If for example the business cycle exhibits 'deepness', it implies that the troughs will be deeper than the peaks are tall. On the other hand, 'steepness' may imply that business cycle contractions are steeper than expansions. Thus, 'deepness' relates to the amplitude of the troughs and the peaks, while 'steepness' relates to the slope.

After decomposing into trend and cycle(s) (see Speight and McMillan, 1998) the detrended series can be tested for asymmetries. Koopman *et al.* (1995) shows that a univariate time-series can be decomposed with a stochastic trend. Although the data period is extremely short we estimated the model hyperparameters with STAMP using the Kalman filter. Over the period 1989:1 to 1998:4, there appear to be three cycles in the 90-day bank bill rate with periods of 6.8, 2.0 and 3.5

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[7] Bec *et al.* (2000) explore whether policy has followed a nonlinear rule in the US, Germany and France and conclude that in all 3 countries the treatment of inflation and the output gap are not symmetric in expansions and contractions.

years. There are also three cycles in the real GDP series, with two short ones at 1.4 and 1.5 years, and a longer cycle of 7.4 years.

Denoting the particular series in question by x_t, a 'deepness' test is conducted by regressing on a constant and computing the Newey-West asymptotic heteroskedasticity and autocorrelation consistent standard error (a.s.e) using Parzen weights. The 'steepness' test is very similar to the 'deepness' test, except x_t is replaced by Δx_t, which is the first difference of the detrended series.

$$z_t = (x_t - \overline{x}) / \sigma(x)^3 \tag{5.1}$$

The p-values in Table 7 indicate that the null hypothesis of symmetry cannot be rejected at the 5 percent significance level for any series except for the steepness test in the output gap series. These results suggest in contrast to Harris and Silverstone (1999a) that the cycles are reasonably symmetric over the 1989:1 to 1998:4 period. Harris and Silverstone (1999a) using seasonally adjusted real GDP series covering 1978:1 to 1999:1 find that the real GDP cycle displays negative skewness and expansionary steepness. This may be due to the shorter time period used here. Razzak (1997) also finds asymmetry in the inflation-output relationship using New Zealand data.

Table 7. **Asymmetric 'deepness' and 'steepness' tests**

Variable	z_t	a.s.e.	p-value	Δz_t	a.s.e.	p-value
90 day bank bill	–0.632	0.716	0.383	0.424	0.918	0.647
Real GDP	–0.424	0.821	0.608	0.152	0.705	0.525
Output gap	0.003	0.126	0.981	0.057	0.025	0.028*
Inflation	–0.141	0.660	0.832	0.035	0.663	0.959

*Significant at the 5 percent significance level.

6 Cointegrating relationships

As a final step in the analysis we explored whether there are cointegrating relationships between inflation, the output gap and the interest rate on the basis of which a policy reaction function could be statistically supported. Since New Zealand is an open economy we extend the analysis to include the exchange rate, represented here by the TWI (Trade Weighted Index), to be part of the reaction function.

With such short data series it is not surprising that the results show higher orders of integration than theory would imply. The 90-day bank bill rate, output gap, and inflation rate are all I(1) processes. An Augmented Dickey-Fuller (ADF) test suggests that the TWI is an I(2) process whereas the Phillips-Perron (PP) test indicates that it is I(1). In line with most available statistical evidence we assume the TWI is an I(1) process. Results from the cointegration tests suggest that a cointegrating relationship exist between the 90-day bank bill rate, output gap, inflation rate, and TWI. This indicates that the unit root test result for the TWI is likely to be a sample-specific result, thus the TWI is also likely to be an I(1) series. Indeed, if we lengthen the sample to March 1999, the ADF test indicates that TWI is an I(1) series. Spectral analysis of the TWI in first difference also confirms this result.

6.1 Cointegration – symmetric approach

The Johansen method was used to provide evidence on the existence of a cointegrating relationship among the variables that enter the policy reaction function. The order of Vector Autoregression (VAR) is chosen to be 2 using the AIC, SBC and HQC model selection criteria. Table 8 shows that the Johansen Maximal Eigenvalue and Trace statistics indicate that there is one cointegrating relationship between R, INFLX and GAP (using both ex post and real time output gap measures).[8]

Table 8. **Test statistics and 95% critical values for the cointegration VAR model**

Cointegration LR test	Ho: r=0 H1: r=1	Ho: r<=1 H1: r=2
Maximal eigenvalue		
Test statistic	31.5771 (24.2924)*	5.8349 (4.9617)
95% critical value	22.0400	15.8700
Trace		
Test statistic	40.1925 (31.8961)*	8.6154 (7.6037)
95% critical value	34.8700	20.1800

Note: Figures in parenthesis refer to the statistics obtained using the real time GAP.
r = number of cointegrating vectors.

The (normalized) Maximum Likelihood (ML) Johansen cointegrating vector estimates of the (ex post) policy reaction function and estimates obtained using the Phillips-Hansen fully modifies OLS (FM-OLS) procedure are shown in Table 9. (Numbers in brackets are asymptotic standard errors of estimated coefficients).

Table 9. **Ex post reaction functions: 1989–1998 ML and FM-OLS Estimates**

Model	Johansen	Phillips-Hansen
CONST	4.9164*	5.1838*
	(0.3180)	(0.2553)
GAP	0.1366	0.2275*
	(0.1014)	(0.0749)
INFLX	1.4377*	1.3886*
	(0.1131)	(0.0795)

* significant at the 5% level

[8] The r=1 choice was also supported by the AIC, SBC and HQC procedures.

Note that the GAP coefficient is significant at the 5 percent level under the Phillips-Hansen but not the Johansen estimator. When the procedure is repeated for a 'real time' policy reaction function, the Johansen estimated coefficients for GAP and INFLX are very close to the numerical values suggested by the conventional Taylor rule.[9]

We also considered the addition of the exchange rate, TWI, to the equation. The same pattern is observed. The null hypothesis of no cointegrating relation cannot be accepted and furthermore the null hypothesis of at least one cointegrating vector is not rejected, thus indicating that there also exists a cointegrating vector between R, INFLX, TWI and GAP. However, some aspects of the results are less satisfactory. While the weight for INFLX is slightly lower than its counterpart shown in Table 9, the coefficient on GAP is negative (although insignificant) implying that such effect as there is appears perverse. The coefficient on TWI is positive but insignificant. While we do not pursue this one might very well feel that given the emphasis placed on the exchange rate by the RBNZ over the period, inserting the exchange rate in the policy rule could turn out to improve the representation of policy.

6.2 Cointegration – asymmetric approach

The cointegration tests performed above are based on the assumption that there is symmetric adjustment in the short-run error correction model (ECM). That is, any short-run changes in the 90-day bank bill, output gap, or inflation are strictly proportional to the absolute value of the error correction term (Z_{t-1}) in the error correction model specified below:

$$\Delta R_t = \alpha_1 + \alpha_2 \Delta GAP_{t-1} + \alpha_3 \Delta INFLX_{t-1} + \alpha_4 \Delta R_{t-1} + \alpha_5 Z_{t-1} + \omega_t \qquad (6.1)$$

However, despite of not finding evidence of asymmetric adjustment for the 90-day bank bill and inflation, it is still possible for the adjustment to disequilibrium in the ECM to be asymmetric. We use an asymmetric version of the cointegration test developed by Enders and Siklos (1999) called the momentum threshold autoregressive model (M-TAR). The model can be written as:

$$\Delta\hat{\varepsilon}_t = I_t \rho_1 \hat{\varepsilon}_{t-1} + (1 - I_t)\rho_2 \varepsilon_{t-1} + \upsilon_t^* \qquad \upsilon_t^* \sim IID(0, \sigma^2) \qquad (6.2)$$

$$I_t = \begin{cases} 1 \text{ if } \Delta\hat{\varepsilon}_t \geq \tau \\ 0 \text{ if } \Delta\hat{\varepsilon} < \tau \end{cases} \qquad (6.3)$$

where I_t is the Heaviside indicator function based on threshold value τ.

The residuals from the estimated policy reaction function (3.1) are used to estimate (6.3). The value of τ is generally unknown and needs to be estimated along with ρ_1 and ρ_2. Enders and Siklos (1999) suggest using Chan's (1993) grid-search method to find a consistent estimate of the threshold. The estimated residuals from (6.2) are sorted in ascending order and the top and bottom 15

[9] Estimates of the backward-forward looking reaction function using the Phillips-Hansen FM-OLS approach confirm the pattern of the results reported in Table 6.

percent are discarded. The remaining 70 percent of the arranged values act as possible thresholds, and (6.3) is run with each possible threshold. The τ that results in the lowest residual sum of squares is chosen to be the preferred threshold value. This is then used to test for cointegration using the t-Max* and F*-test proposed in Enders and Siklos (1999), as well as the Wald test to test the null hypothesis of symmetric adjustment. The M-TAR model using the consistent estimate of the threshold (t-statistics in parentheses) is:

$$\Delta\hat{\varepsilon}_t = -\underset{(-2.149)}{0.3286} I_t \hat{\varepsilon}_{t-1} - \underset{(-3.094)}{0.7585}(1 - I_t)\varepsilon_{t-1} + \upsilon_t \tag{6.4}$$

where

$$I_t = \begin{cases} 1 & \text{if } \Delta\hat{\varepsilon}_t \geq -0.832 \\ 0 & \text{if } \Delta\hat{\varepsilon}_t < -0.832 \end{cases} \tag{6.5}$$

The diagnostic test statistics suggest adequate functional form, homoscedasticity, and no evidence of serial correlation for the residuals of (6.3). However, the normality test indicates lack of normality in the residuals. The point estimates of both ρ_1 and ρ_2 are significant at the 5 percent significance level, and suggest the speed of adjustment is more rapid for negative than for positive discrepancies from τ = –0.832. The t-Max* statistic is the larger t-statistic of ρ_1 and ρ_2, which is –2.149 in this case. The cointegration F*-test where $\rho_1 = \rho_2 = 0$ has a test statistic of 13.777. Compared with the critical values generated by Enders and Siklos (1999), both statistics indicate that one cannot accept the null hypothesis of no cointegration at the 5 percent significance level.

To check the robustness of the model, we estimate the M-TAR model with the threshold value set equal to zero. The diagnostic test statistics give similar results, i.e. lack of normality in the errors, but no serial correlation, hetereoscedasticity, or inadequate functional form. The t-Max* statistic of –2.3 and F* statistic of 11.1 reject the null hypothesis of no cointegration at the 5 percent level.

While our results confirm the existence of a long-run relationship between the three variables, the adjustment mechanism does not appear to be asymmetric. The Wald test statistic of whether $\rho+ = \rho_2$ is 2.213 (p-value = 0.137) for the model with τ = –0.832, and 0.133 (p-value = 0.715) for the model with τ = 0. If the adjustments between positive and negative discrepancies were not equal (ρ_1 not equal to ρ_2) this would imply asymmetric adjustment. Therefore, both versions of the M-TAR model suggest cointegration without statistically significant asymmetric adjustment. This result is in line with the deepness and steepness tests, as well as the Johansen maximum likelihood cointegration test.

The major difference between the two M-TAR models is the point estimates' magnitudes. In the first model where τ = –0.832, the speed of adjustment for negative discrepancies is faster than positive, while the opposite is true for the second model where τ = 0. However, as the Wald test results indicate, ρ_1 and ρ_2 are not significantly different from each other. Consequently, one cannot conclusively comment on the relative speed of adjustment between the positive and negative discrepancies. Mayes and Virén (2000) show that there is an important difference in the coefficients of the threshold model for the Okun curve depending whether the mean or the maximum likelihood estimates of τ are used.

6.3 Error correction model

Finding no statistical evidence of asymmetric adjustment leads to the estimation of an error correction model with symmetric adjustment for the period 1989–1998 (t-values in parentheses):[10]

$$\Delta R_t = \underset{(0.115)}{0.019}\Delta GAP_{t-1} - \underset{(0.521)}{0.104}\Delta INFLX_{t-1} + \underset{(4.396)}{0.565}\Delta R_{t-1} - \underset{(3.956)}{0.421}Z_{t-1} \qquad (R^2 adj. = 0.471) \tag{6.6}$$

$$\Delta GAP_t = \underset{(0.518)}{0.077}\Delta GAP_{t-1} - \underset{(2.386)}{0.421}\Delta INFLX_{t-1} + \underset{(0.584)}{0.066}\Delta R_{t-1} - \underset{(3.312)}{0.312}Z_{t-1} \qquad (R^2 adj. = 0.246) \tag{6.7}$$

$$\Delta INFLX_t = \underset{(2.378)}{0.352}\Delta GAP_{t-1} + \underset{(1.039)}{0.183}\Delta INFLX_{t-1} + \underset{(1.521)}{0.173}\Delta R_{t-1} + \underset{(1.791)}{0.169}Z_{t-1} \qquad (R^2 adj. = 0.159) \tag{6.8}$$

Equations (6.6) and (6.7) are both well specified in terms of standard diagnostic tests, but (6.8) suffers from serial correlation and lack of normality in errors. The t-statistics on the ΔGAP_{t-1} and $\Delta INFLX_{t-1}$ terms in (6.7) and (6.8) seem to suggest that there is bi-directional Granger causality between output gap and inflation. The error correction term in (6.6) suggests that about 42 percent of the discrepancy between the actual interest rate and its target value recommended by the policy rule in period t–1 is removed in period t. Note that interest rate adjustment in (6.6) takes place almost entirely through the error correction term aside from a lagged interest rate change. This provides further support to our earlier findings of the presence of a smoothing element in interest rate policy settings.

7 Conclusions

In some respects it is surprising how well a simple relationship like a Taylor rule with coefficients imposed from U.S. experience can describe New Zealand monetary policy. It reflects the fact that policy has been largely counter cyclical. However, re-estimating the relationship with New Zealand data shows the expected result that monetary policy has been focused mainly on the inflation target with little weight on output fluctuations, just as required by the Policy Targets Agreements laid down by the government. We also find that policy has been relatively robust to definitions of the output gap. This is fortunate because the output gap is unobservable and large and persistent errors can be made in its

[10] The results presented here use the ex post gap data and are based on the Johansen estimate of the cointegrating vector. They are very similar to the ECM estimates obtained from a model that used real time output gap data.

estimation by the central bank, much to the detriment of the economy as Orphanides (1997) shows for the United States.

More surprising is the finding that a Taylor rule that relates policy to current and past values of output and inflation is not particularly inferior to one that is forward-looking and targeting expected inflation. As the FPS model sets out very clearly, New Zealand policy has been clearly focused on the future, with the current horizon extending six to eight quarters ahead. In part this can be explained by the considerable persistence in policy. Policy has adjusted relatively smoothly and slowly to shocks. Again this experience very much follows the advice from outside experience, whether from Blinder (1998) or Svensson (1997), that inflation targeting policy should be 'flexible' and not rigid and should be restrained in response – if only because we do not know very well how the economy works (Brainard, 1967; Mayes and Razzak, 1998). In the case of the United States Orphanides (1997) found both that a forward looking approach worked rather better. In the New Zealand case we have been able to use the central banks's published forecasts of inflation in order to test whether its policy was forward looking. We have not been able to use their forecasts of the output gap as they simply do not exist in either published or unpublished form for much of the period. Instead, we have constructed output gap forecasts using information from the RBNZ's Economic Forecasts and Monetary Policy Statements.

Orphanides also showed that using just the data available at the time enabled the rule to fit the data rather more accurately in the United States. We found this made little difference. One possible reason could be that the Bank could forecast current inflation and output rather better than the initial official estimates and hence did not suffer from as great an information loss compared to hindsight as one might have imagined. Since the Bank was not using published models for much of our ten year data period we cannot test this accurately. However, since the resumption of publication in 1997 it may again be possible to test this in the future. (There is some evidence that 'real time' data – the information available at the time the decisions are made – are more volatile than their final ex-post counterparts, which would give policy makers at the time more of problem in setting policy than is the case after the event.)

The Taylor rule is symmetric yet we have many reasons for believing that the economy exhibits clear asymmetry over the course of the economy of the cycle (Harris and Silverstone, 1999b; Mayes and Virén, 2000). The 1989–1998 database that we use appears to be too short to indicate this clearly although we find asymmetry in the behaviour of the output gap. In so far as there is asymmetry it is of the expected form with recessions being sharper than recoveries but not so prolonged. The adjustment mechanism also appears to show only limited asymmetry. There is no clear evidence that the Reserve Bank has been more prepared to tolerate recessions than inflationary expansions, although the use of real time data suggests this may have been true for the period after 1995.

Finally it is clear that omitting the exchange rate from the policy formation process in a small open economy like New Zealand leaves out a significant part of the story. The exchange rate has featured as an important element in the various *Monetary Policy Statements*, both as an explanation of the reaction of policy and as part of the adjustment mechanism after shocks (Mayes and Vilmunen, 1999).

Our results do not lead to clear conclusions in favour of rules or discretion. However, what they do show is that whatever the authorities thought at the time, their behaviour conforms quite well to simple inflation targeting rules of the ‘flexible’ form advocated by Svensson (1997) and others. Although output variation may not have been assigned much importance in New Zealand compared to the original Taylor (1993b) specification, this is unlikely to have had much effect on the overall impact of the policy as it is robust to this degree of difference (Amano *et al.*, 1999). Thus on the one hand while central banks may rebel against the idea of following rules (Issing, 1999) the behaviour in the New Zealand case would not have been substantially different if a rule had been followed. On the other if this represents discretion, then following a rule would make little difference. As New Zealand is likely to be towards the more ‘methodical’ end of the spectrum in setting policy over this period as a result of its transparent framework, perhaps its ex-post behaviour is also more likely to appear more rule-like.

References

Amano, R. – Coletti, D. – Macklem, T. (1999) **Monetary Policy Rules when Economic Behaviour Changes.** Monetary Policy Under Uncertainty, Reserve Bank Of New Zealand Workshop Proceedings.

Amtenbrink, F. – de Haan, H. (1999) **The Democratic Accountability of Central Banks: a comparative study of the European Central Bank.**

Archer, D. – Brookes, A. – Reddell, M. (1999) **A Cash Rate System for Implementing Monetary Policy.** Reserve Bank of New Zealand Bulletin, vol. 62(1), 51–61.

Ball, L. (1997) **Efficient Rules for Monetary Policy.** Discussion paper G97/3, Reserve Bank of New Zealand, Wellington, New Zealand.

Bec, F. – Salem, M.B. – Collard, F. (2000) **Nonlinear Monetary Policy Rules: evidence from the US, French and German central banks.** Mimeo.

Black, R. – Cassino, V. – Drew, A. – Hanson, E. – Hunt, B. – Rose, D. – Scott, A. (1997a) **The Forecasting and Policy System: an introduction.** Reserve Bank of New Zealand.

Black, R. – Cassino, V. – Drew, A. – Hanson, E. – Hunt, B. – Rose, D. – Scott, A. (1997b) **The Forecasting and Policy System: the core model.** Research paper 43, Reserve Bank of New Zealand.

Blinder, A.S. (1998) **Central Banking in Theory and Practice.** Cambridge: Cambridge University Press.

Bowden, R. – O'Donovan, B. (1966) **Financial Markets: Volatility and Policy.** 279–314 in B. Silverstone, A. Bollard and R. Lattimore, eds. A Study of Economic Reform: the case of New Zealand, Amsterdam: North Holland

Brainard, W.C. (1967) **Uncertainty and the Effectiveness of Policy.** American Economic Review, vol. 57(3), 411–425.

Bryant, R.C. – Hooper, P. – Mann, C. (1993) **Evaluating Policy Regimes: New Research in Empirical Macroeconomics.** Brookings: Washington DC.

Buiter, W.H. (1981) **The Superiority of Contingent Rules over Fixed Rules in Models with Rational Expectations.** Economic Journal, 91, September, 647–670.

Cassino, V. (1995) **The Distribution of Price Shocks to the New Zealand Economy.** Reserve Bank of New Zealand.

Chan, K.S. (1993) **Consistency and Limiting Distribution of the Least Squares Estimator of a Threshold Autoregressive Model.** The Annals of Statistics 21, 520–533.

Clark, P.B. – Laxton, D. – Rose, D. (1996) **Asymmetry in the US output-inflation nexus: issues and evidence.** IMF Staff Papers, vol. 43, no. 1.

Conway, P. – Hunt, B. (1997) **Estimating Potential Output: a semi-structural approach.** Discussion paper G97/9, Reserve Bank of New Zealand, Wellington, New Zealand.

de Brouwer, G. – O'Regan, J. (1997) **Monetary-Policy Rules: An Application to Australia.** Paper presented at the Reserve Bank of New Zealand Monetary Policy Workshop, October.

Drew, A. – Hunt, B. (1999) **The effects of potential output uncertainty on the performance of simple policy rules.** 73–102 in Monetary Policy under Uncertainty Reserve Bank of New Zealand.

Enders, W. – Siklos, P.L. (1999) **Cointegration and Threshold Adjustment.** Working Paper, University of California, San Diego.

Grimes, A. (1996) **Monetary Policy.** Chapter 8 in B. Silverstone, A. Bollard and R. Lattimore, eds. A Study of Economic Reform: the case of New Zealand, Amsterdam: North Holland.

Guthrie, G. – Wright, J. (1997) **Market Implemented Monetary Policy with Open Mouth Operations.** University of Canterbury, mimeo.

Harris, R. – Silverstone, B. (1999a) **Asymmetric Adjustment of Unemployment and Output in New Zealand: Rediscovering Okun's Law.** University of Waikato Working Paper 99/1.

Harris, R. – Silverstone, B. (1999b) **Asymmetric Adjustment of Unemployment and Output: Cross-country Estimates of Okun's Law.** University of Waikato Discussion Paper 99/2.

Issing, O. (1999) **The Eurosystem: Transparent and Accountable or "Willem in Euroland".** Journal of Common Market Studies, vol. 37(3), 503–520.

Koopman, S.J. – Harvey, A.C. – Doornik, J.A. – Shephard, N. (1995) **STAMP 5.0: Structural Time Series Analyser, Modeller and Predictor.** London: Chapman and Hall.

Laxton, D. – Rose, D. – Tambakis, D. (1997) **The US Phillips curve: the case for asymmetry.** IMF (September).

Mayes, D.G. (2000) **The Operation of Monetary Policy in New Zealand.** Evidence submitted to the Review of Monetary Policy, New Zealand Treasury.

Mayes, D.G. – Razzak, W. (1997) **Transparency and Accountability: Empirical Models and Policy Making at the Reserve Bank of New Zealand.** Paper presented at the Tinbergen Institute, Amsterdam, May.

Mayes, D.G. – Razzak, W. (1998) **Transparency and Accountability: Empirical Models and Policy Making at the Reserve Bank of New Zealand.** Economic Modelling, vol. 15(3), 377–394.

Mayes, D.G. – Riches, B. (1996) **The Effectiveness of Monetary Policy in New Zealand.** Reserve Bank of New Zealand Bulletin, vol. 59(1), 5–20.

Mayes, D.G. – Vilmunen, J. (1999) **Unemployment in a Small Open Economy: Finland and New Zealand.** Bank of Finland Discussion Paper 10/99.

Mayes, D.G – Virén, M. (2000) **Asymmetry and the Problem of Aggregation in the Euro Area.** Bank of Finland Discussion Paper 11/2000.

McCallum, B.T. (1993) **Discretion versus Policy Rules in Practice: Two Critical Points A Comment.** Carnegie-Rochester Conference Series on Public Policy, 39, December, 215–220.

Nicholl, P. (1995) paper presented to SEACEN, Kuala Lumpur.

Orphanides, A. (1997) **Monetary Policy Rules Based on Real-Time Data.** Board of Governors of the Federal Reserve System, December.

Razzak, W. (1997) **The Inflation-Output Trade-Off: Is the Phillips Curve Symmetric? A Policy Lesson from New Zealand.** Discussion paper G97/2, Reserve Bank of New Zealand, Wellington, New Zealand.

Reserve Bank of New Zealand (1997) **The Computation of Underlying Inflation.** Paper prepared by Bernard Hodgetts.

Roger, S. (1998) **Core Inflation: Concepts, Uses and Measurements.** Reserve Bank of New Zealand Discussion Paper G 98/9, July.

Rudebusch, G. (2001) **Term Structure Evidence on Interest Rate Smoothing and Monetary Policy Inertia.** Federal Reserve Bank of San Francisco Working Paper 2001–02.

Sichel, D.E. (1993) **Business Cycle Asymmetry: A Deeper Look.** Economic Inquiry, 31(2), 224–236.

Silverstone, B.D.J. (1978) **A Review of Monetary Policy Reaction Functions with some Preliminary New Zealand Illustrations.** New Zealand Economic Papers, 12, 49–75.

Speight, A.E.H. – McMillan, D.G. (1998) **Testing for Asymmetries in UK Macroeconomic Time Series.** Scottish Journal of Political Economy, 45(2), 158–170.

Svensson, L.E.O. (1997) **Inflation Targeting in an Open Economy: Strict or Flexible Inflation Targeting.** Public Lecture Victoria University of Wellington, November.

Svensson, L.E.O. (2001) **Independent Review of the Operation of Monetary Policy.** Wellington: The Treasury.

Tarkka, J. – Mayes, D.G. (1999) **The Value of Publishing Official Central Bank Forecasts.** Bank of Finland Discussion Paper 22/99.

Taylor, J.B. (1993a) **Macroeconomic Policy in a World Economy: From Econometric Design to Practical Operation.** New York: W.W. Norton.

Taylor, J.B. (1993b) **Discretion versus Policy Rules in Practice.** Carnegie-Rochester Conference Series on Public Policy, 39, 195–214.

Wong, J. – Grimes, A. (1992) **The New Zealand Monetary Aggregates.** In Reserve Bank of New Zealand Monetary Policy and the New Zealand Monetary Financial System, (3rd edn.) Wellington: Reserve Bank of New Zealand.

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