Inter-forecast monetary policy implementation: responding to unexpected exchange rate developments

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Although the stance of monetary policy is primarily determined at a quarterly interval, in the light of a comprehensive inflation projection, the implementation of policy occurs day to day. This article addresses the question: 'how should movements in the exchange rate be taken into account in day-to-day policy implementation?'

In broad terms, there are two options:

- Adopt a presumption, pending the next comprehensive projection, that any unexpected exchange rate movement is a consequence of some other economic event that, for the time being, is unobservable. In this case, the appropriate policy response is to do nothing between inflation reviews, and allow monetary conditions to vary with the exchange rate developments.

- Assume that the movement in the exchange rate has occurred in isolation, in which case the appropriate policy response is to offset these developments by shifting the short-term interest rate. It is this assumption that underlies the use of a Monetary Condition Index (MCI) as a guide to monetary policy implementation – that exchange rate shocks generally occur in isolation.

This article evaluates which of the above assumptions is best for New Zealand when implementing monetary policy. Using the Reserve Bank's model of the economy, the authors show that it is only in the situation when exchange rate changes occur in isolation that maintaining a fixed-MCI during the quarter will result in more stable economic outcomes. However, the evidence that exchange rate shocks do not occur in isolation is overwhelming. In this situation, holding the interest rate fixed between inflation forecasts appears to be the best approach. It leads to smaller required resets in interest rates because there are no inter-forecast adjustment that need to be reversed once a full assessment of the inflation outlook is completed. Further, by reducing the magnitude of required changes in the interest rate once the inflation outlook has been completed, it reduces the risk that inflation control will deteriorate if uncertainty motivates the policymaker to smooth interest rate adjustments.

The work presented comprises some of the analysis that suppported the decision by the Reserve Bank to adopt an Official Cash Rate as the primary instrument of policy implementation, and, before that, to relax and eventually remove the MCI bands that had been used to guide monetary policy implementation between the quarterly *Monetary Policy Statements*.

1 Introduction

Conducting monetary policy with an explicit inflation target involves a sequence of policy decisions. First, a view must be formed on the stance of monetary policy expected to achieve the inflation objective. The decision on the appropriate stance is primarily **formulated** on the basis of economic projections that cover the period over which monetary policy has the strongest influence on inflation. In the case of New Zealand, this involves assessing inflation pressure one to two years ahead. As time moves on and new information comes to hand, policymakers must then decide if, and by how much, their policy stance should be adjusted in order to stay on target. These formal projections are prepared quarterly as this is the period over which the Bank has generally judged that there is sufficient new information to warrant a formal review of the economic outlook.

Once the stance of policy has been formulated, the monetary authority must then decide how to **implement** it. The implementation of policy involves the monetary authority setting its instrument (eg an Official Cash Rate) in order to achieve the required monetary policy stance. Implementation by its nature is continuous, whereas formal assessments of the economy, using new information to develop a fully-revised view of the inflation outlook, is something that can be done only periodically. In this sense, the formulation of monetary policy is infrequent, while the implementation of policy is near continuous.

The question we address in this article is how the chosen policy instrument is best adjusted in the interval between the formal inflation assessments (ie the inter-forecast implementation of monetary policy.) To address this issue, the Reserve Bank's model is used to compare the economic stabilisation properties of a 'fixed-MCI' strategy to a 'fixed-interest rate' strategy. The alternative implementation rules are compared on the basis of their inflation and output stabilisation properties, and their implications for the variability of the policy instrument. In the analysis presented, the policy instrument is assumed to be the 90-day interest rate.[1]

The two alternative implementation rules considered have significant relevance to the recent changes in implementation procedures at the Reserve Bank of New Zealand.

The 'fixed-interest rate' rule, where the official interest rate is adjusted only after a formal assessment of the inflation outlook, is consistent with the recent introduction of New Zealand's Official Cash Rate (OCR). Such a framework also operates in, for example, Australia and the United States, where the official interest rate is altered only after a comprehensive review of the economic outlook.

The alternative implementation rule considered is one that adjusts the policy instrument to keep a Monetary Conditions Index (MCI) constant. In other words, a simple mechanical rule is used to adjust the policy instrument in response to unexpected exchange rate developments that occur between forecasts. The MCI combines the policy instrument (the 90-day interest rate) and the exchange rate according to their relative influence on medium-term aggregate demand outcomes. An MCI-based implementation strategy has been operating with varying degrees of transparency and flexibility in both Canada and New Zealand over recent years.

The results of our simulation analysis suggest that the **inflation** and **output** stabilisation properties of the competing implementation strategies are virtually identical under most circumstances. This result is largely due to the quarterly frequency of formal inflation forecasts and policy resets being sufficient to compensate for any inter-forecast implementation differences.

However, the results also indicate that the **interest rate** adjustments associated with inflation forecasts are larger under the fixed-MCI strategy. The underlying logic of these results is that a predetermined interest rate response to unexpected exchange rate developments may often prove inappropriate, necessitating an interest rate correction at the time of the formal reassessment. In other words, at the time of the formal quarterly reset, the Bank has to reverse some of the interest rate changes because other real factors

[1] Generally if the monetary policy instrument is the cost of short-term liquidity, it will be of shorter duration than the 90-day rate, for example, the interest rate on borrowing cash overnight. However, for the purposes of this analysis the use of a quarterly frequency model necessitates the assumption that the policy instrument be the shortest term interest rate available, ie the 90-day interest rate.

lay behind the exchange rate developments. To minimise the quarterly interest rate reset, it thus appears best to first assess *why* the exchange rate may have changed.

In addition, the simulations also highlight that if the size of the formal interest rate reset was constrained for some reason, then the inflation outcome can become more variable under the fixed-MCI implementation regime. In other words, the monetary authority may not be willing to move interest rates by enough to compensate for both the inflation developments and the inappropriate inter-forecast interest rate changes. It is easy to think of situations when the monetary authority is very uncertain about the outlook and prefers to adjust the stance of policy only gradually. This gradual adjustment behaviour is observed in monetary policy internationally.

Overall, the results suggest that, on average, it is not possible to improve economic outcomes by choosing one implementation approach over the other. The results show that the only time that a mechanical rule such as a fixed-MCI results in better outcomes is when, relative to the most recent inflation forecast, the exchange rate is the **only** thing that is not evolving exactly as projected. In other words, the only unexpected development during the period is a movement in the exchange rate. Generally, however, an unexpected exchange rate change will reflect some other change that the monetary authority must also take into account when formally assessing the stance of policy.

This result is consistent with the increasingly flexible approach the Reserve Bank took to the inter-forecast implementation of monetary policy as 1998 progressed. The MCI was increasingly allowed to drift from the path laid out in the *Monetary Policy Statements* as new information came to light. Implicitly, the Reserve Bank shifted from the fixed-MCI assumption that unexpected exchange rate developments occur in isolation. Instead, under the flexible MCI approach (and new OCR system), the Reserve Bank implicitly assumes that between forecasts, unexpected exchange rate developments reflect events that must be accounted for when setting policy. The best way to account for those events is within the context of a complete inflation forecast. This research suggests that a formal six-weekly, or even quarterly, reassessment of *why* the exchange rate evolved as it did is frequent enough for the Bank to maintain control over medium-term inflation under the vast majority of circumstances. Moreover, pre-announced reassessments reduce financial market nervousness about whether or when the Reserve Bank will change its policy stance.

The remainder of this article is structured as follows. In section 2, a more detailed discussion of the origin of the MCI is presented, along with a discussion of the conditions that would make it an appropriate guide for adjusting the policy instrument between formal assessments of the medium-term inflation outlook. The results from simulation analysis comparing the performance of the alternative implementation strategies are presented in Section 3. Some conclusions and policy implications are offered in Section 4. A very brief outline of the simulation technique used to compare the two alternative strategies is presented in the Appendix.

2 The Monetary Conditions Index

2.1 The MCI as a summary measure of monetary conditions

In an open economy such as New Zealand, the exchange rate has an important influence on inflation developments. Consequently, to achieve low and stable inflation, monetary policy decisions need to factor in the influence of both interest rates and the exchange rate. The important role of the exchange rate arises from both its direct price effects on inflation (via changes in imported goods prices) and through its influence in determining the level of demand for domestically produced goods and services.[2] The difference between that level of demand and the economy's supply capability is viewed to be one of the key determinants of persistent inflationary pressures.

Indices that combine an interest rate and the exchange rate are thus a useful summary measure of overall monetary conditions in an open economy. The weights used to combine interest rates and the exchange rate into a single summary measure are derived from their relative importance in determining the level of aggregate demand. The more important

[2] See Orr, White and Scott (1998) for details about the role of the exchange rate in influencing New Zealand's inflation process.

the short-term interest rate is relative to the exchange rate, the larger the weight given to it in the index. For example, the empirical evidence suggests that for New Zealand, the 90-day interest rate is twice as important as the TWI exchange rate in determining the level of aggregate demand and thus the Monetary Conditions Index (MCI) weights are 2 to 1.[3] In Canada, the MCI weights have been estimated to be closer to 3 to 1.[4]

Consideration of the historical paths of MCIs for several economies shows how MCIs help to provide insight as to why the level of aggregate demand evolved as it did. These insights are often less obvious when considering either the economies' exchange rates or interest rates in isolation. MCIs have also served as an effective communications device for monetary policymakers in explaining current policy actions that are motivated, in part, by the recent historical behaviour of interest rates relative to the exchange rate. The usefulness of MCIs is further reflected by the fact that many international organisations like the IMF and the OECD as well as private firms use them to evaluate the stance of monetary policy in many countries.

2.2 The MCI as a guide to inter-forecast implementation

In addition to the MCI's role as a summary measure of current and past monetary conditions, it has also been used to guide the inter-forecast implementation of monetary policy. Both the Reserve Bank of New Zealand and the Bank of Canada[5] have used the MCI, to varying degrees, to help determine how the short-term interest rate should evolve between inflation forecasts if the exchange rate evolves differently from expectations.

Within an inflation-targeting framework, the forecast objective is to determine the stance for policy that will achieve the medium-term inflation objective. However, because the appropriate interest rate setting is conditional on a projected path for the exchange rate, it becomes convenient to use an MCI to summarise the resulting projected paths for interest rates and the exchange rate. Given the difficulty in accurately forecasting exchange market behaviour, the projected forward path for the MCI also becomes a useful guidepost for policymakers to determine how far monetary conditions are away from those projected when unexpected exchange rate movements occurred.

Further, the economic framework from which the MCI is derived suggests that adjusting the policy instrument to maintain the MCI on its projected path is consistent with achieving the medium-term inflation objective if two key assumptions are satisfied.

- The first assumption is that the **direct-price** effect of the unexpected change in the exchange rate must not have any impact on the medium-term inflation outlook. In other words, the profile projected for aggregate demand before the unexpected change must be expected to yield the same inflation outcome after the change in the exchange rate.
- The second assumption is that the unexpected change in the exchange rate must not reflect the fact that **other key factors influencing aggregate demand** have changed. These could be factors such as the terms of trade or the level of foreign demand for the country's exports. If this condition holds, the same path for monetary conditions should result in the same medium-term profile for aggregate demand. The only difference will be in the 'mix' of monetary conditions and the external/domestic composition of demand.

In practice, no central bank has attempted to fix precisely the level of an MCI between formal medium-term inflation forecasts. However, both the Reserve Bank of New Zealand and the Bank of Canada have used the MCI to guide inter-forecast policy implementation. At the Bank of Canada, the forward profile for the MCI contained in the economic projections is not published. However, when the exchange rate evolves differently than policymakers at the Bank of Canada expect, they decide on the extent to which the projected level of the MCI should be defended inter-forecast.

At the Reserve Bank of New Zealand, the inter-forecast use of the MCI worked slightly differently. The level for the MCI

[3] See Dennis (1997) for details about the empirical estimates of the MCI ratio for New Zealand.

[4] See Duguay (1994) for the empirical estimates of the Canadian MCI ratio.

[5] See Freedman (1994) for a discussion of the use of the MCI as an operational target for monetary policy at the Bank of Canada.

consistent with achieving the inflation objective in the most recent medium-term inflation outlook is published. In the first instance, the decision on how closely to hold monetary conditions to the projected level was left in the hands of the financial markets. However, when the Reserve Bank determined that the market had allowed conditions to drift too far from this level - given the information that had accrued - it signalled this to the market.

Of course, the Bank's decision on how closely to maintain monetary conditions to the projected level evolved as it gained experience with the MCI. In June 1997, when the MCI was first formally introduced the Bank announced 'tolerance bands' around the projected path to constrain the extent to which actual conditions could deviate (the so-called +/- 50 MCI-point bands). However, during 1997 and into 1998, as the extent of the Asian crisis continued to surprise the Bank and the financial market, the MCI was increasingly allowed to drift from its projected path. As the second half of 1998 progressed, the MCI band disappeared completely.

Figure 1 (opposite) highlights the extent, after June 1997, that actual monetary conditions were allowed to deviate from those projected by the Bank for the upcoming quarter. As information came to hand, the actual MCI was able to adjust immediately, primarily driven by exchange rate developments during the Asian crisis. By the end of the third quarter of 1998, the MCI had moved considerably from that projected for the period. At the release of the November 1998 *Monetary Policy Statement*, the Bank acknowledged formally the removal of an explicit MCI band.

The Bank's recently announced shift from a cash volume instrument (ie the settlement cash target) to a cash interest rate instrument (ie the Official Cash Rate), provided an opportunity to reinforce the flexible nature of the MCI. Although the projected MCI will continue to be published, under the OCR scheme the Bank will no longer frame its implementation decision in terms of a 'desired' level for the MCI. If the Bank changes its policy stance, it will shift the OCR. In other words, between formal OCR reviews, the MCI will continue to be permitted to drift from that projected by the Bank.

In summary, the efficacy of an MCI as an inter-forecast guide to monetary policy will depend on how often the two conditions outlined above are satisfied. The structure of the Bank's core FPS model assumes that the first condition is largely satisfied, which is consistent with the available evidence for New Zealand.[6] That is, the direct-price effects of exchange rate changes have very little impact on medium-term inflation outcomes.[7] This leaves the question 'How critical to the performance of MCI-based inter-forecast strategies is the assumption that nothing else influencing aggregate demand has changed?' We turn to consider this question in the next Section.

3 Comparing alternative strategies

The inflation forecast motivating the decision on the setting of monetary policy is based on the information available to policymakers at the time. However, as time moves on, policymakers will acquire more information about any unexpected events that are influencing the current economic outcomes. At first glance, this might suggest that an inter-forecast implementation strategy, that adjusts the short term interest rate in light of new information, has the potential to improve macroeconomic outcomes. One obvious example is offsetting unexpected exchange rate developments with interest rate changes, in other words, defending some MCI level. To test this hypothesis, we use the Reserve Bank's macroeconomic model[8] to compare alternative inter-forecast implementation strategies.

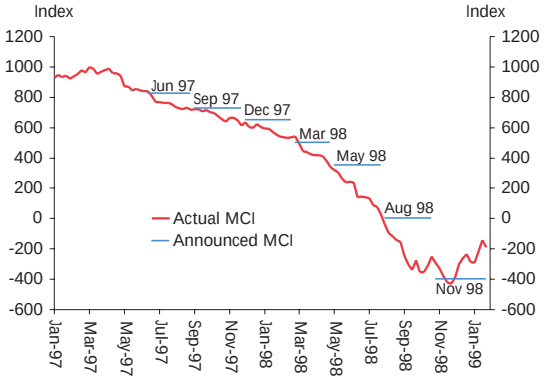
The FPS policy simulations that are used for the analysis have been designed to incorporate the key features of the Bank's policy setting process. In these simulations, a setting for the interest rate is calculated once every quarter, based on the inflation forecast that is formulated using incomplete infor-

[6] The empirical evidence used to support this structure was drawn from the 1987 to 1995 period. For more details on the structure of the Reserve Bank's Forecasting and Policy System (FPS) model and its calibration see Black *et al* (1997).

[7] Policy experiments presented in Conway *et al* (1998) suggest that it is more prudent from the policymaker's perspective to assume that the direct price effects of exchange rate changes do not enter inflation expectations rather than to assume that they do.

[8] A complete description of the structure and properties of FPS can be found in Black *et al* (1997).

Figure 1: Actual and announced MCI developments since 1997



mation about how current and future outcomes will evolve. The forecast process includes:

- A formal quarterly evaluation of the medium-term inflation outlook to determine the required adjustment to the interest rate necessary for projected inflation to be returned to the mid-point of the target band.
- An inflation forecast that is based on incomplete information about the current period's key macroeconomic outcomes, such as the level of real economic activity and inflation.

Policy uncertainty (incomplete information) is generated in this analysis by introducing shocks or 'surprises' that impact on five key macroeconomic variables: the exchange rate, inflation, domestic demand, foreign demand, and New Zealand's terms of trade.[9] The magnitude of these shocks is taken from New Zealand's own historical experience.

Because the efficacy of using the MCI as an inter-forecast guide will most likely depend on the nature of the economic surprises, three different processes for generating the unexpected events are examined.

- First, we consider the full range of shocks that the empirical evidence suggests is most representative of the types of surprises that the New Zealand economy generally experiences.[10]
- Secondly, we remove any surprises to the exchange rate that are caused by other developments. That is, although shocks to foreign demand, the terms of trade, domestic demand, and inflation still occur, their effects on the exchange rate are ignored. What we are left with could be thought of as 'pure' exchange rate shocks, (ie exchange rate shocks that are completely unrelated to any of the other fundamentals.)
- Thirdly, we consider a world where the only source of economic surprise is unexpected changes in the exchange rate. In this world, there are no other economic shocks at all except those to the exchange rate.

In addition to the fixed-interest rate and 2:1 fixed-MCI implementation strategies, we also test a range of less rigid interest rate responses. In these cases, the interest rate is adjusted only partially to the unexpected change in the exchange rate, as opposed to the full adjustment as suggested by their relative weights in the formal MCI. One can usefully think of these strategies as bands around the MCI path contained in the most recent medium-term inflation outlook. The closer the interest rate response is to the fixed MCI case, the narrower is the band around the MCI. The closer is the response to the fixed-instrument case, the wider is the band (ie the interest rate is responding very little to unexpected exchange rate changes).

3.1 The base-case surprise process – the full range of representative shocks

'Which implementation regime results in the least economic variability?'

The base-case structure for the surprises that influence the key economic outcomes includes shocks to the five key variables: domestic demand for goods and services, inflation, the exchange rate, foreign demand for domestically produced goods and services, and the terms of trade that the New Zealand economy faces. The interrelationships between these surprises are also included. For example, this means that surprises that affect foreign demand also influence the exchange rate, the terms of trade, domestic demand and inflation. The statistics presented in table 1 summarise the resulting variability in the key economic variables of interest. The variability presented summarises the deviation each var-

[9] The interested reader can reader can find a relatively non-technical discussion of the simulation technique used for the analysis in the Appendix. A more detailed description of the simulation technique can be found in Drew and Hunt (1998), and a more detailed discussion of the modifications for addressing an inter-forecast question can be found in Hunt (1999).

[10] The empirical tests of alternative shock generating processes are presented in Drew and Hunt (1998).

Table 1: Variability in key macroeconomic variables

Inter-forecast strategy	Root mean squared deviations from equilibrium		
	Output (percent)	CPI inflation (percentage point)	Nominal interest rate (percentage point)
Fixed instrument	3.30	1.15	3.82
Fixed MCI	3.32	1.15	3.85
Tightly banded MCI	3.31	1.15	3.83
Loosely banded MCI	3.30	1.15	3.82

iable averages from its long run, or equilibrium, level. In other words, the statistics summarise the extent to which the economic variables are buffered by the shocks, and for how long this persists. A full description of the calculations exist in the appendix.

The first point to note is that the variability of inflation and output is virtually identical using either the fixed-MCI or fixed-interest rate implementation process. That is, responding between forecasts to unexpected exchange rate developments does not alter the key economic outcomes. However, summary statistics show that responding to unexpected exchange rate developments increases slightly the variability of the policy instrument (ie the 90-day interest rate).[11]

'Which implementation regime results in the smallest quarterly results?'

Although using the MCI as an inter-forecast guide to implementation does not appear to improve macroeconomic performance, it is relevant to ask if a fixed-MCI strategy reduces the required adjustments in the policy instrument at the time of the inflation forecast. A possible argument in favour of a fixed-MCI is that, responding to the unexpected exchange rate changes anticipates what the required change in the interest rate will be once a formal assessment of the medium-term inflation outlook has been completed.

In order to test this idea, we need to examine the magnitude of the change in the interest rate that is required once a formal assessment of the medium-term inflation outlook has been completed. Under the fixed-instrument strategy, the size of the change is simply the average absolute value of the change in the instrument that occurs at the quarterly inflation forecast.

However, under various MCI-based strategies, the instrument is also adjusted throughout the quarter. Thus, the magnitude of change associated with the inflation forecast is the difference between the interest rate setting at the end of the quarter and the new value consistent with the medium-term inflation outlook at the beginning of the next quarter. Statistics summarising the behaviour of the quarterly interest rate change (ie the average absolute value) are presented in table 2.

Relative to the fixed-interest rate case, following a fixed-MCI strategy implies that the required changes in the policy instrument are on average roughly 50 basis points larger. Intuitively, the more loosely banded the MCI, the closer the required changes are to the fixed-instrument case. These results do not support the claim that responding to unex-

Table 2: Behaviour of instrument changes at inflation forecasts

Inter-forecast strategy	Behaviour of the change in interest rate at the inflation forecast (percentage points)			
	Average reset	Minimum reset	Maximum reset	Standard deviation
Fixed instrument	1.32	0.03	4.37	0.99
Fixed MCI	1.79	0.04	6.00	1.36
Tightly banded MCI	1.54	0.03	5.16	1.16
Loosely banded MCI	1.34	0.03	4.45	1.00

[11] It is worth noting that this variability is at the quarterly frequency. Since FPS is a quarterly frequency model, this analysis can shed no light on the implications of these different inter-forecast approaches for the day-to-day variability in interest rates.

Table 3: The implications of constraints on interest rate adjustments

Inter-forecast strategy	Root mean squared deviations from equilibrium		
	Output (percent)	CPI inflation (percentage point)	Nominal interest rate (percent)
Fixed MCI constrained	3.14	1.49	3.35
Fixed MCI unconstrained	3.32	1.15	3.85

	Behaviour of the change in interest rate at the inflation forecast (percentage point)			
	Average reset	Minimum reset	Maximum reset	Standard deviation
Fixed interest rate	1.32	0.03	4.37	0.99
Fixed MCI constrained	1.29	0.03	4.31	0.98
Fixed MCI unconstrained	1.79	0.04	6.00	1.36

pected exchange rate developments, by fixing an MCI, better anticipates where policy will be headed once a formal inflation outlook is considered. Rather, these results suggest that adjusting the policy instrument inter-forecast to offset unexpected exchange rate changes typically takes the instrument away from, rather than towards, what the next inflation forecast will indicate is required.

Adjusting the instrument to hold an MCI fixed over the quarter leaves the monetary authority (on average) in the position of wanting to recant once a more detailed policy assessment has been done. The more detailed inflation forecast factors in the implications for the medium-term inflation outlook of **all** the new information that has been revealed over the period, not just the unexpected change in the exchange rate taken in isolation.

3.2 Constraints on the magnitudes of instrument changes

'Given the larger instrument changes required under the fixed-MCI implementation rule, what would happen if there are constraints on the magnitudes of the instrument adjustments associated with quarterly inflation forecasts?'

Policy decisions are fraught with uncertainty, generally leading policymakers to be conservative in their actions in an effort to avoid reversals and the associated accusations of being unable to make up their minds. Although not all the research on the implications of uncertainty for monetary policy suggests that caution is best, conventional wisdom is to respond cautiously. Much of the research on uncertainty has been motivated by the empirical observations that policymakers historically have behaved more cautiously than would be suggested if there were no uncertainty about how the economy evolves**.**

To examine the implications of constraints on the size of instrument changes associated with inflation forecasts, we replicate the previous experiment for the fixed-MCI strategy. This time, however, we constrain the magnitudes of the interest rate changes associated with inflation forecasts to match those experienced under the fixed-interest rate implementation case. In other words, we do not allow average changes under the fixed-MCI strategy to exceed those under the fixed-interest rate strategy. This is not meant to imply that the interest rate behaviour under the fixed- interest rate strategy in any way reflects the policymaker's true preferences over interest rate variability. Rather the fixed- interest rate case is simply used as a benchmark for comparison.

The results presented in table 3 suggest that if interest rate changes are constrained then inflation variability increases and output variability declines slightly. The increase in inflation variability would add just over 1 percentage point to the inflation target band that could be achieved 90 per cent of the time.[12]

The intuition underlying these results is similar to that outlined earlier. The size of the quarterly (inflation-forecast) interest rate change is larger under a fixed-MCI because it was adjusted unnecessarily inter-forecast. In the unconstrained base-case, however, the instrument change once

[12] The bandwidth that is achievable 90 per cent of the time would increase from –0.4 to 3.4 to roughly –1.0 to 4.0.

an inflation forecast was completed was large and frequent enough to offset the potential negative economic impacts. In this situation, the constrained interest rate adjustment leads to economic outcomes deteriorating.

3.3 Exchange rate surprises that are not related to the other macroeconomic surprises – the case of "pure" exchange rate shocks

'What if exchange rate surprises are completely unconnected to the other macroeconomic surprises ie unrelated to fundamentals?'

One condition for making the MCI an optimal strategy for responding to unexpected exchange rate surprises is that they are unrelated to other factors that affect aggregate demand. It has thus been argued that the higher the ratio of 'pure' exchange rate shocks to other surprises, the better MCI-based implementation rules will perform. The simulation techniques we use incorporates surprises to the exchange rate that, in part, arise from other factors such as foreign demand and terms of trade shocks. Consequently, it may just be that only a few of the exchange rate surprises used in the experiment actually satisfy the pure exchange rate shock condition. To test if this is the reason underlying the previous results in table 3, we repeat those experiments. But, this time we do not include any exchange rate surprises that are related to other macroeconomic surprises. The results are presented in tables 4 and 5. Output and inflation variability is unchanged. Under the MCI-based strategies, the size of the change in the interest rate associated with a quarterly inflation forecast is slightly higher relative to the fixed interest rate implementation rule. In short, although the magnitudes of the increases in the required quarterly reassessments under the fixed- and banded-MCI strategies are smaller, the same qualitative story as before prevails. The results suggest that the effectiveness of a fixed- or banded-MCI strategy does not depend on the proportion of exchange rate surprises that are unrelated to the other macroeconomic surprises. It still appears that it is other macroeconomic surprises that are, on average, dominating the change in the medium-term inflation outlook.

3.4 A world of only exchange rate surprises

'What nature of macroeconomic surprises would have to exist before fixing or banding the MCI improved macroeconomic outcomes?'

The results to this point suggest that under MCI-based strategies, macroeconomic performance is virtually identical to that achieved by following a fixed-interest rate strategy. The obvious question becomes 'When does holding an MCI fixed improve macroeconomic performance?' To investigate this

Table 4: Variability in key macroeconomic variables

Inter-forecast strategy	Root mean squared deviations from equilibrium		
	Output (percent)	CPI inflation (percentage point)	Nominal interest rate (percent)
Fixed interest rate	1.65	0.72	2.15
Fixed MCI	1.65	0.71	2.16
Tightly banded MCI	1.65	0.71	2.15
Loosely banded MCI	1.65	0.72	2.15

Table 5: Behaviour of interest rate changes at inflation forecasts

Inter-forecast strategy	Behaviour of the change in interest rate at the inflation forecast (percentage points)			
	Average reset	Minimum reset	Maximum reset	Standard deviation
Fixed interest rate	0.80	0.02	2.70	0.60
Fixed MCI	0.92	0.02	3.04	0.69
Tightly banded MCI	0.84	0.01	2.79	0.64
Loosely banded MCI	0.80	0.02	2.67	0.60

question, the simulation experiment is repeated, but with surprises impacting only on the exchange rate. The results are presented in table 6. They indicate that, in a world of only exchange rate surprises, macroeconomic variability is reduced holding an MCI fixed relative to holding an interest rate fixed. The improvement, however, is relatively small. The magnitudes of the quarterly resets are minimised when the MCI is fixed inter-forecast.[13]

In practice, of course, it is never the case that the only source of shocks is those to the exchange rate. Surprises will occur in the outcomes of domestic output, world demand, the terms of trade, and so on. Given that these surprises will arise, a fixed-interest rate will result in a smaller instrument adjustment being necessitated at the time of the formal projections of medium-term inflation pressures, with no difference in macroeconomic outcomes.

Table 6: Variability in key macroeconomic variables

Inter-forecast strategy	Root mean squared deviations from equilibrium		
	Output (percent)	CPI inflation (percentage point)	Nominal interest rate (percent)
Fixed interest rate	1.08	0.70	2.53
Fixed MCI	0.98	0.63	2.45
Tightly banded MCI	1.01	0.65	2.45
Loosely banded MCI	1.06	0.69	2.50

4 Summary and conclusion

For open economies such as New Zealand, Monetary Conditions Indices (MCIs) that combine an interest rate and the exchange rate have proved to be, and remain, useful summary measures of the path of monetary conditions. This arises because of the important role that both interest rates and the exchange rate play in determining the medium-term inflation objective of monetary policy. However, the use of MCIs has been expanded to include guiding inter-forecast adjustments to the interest rate in response to unexpected exchange rate changes. In this article we have presented simulation results from the Reserve Bank's macroeconomic model (FPS) that answer the question 'under what conditions is it appropriate to use the MCI as a guide to inter-forecast instrument adjustments?' The results suggest that, relative to following a fixed-interest rate strategy, holding an MCI fixed can improve macroeconomic performance **only if** surprises to the exchange rate are the **sole source** of unexpected macroeconomic variability. When there are other surprises that affect economic outcomes and when those surprises are interrelated, following a fixed- or banded-MCI strategy does not reduce the variability of output or inflation. Additionally, using the MCI as a guide to inter-forecast instrument adjustment can lead to larger required changes in the policy instrument once a full assessment of the medium-term inflation outlook has been completed. If there are constraints placed on the magnitudes of the changes in the policy instrument once the medium-term inflation outlook is considered, holding an MCI fixed inter-forecast can lead to greater variability in inflation.Taken together, these results provide some of the economic motivation for the Reserve Bank's increasingly flexible use, during 1998, of the MCI as an inter-forecast guide to policy implementation. The Bank's MCI was first formally published in the June 1997 *Monetary Policy Statement*, along with a conditional band. Soon after, however, as information came to hand that there were very important real factors driving the unexpected evolution of the exchange rate (primarily the deteriorating Asian financial situation), the Bank's flexibility regarding the inter-forecast MCI level increased. Since the middle of 1998 at least, the real factors driving the exchange rate have taken precedence in determining how monetary conditions should be allowed to evolve between formal economic projections. The introduction of an OCR in March 1999, with discrete 6-

[13] For this result to hold, the base-case policy rule needs to be efficient. The interested reader can find a more detailed discussion of this point in Hunt (1999).

weekly reset opportunities for implementing policy, is consistent with this shift of the MCI to summary-measure status and its removal from inter-forecast policy implementation.

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Appendix: The simulation technique for comparing alternative inter-forecast strategies and measures of variability

This appendix outlines the technique used to evaluate the alternative inter-forecast-implementation strategies ie a fixed-MCI or a fixed-interest rate rule. First a relatively non-technical description of a stochastic simulation technique using FPS is presented with a focus on how it approximates the monetary policy setting process. Second a discussion of how the simulation technique is modified so that the quarterly-frequency-modelling framework can be used to evaluate alternative inter-forecast implementation strategies is presented. A more detailed description of the stochastic simulation technique can be found in Drew and Hunt (1998), and a more detailed discussion of the modifications for addressing an inter-forecast question can be found in Hunt (1999).

Policy experiments – stochastic simulations

To compare alternative inter-forecast implementation strategies we use the Reserve Bank of New Zealand's macroeconomic model FPS under policy experiments called stochastic simulations.[14] These stochastic simulations are designed to incorporate the key features of the Bank's policy setting process. The key features include:

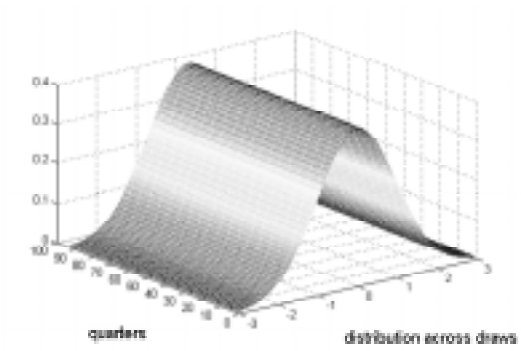
- A formal quarterly evaluation of the medium-term inflation outlook to determine the required adjustment to the policy instrument necessary for projected inflation to be returned to the mid-point of the target band.
- An inflation forecast that is based on incomplete information about the current period's key macroeconomic outcomes, such as the level of real economic activity and inflation.

Policy uncertainty (incomplete information) is generated in the analysis by introducing shocks or 'surprises' that impact on five key macroeconomic variables: the exchange rate,

[14] A complete description of the structure and properties of FPS can be found in Black *et al* (1997).

inflation, domestic demand, foreign demand, and New Zealand's terms of trade. The magnitude of these shocks is taken from New Zealand's own historical experience. The incidence of shocks is generated randomly to produce long sequences of hypothetical macroeconomic surprises that could hit the economy. For each alternative strategy considered, we run 100 different sequences of shocks (draws) for 100 quarters into the future (ie 25 years). We can then calculate a distribution of outcomes for economic variables such as inflation, output, interest rates and the exchange rate for each quarter across the 100 draws. These distributions can be averaged over the entire 100-quarter period. See figure 2 for a graphical representation of the distributions for each quarter that are averaged to produce the summary statistics presented in the tables in the article.

Figure 2: Hypothetical distributions across draws



The technique for generating the macroeconomic surprises also accounts for the interaction amongst those surprises. For example, surprises to foreign demand or the terms of trade often affect the exchange rate as well. This cross-correlation dimension is captured because it is particularly important for evaluating inter-forecast strategies. Using the MCI as an inter-forecast guide embodies some key assumptions regarding the source of exchange rate surprises and it is important to test how restrictive that assumption is.

Addressing the inter-forecast implementation issue

To use a quarterly frequency model like FPS to address an inter-forecast issue requires a slightly different simulation technique than is normally used. The technique relies on a multi-step procedure for calculating the relevant setting for the policy instrument. The multi-step procedure incorporates adjustments to the initial instrument setting that replicate how the use of an MCI as an inter-forecast guide would affect the instrument setting. The real-time information constraints faced by the monetary authority are respected.

First, consider how the process works under a fixed-interest rate inter-forecast strategy. The first step is to calculate the instrument setting based on a full assessment of the medium-term inflation outlook. The policy stance is calculated based on the available information and a model of the economy (FPS). The information available includes:

- **current** values of the exchange rate and interest rates.
- **last quarter's** outcomes for all other macroeconomic variables.
- **projected values** for important exogenous macroeconomic variables such as foreign demand and interest rate levels.

The instrument setting is then determined using the model's policy rule - which sets the instrument (ie 90-day interest rate) to return inflation to the midpoint of the target range in the medium term. The current period's macroeconomic outcomes are determined in the second step using the model, the interest rate setting calculated in the first step, and surprises that occur during the period ie unexpected developments in inflation, domestic demand, foreign demand and the terms of trade. That period's economic outcomes then become part of the policymaker's information set at the start of the next period's reset and the process is repeated.

For the case of the fixed-MCI inter-forecast strategy, an extra step is needed to calculate the instrument setting that determines the current period's macroeconomic outcome. Because the policymaker can observe the path of the exchange rate as it moves between forecasts, it can adjust its

instrument in response to unexpected developments. To capture this, the quarterly instrument setting is adjusted to take account of the unexpected part of the movement in the exchange rate that occurs during the quarter. For example, if during the quarter there was an unexpected 2 per cent increase in the exchange rate, the initial policy instrument setting would be decreased by 1 percentage point during the period.[15] This would maintain the MCI at the level determined by the full medium-term inflation outlook of the first step. The MCI-adjusted instrument setting, the model and the period's surprises then determine the macroeconomic outcome. The key difference here compared to the fixed-instrument case is that the exchange rate surprise has been factored in to the instrument setting using a mechanical adjustment based on fixing the MCI.

Following the above instrument setting process, stochastic simulations are used to generate long sequences of hypothetical macroeconomic outcomes under each alternative inter-forecast strategy. The same set of unexpected surprises is used to generate these long sequences of outcomes for each alternative so that they can be compared under identical conditions. To generate these hypothetical macroeconomic outcomes, 100 experiments (draws) running for 100 sequential quarters are conducted for each of the alternative strategies considered. Because of the multi-step instrument setting process used, the set of summary statistics presented for each alternative inter-forecast strategy in the article requires 200,000 model simulations to generate.

Measures of variability

To calculate the root mean squared deviation (RMSD) for output and the real exchange rate displayed in the tables the following formula is applied:

$$\text{RMSD(y)} \quad \left(\frac{1}{D}\right)\sum_{d=1}^{D}\sqrt{\left[\left(\frac{1}{\text{T -1}}\right)\sum_{t=1}^{T}\left(\frac{y_{t,d}-ycon_t}{ycon_t}\right)^2\right]}$$

where:

D is the number of draws in the stochastic simulation experiments

T is the time frame over which the stochastic simulations are run for an individual draw, d.

$y_{t,d}$ is the model solution for a variable y at time t for draw d.

$ycon_t$ is the equilibrium or 'control' value for the variable y at time t.

Similarly, for CPI inflation and the nominal interest rate the RMSD statistic is calculated as:

$$\text{RMSD(y)} = \left(\frac{1}{D}\right)\sum_{d=1}^{D}\sqrt{\left[\left(\frac{1}{\text{T -1}}\right)\sum_{t=1}^{T}\left(y_{t,d}-ycon_t\right)^2\right]}$$

[15] The proxy used to capture the *ex post*-unexpected change in the exchange rate was that from the fixed-interest rate simulations. The stochastic experiments used exactly the same set and ordering of shocks for both the fixed MCI and fixed interest rate implementation strategies. Consequently, calculating the unexpected change in the exchange rate from the fixed-interest rate case provides a very good proxy for the unexpected exchange rate change under the other intra-forecast strategies. Further details are provided in Hunt (1999).