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# Inter-forecast monetary policy implementation: fixed-instrument versus MCI-based strategies

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## Abstract[1]

Monetary policy authorities can adjust their instrument at any point in time to achieve their policy objective. In some countries, such as the United States and the United Kingdom, policymakers choose to usually make adjustments only after a formal medium-term inflation forecast. Other countries, like Canada and New Zealand, have used simple inter-forecast strategies to make further instrument adjustments given unexpected developments in the exchange rate. These alternative strategies may be usefully thought of as fixing or banding a measure of "monetary conditions" that is comprised of the exchange rate and a short-term interest rate that is closely linked to the policy instrument. Such measures have come to be referred to as Monetary Conditions Indices (MCI).

The research presented in this paper uses the Reserve Bank of New Zealand's macroeconomic model to examine the stabilisation properties of various inter-forecast instrument-adjustment strategies used by a monetary authority that targets inflation. The results indicate that, in most cases, adjusting the policy instrument inter-forecast to fix or band an MCI does not reduce the variability of inflation or output relative to holding the instrument fixed. However, in the special case where the only source of macroeconomic variability is unexpected shocks to the exchange rate, fixing an MCI does reduce inflation and output variability. Furthermore, in all but the special case, the MCI-based strategies lead to larger adjustments in the policy instrument once the next inflation forecast is considered. Consequently, if policymakers are averse to large changes in the policy instrument, following an inter-forecast MCI-based strategy can increase inflation variability relative to the fixed-instrument strategy.

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# 1 Introduction

The adoption of explicit or implicit inflation targets has resulted in considerable convergence in the process for formulating monetary policy across many industrialised countries.[2] This characterisation of monetary policy formulation as ‘inflation forecast targeting’ is formalised in Svensson (1997). When deciding what the current policy stance should be, policymakers consider, among other things, how inflation is likely to evolve into the future. Once policymakers have decided on the appropriate stance, policy formulation gives way to implementation, the process of adjusting the chosen instrument of monetary policy to achieve the desired stance. Here also, there has been considerable convergence as many central banks adjust the cost of short-term liquidity to achieve their desired policy stance. Although the medium-term inflation assessments generally occur at discrete points in time, policymakers also have the option of adjusting instrument settings in the interval between these formal assessments. This is an area of implementation where differences appear across central banks. Many central banks, such as the Federal Reserve System and the Bank of England, usually adjust their policy instruments only after formal inflation assessment. Others, like the Reserve Bank of New Zealand and the Bank of Canada[3], either rely, or have relied on simple rules of thumb to guide adjustments in the policy instrument between inflation forecasts. In this paper, the macroeconomic stabilisation properties of these alternative approaches to policy implementation are compared.

The frequency with which monetary authorities produce inflation forecasts is determined largely by the frequency with which new information on key macroeconomic data becomes available. In countries where sufficient new data is available monthly, formal inflation reviews tend to be more frequent. For example, in the United States and the United Kingdom inflation reviews occur 6 weekly and monthly respectively. In countries where new information is available less frequently, new inflation forecasts tend to only be prepared quarterly. This is the case in Canada and New Zealand. Although it is clear why these information constraints influence forecasting frequency, not all important information is available only at discrete intervals. The exchange rate is one important financial price, particularly for open economies, that is observable immediately and continuously. The inter-forecast implementation strategies used by the Reserve Bank of New Zealand and the Bank of Canada to adjust the instrument settings between inflation forecasts have done so in response to unexpected movements in the exchange rate. One can think of these inter-forecast strategies as trying to improve macroeconomic performance by responding quickly to the information contained in unexpected exchange rate movements.

The notion that responding quickly to unexpected developments in the exchange rate might improve the stabilisation properties of monetary policy reflects the important influence that the exchange rate has on the inflation objective. In open economies,

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2 New Zealand, Canada, Australia, the United Kingdom, Sweden, Israel and the European Central Bank all have formal inflation targets. Monetary policy in many other countries such as the United States can be thought of as having implicit inflation targets. Some empirical evidence supporting this can be found in Clarida, Gali, and Gertler (1997).

3 See Freedman (1994) for a discussion of how the MCI has been used as an operational target for monetary policy in Canada.

there are two channels through which the exchange rate can influence inflation. The first is the direct effect that movements in the exchange rate have on the prices of imported consumption, investment and intermediate goods. The second is the indirect effect on demand by the external sector and domestic agents for the goods and services produced in the economy. The level of that demand relative to the economy's productive capacity is generally viewed to be the primary source of persistent inflationary pressures. Because of the important influence of the exchange rate on the inflation forecast in an open economy, the policy instrument setting is conditional on a projected path for the exchange rate. Consequently, if the exchange rate turns out to be different than projected, it is possible that macroeconomic outcomes could be improved by adjusting the initial instrument setting in light of that new information.

In practice, the relative short-term interest rate and exchange rate elasticities of demand have been used to guide how much the policy instrument has been adjusted given the unexpected changes in the exchange rate. The relative demand elasticities of these two components have also been used to combine them into Monetary Conditions Indices (MCIs), summary measures of the influence of domestic and foreign monetary conditions on the level of a country's aggregate demand. The forward path for a country's MCI that is contained in the most recent inflation forecast can be interpreted as the path for monetary conditions consistent with achieving the inflation objective. Consequently, one can think of the inter-forecast implementation strategies that are based on the relative interest and exchange rate elasticities of demand as fixed- or banded-MCI strategies.

There are two implicit assumptions embodied in the notion that the inflation objective will be achieved by maintaining a previously-determined level of monetary conditions in the face of unexpected exchange rate movements.

- The first is that the direct effect of the exchange rate movement on imported goods prices will not become entrenched in generalised inflation expectations. That is, the same demand conditions projected prior to the unexpected exchange rate movement will yield similar medium-term inflation outcomes after the unexpected exchange rate movement.

- The second assumption is that the exchange rate movement is itself in no way related to changes in other real factors in the economy that influence demand conditions. As a result, the same level of monetary conditions prior to the unexpected exchange rate movement will yield similar demand conditions after the movement.

These two conditions can be placed in the more formal framework initially set out in Poole (1970). Poole demonstrates that the choice of the optimal policy instrument depends on the structure of the economy and the stochastic disturbances to which it is subjected. The condition that the direct-price effect of exchange rate movements does not become entrenched in inflation expectations relates to the structure of the economy. The condition that unexpected changes in the exchange rate do not reflect changes in other factors influencing aggregate demand relates to the nature of the stochastic disturbances to which the economy is subjected.

In New Zealand, the inter-forecast operation of the MCI worked as follows. The level for monetary conditions contained in the most recent economic projection was, and will continue to be, public information and the decision of how closely to maintain monetary conditions to this level was, in the first instant, left to market participants. However, if the Reserve Bank determined that the market had allowed conditions to drift too far from this level, it signalled this information to the market. Ultimately, the Reserve Bank could have adjusted the quantity of liquidity in the payments system to ensure that the market outcome for the level of monetary conditions was as desired.

In Canada, the inter-forecast decision about how closely to maintain monetary conditions to the track contained in the most recent inflation forecast is made by the monetary authority. Short of undertaking a new inflation forecast, policymakers evaluate the likelihood that the two conditions outlined above will hold in the situation at hand. The extent to which they shift the policy instrument to remain close to the most recent forecast path for monetary conditions reflects the degree to which they feel that the two conditions are satisfied.

In this paper, the macroeconomic stabilisation properties of MCI-based inter-forecast implementation strategies, such as those used by the Reserve Bank of New Zealand and the Bank of Canada, are compared to the stabilisation properties of a fixed-instrument strategy, such as those used in the United States and the United Kingdom. The strategies are ranked based on their relative performance in reducing the variability in inflation, output, interest rates and the exchange rate. Neither the Reserve Bank of New Zealand nor the Bank of Canada has ever held their respective MCI completely fixed between inflation forecasts. Therefore, several MCI-based inter-forecast implementation strategies are compared to the fixed-instrument strategy. The fixed-MCI strategy corresponds to the case where the instrument is adjusted to precisely offset *all* unexpected movements in the exchange rate. The tightly-banded-MCI strategy offsets *most* of the unexpected movement in the exchange rate and the loosely-banded-MCI strategy offsets only a *small portion*. The fixed instrument strategy contains absolutely *no response* to the unexpected change in the exchange rate that occurs between inflation forecasts. Stochastic simulations of the Reserve Bank's *Forecasting and Policy System* (FPS) model are used to generate the data for comparison.

The results suggest that fixing or banding an MCI does not materially alter the variability of real output and inflation relative to the case where the interest rate is held fixed over the quarter. This result, however, is conditional on there being no constraint on the magnitude of the change in the instrument once a full inflation forecast has been completed. Under MCI-based inter-forecast strategies, the magnitude of the required change in the instrument, once an inflation forecast is completed, is larger. If constraints are placed on the magnitudes of the changes in the instrument, then fixing or banding an MCI rather than fixing the instrument can lead to an increase in inflation variability. In the special case where the economy is subjected *only* to exchange rate shocks, MCI-based inter-forecast strategies reduce inflation and output variability slightly, without inducing more interest rate variability.

It is worth noting that as of 17 March 1999, the Reserve Bank of New Zealand moved to a fixed-instrument strategy and away from an MCI-based implementation approach.

At that time, the Official Cash Rate became the policy instrument. The Reserve Bank announced that it would normally adjust the level of the Official Cash Rate eight times each year. Four of those would be associated with the regular quarterly inflation forecasts and the expectation is that most of the significant changes in the policy instrument will occur at those times. The four inter-forecast opportunities will allow for further adjustments in the instrument if there are exceptional economic events that have clear implications for the inflation objective or if a cautious instrument adjustment appears prudent.

The remainder of the paper is structured as follows. Section 2 contains a brief description of the core FPS macroeconomic model. Section 3 provides some motivation for why inter-forecast adjustment of the instrument might improve macroeconomic outcomes. The simulation technique used to address the continuous-time inter-forecast question is outlined in section 4, along with the comparison of the macroeconomic outcomes achieved under various inter-forecast strategies. As outlined in Poole (1970) the efficacy of the MCI-based inter-forecast strategies will depend, in part, on the characterisation of the shock-generating process. In recognition of this, the robustness is checked under alternative characterisations of the process generating the stochastic disturbances. The implications of the monetary authority making errors on the relative interest rate and the exchange rate elasticities of demand are examined in section 5. A brief summary is presented in section 6.

## 2 The Forecasting and Policy System Model (FPS) [4]

The Reserve Bank's *Forecasting and Policy System* consists of a set of models that together form the framework for generating economic projections and conducting policy analysis. The system consists of the core macroeconomic model, indicator models and satellite models. To prepare economic projections, all the models in the system are used. To conduct policy analysis, like that presented in this paper, just the core macroeconomic model is used.

The core FPS model describes the interaction of five economic agents: households, firms, a foreign sector, the fiscal authority and the monetary authority. The model has a two-tiered structure. The first tier is an underlying steady-state structure that determines the long-run equilibrium to which the economy converges. The second tier is the dynamic adjustment structure that traces out how the economy converges towards that long-run equilibrium.

The long-run equilibrium is characterised by a neoclassical balanced growth path. Along that growth path, consumers maximise utility,[5] firms maximise profits and the fiscal authority achieves exogenously-specified targets for debt and expenditures. The foreign sector trades in goods and assets with the domestic economy. Taken together,

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[4] See Black, Cassino, Drew, Hansen, Hunt, Rose and Scott (1997) for a more complete description of the FPS core model.

[5] The specification is based on the overlapping generations framework of Yaari (1965), Blanchard (1985), Weil (1989) and Buiter (1989), but in a discrete time form as in Frenkel and Razin (1992) and Black *et al* (1994).

the actions of these agents determine expenditure flows that support the set of stock equilibrium conditions underlying the balanced growth path.

The dynamic adjustment process overlaid on the equilibrium structure embodies both “expectational” and “intrinsic” dynamics. Expectational dynamics arise through the interaction of exogenous disturbances, policy actions and private agents’ expectations. Policy actions are introduced to re-anchor expectations when exogenous disturbances move the economy away from equilibrium. Because policy actions do not immediately re-anchor private expectations, real variables in the economy must follow disequilibrium paths until expectations return to equilibrium. To capture this notion, expectations are modelled as a linear combination of a backward-looking autoregressive process and a forward-looking model-consistent process. Intrinsic dynamics arise because adjustment is costly. The costs of adjustment are modelled using a polynomial adjustment cost framework (see Tinsley (1993)). In addition to expectational and intrinsic dynamics, the behaviour of the fiscal authority also contributes to the overall dynamic adjustment process.

On the supply side, FPS is a single good model. That single good is differentiated in its use by a system of relative prices. Overlaid on this system of relative prices is an inflation process. While inflation can potentially arise from many sources in the model, it is fundamentally the difference between the economy’s supply capacity and the demand for goods and services that determines inflation in domestic prices. Further, the relationship between goods-markets disequilibrium and inflation is asymmetric. Excess demand generates more inflationary pressure than an identical amount of excess supply generates in deflationary pressure.[6] Although direct exchange rate effects have a small impact on domestic prices and, consequently, on expectations,[7] they enter consumer price inflation primarily as price level effects (see Section 3 for more details). The monetary authority effectively closes the model by enforcing a nominal anchor. Its behaviour is modelled by a forward-looking reaction function that moves the short-term nominal interest rate in response to projected deviations of inflation from an exogenously specified target rate. The policy reaction function responds to deviations in annual CPI inflation[8] from the targeted rate 6, 7 and 8 quarters ahead. In other words, the model’s reaction function characterises monetary policy as “inflation-forecast targeting” as per Svensson (1997).[9]

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6 Although the empirical evidence supporting asymmetry in the inflation process in New Zealand and elsewhere is growing, the most convincing argument for using asymmetric policy models is the prudence argument present in Laxton, Rose, and Tetlow (1994).

7 The direct exchange rate effect on domestic prices is assumed to arise through competitive pressures.

8 The FPS definition of consumer prices does not include credit charges and so is analogous to SNZ CPIX.

9 In Svensson (1997), the policy reaction function is the solution to an optimal control problem and as such is specified in terms of state variables. The FPS reaction function is specified in terms of model-consistent expected inflation and can be thought of as a restricted version of the more general specification in Svensson.

In the model, the primary channel through which monetary policy achieves its objective is via its influence on the level of demand for goods and services relative to the economy's supply capacity (ie the output gap). The open economy dimension means that both interest rates and the exchange rate have important influences on the level of demand for goods and services. Interest rates reflect the relative cost of consuming and investing today versus tomorrow. Consequently, interest rates affect aggregate demand through their impact on the intertemporal consumption/savings decisions of households and the intertemporal investment decisions of firms. The exchange rate influences aggregate demand through its impact on the relative price of domestically- versus foreign-produced goods.

## 3 Motivating inter-forecast instrument adjustments

Deterministic simulation experiments using FPS are presented in Figure 1 to illustrate the conditions under which fixing an MCI would be the appropriate response to an unexpected change in the exchange rate. All variables in the figure are expressed in shock-minus-control terms. The solid lines trace out the model's response following a temporary disturbance to aggregate demand. The dashed lines trace out the path if a temporary disturbance to the exchange rate is added to the demand disturbance. This exchange rate disturbance can be thought of an autonomous temporary shift in the risk premium on New Zealand assets demanded by investors. It is unrelated to any other real factors or fundamentals that influence aggregate demand. One can interpret the solid line as an initial inflation forecast. The dashed line can be interpreted as what would have resulted if the day after the initial inflation forecast was completed, an unexpected depreciation in the exchange rate occurred and the inflation forecast was completely redone based on the new expected exchange rate path. The extent to which the resulting paths for the constructed MCI are identical under the two simulations reflects the extent to which simply adjusting the instrument to hold the MCI fixed at its initially forecasted path would have been the appropriate response and would have obviated the need to re-compute the inflation forecast.

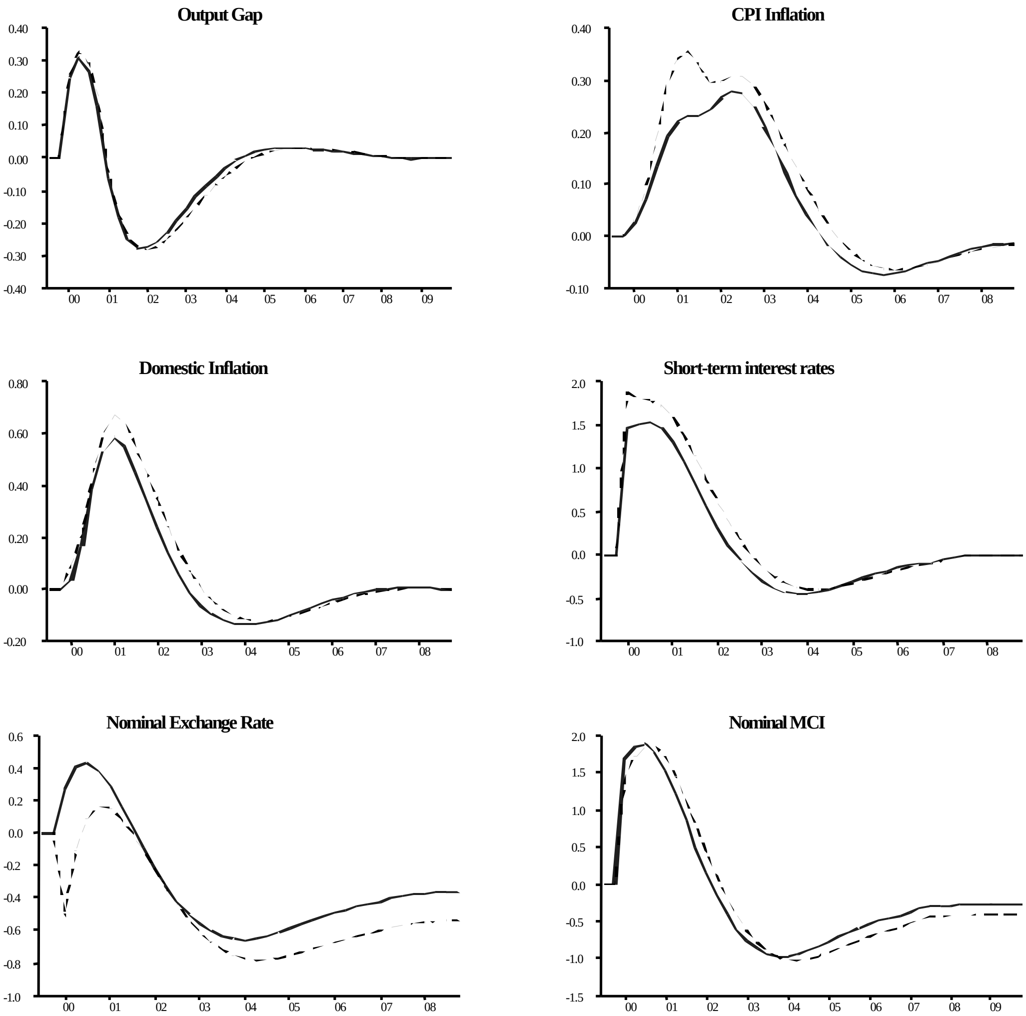
The path for the MCI, constructed using relative weights on the policy instrument and the exchange rate of 2:1,[10] is consistent with returning inflation to the middle of the target band, 1.5 per cent. The path for the instrument, assumed to be the 90-day interest rate, is determined by the model's forward-looking policy reaction function. The exchange rate path is determined largely by the uncovered-interest-parity (UIP) condition in the model's exchange rate equation. The dashed line is the path for monetary conditions that would result if the monetary authority correctly perceived both the demand shock and the exchange rate disturbance. The proximity of the dashed MCI path to the solid MCI path indicates that simply fixing the MCI path mechanically would yield virtually identical monetary conditions to those that arise from redoing the forecast using the new exchange rate path.

[10] The empirical evidence supporting this choice for the weights in New Zealand can be found in Dennis (1997). Empirical evidence on the relative weights used in Canada can be found in Duguay (1994).

The small differences that do arise are due to the structure of the model. FPS has been calibrated to be 2:1 in terms of the relative importance of interest rates and the exchange rate in determining aggregate demand over the medium term. However, this is not sufficient to ensure that the fixed-MCI strategy will be appropriate. The small difference in the two MCI paths in the figure arises from two sources. The first is that the direct effect of the exchange rate on prices does partially flow through to inflation expectations. This reflects the fact that movements in the prices of exports and imports alter domestic competitive pressures, leading to changes in the prices of domestically produced and consumed goods that influence inflation expectations. This can be seen in slightly higher domestic price inflation, given the addition of the exchange rate disturbance. However, the profile for CPI inflation illustrates that the bulk of the direct exchange rate effects in the CPI are primarily level effects that dissipate quite quickly. The second reason for the slight difference between the two MCI paths is because of the different timing of interest rate and exchange rate effects on aggregate demand and the asymmetric interaction of demand conditions and inflation. The exchange rate affects net exports faster than the interest rate influences consumption and investment. Consequently, a slightly larger output gap initially opens up and inflation accelerates more. The nature of the asymmetry in the inflation process means that proportionally more excess supply is required to reduce inflation than initially caused it to rise. Policy must therefore be slightly tighter once these influences are factored into the inflation outlook.

The difference between the two MCI paths in the figure illustrates that the impact of these two effects is relatively small. Fixing the MCI mechanically in the face of this unexpected exchange rate surprise would yield virtually the same policy stance as would be derived by re-computing the inflation forecast using the new exchange rate path. This simulation result suggests that responding early to exchange rate surprises, by adjusting the policy instrument inter-forecast using a fixed- or banded-MCI strategy, may potentially improve macroeconomic outcomes. Essentially the policymaker can make roughly the same adjustment following the simple rules as would be made at the next inflation forecast if the only change incorporated is the surprise to the exchange rate. Using the mechanical rules allows the policymaker to respond earlier. The stochastic policy experiments to which we now turn, check the robustness of this result when we relax the restrictions, satisfied in this determinist experiment, on the nature of the shocks that hit the economy.

**Figure 1**
Shock minus Control
(Demand shock - solid, Demand and Exchange Rate shock - dashed)




## 4 Evaluating inter-forecast strategies

In this section, the macroeconomic stabilisation properties of the alternative inter-forecast strategies are compared. Stochastic simulations of FPS are used to generate the data for comparison. The stochastic simulation technique is outlined in Drew and Hunt (1998). Some extensions to the core FPS model have been subsequently incorporated and these are detailed in appendix 1. Because FPS is a quarterly model, a multi-step procedure is used to calculate an average quarterly value for the instrument setting that is used by the model to solve for the macroeconomic outcomes. This multi-step procedure allows the continuous adjustment that occurs under MCI-based inter-forecast implementation strategies to be incorporated into the instrument's average value in each quarter.

The deterministic simulations presented in section 3 illustrate the economic motivation for holding an MCI fixed between forecasts in the face of unexpected shifts in the exchange rate. In practice this requires continual adjustment of the instrument in response to the inter-forecast evolution of the exchange rate. The multi-step procedure captures the effect of this continuously-adjusting instrument by calculating three interest rate values for the period. The first is the start-of-period value that corresponds to the instrument setting based on the inflation forecast. This setting is calculated using the model. The second is an end-of-period value that reflects where the instrument will finish the period after it has been adjusted to fix or band the MCI in response to unexpected exchange rate developments.[11] This value is calculated outside the model. The third is the instrument setting that is then used by the model to solve for the actual macroeconomic outcome and it is the average of the value at the start of the period and the value at the end of the period. Using the average of the two assumes that the unexpected change in the exchange rate unfolds smoothly throughout the quarter and, consequently, so does instrument adjustment.

In more detail, the multi-step procedure works as follows. In the first step, the instrument adjustment that is based on the inflation forecast is calculated. The available information on the current state of the economy, the expected evolution of exogenous factors, the model and the endogenous policy reaction function determine the instrument setting consistent with achieving the inflation target. The second step is designed to capture how the instrument setting evolves if the monetary authority is banding or fixing an MCI in the interval between inflation forecasts. The unexpected change in the exchange rate, which occurs in the interval between inflation forecasts, is used to adjust the initial instrument setting to calculate an end-of-period value. The end-of-period value reflects the change in the instrument required to keep the MCI fixed at, or within some predetermined band of, the value contained in the most recent inflation forecast. The average value for the instrument over the period and the period's stochastic disturbances are then used to solve for the actual macroeconomic outcome. In the fixed-instrument case the average value is simply the setting calculated in the first step. The current period's outcome and, consequently, any forecast errors become available to the policymaker in the subsequent period and the process starts again.[12] Figure 2 contains a pictorial representation of the technique.

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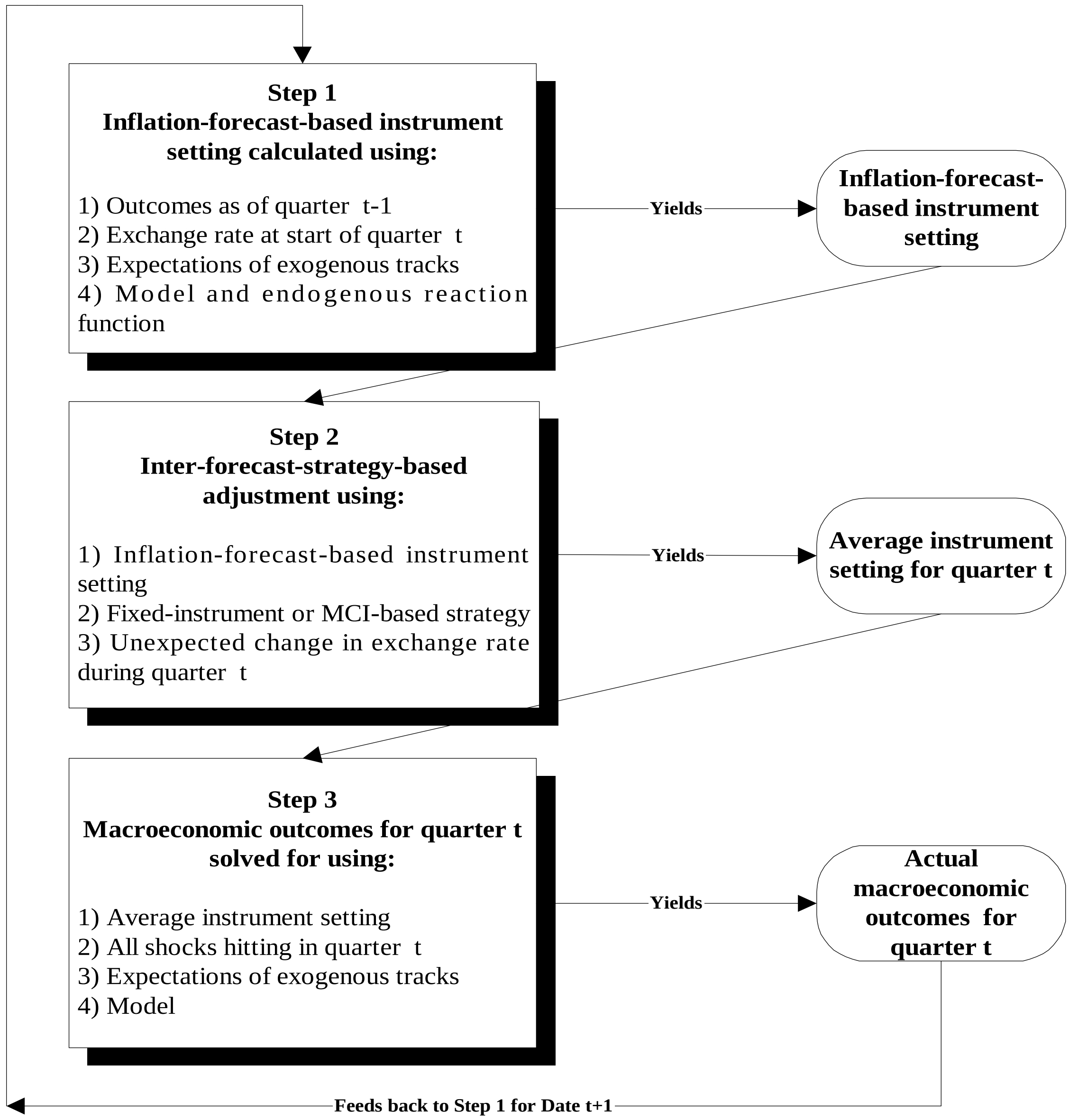
[11] One trick here is that a proxy needs to be used for the unexpected change in the exchange rate. Because of the key role played by the unexpected change in the exchange rate, it is important that the proxy be a good one. Several alternatives for this proxy were tested. The proxy that provided the best match to the *ex post* unexpected change was the unexpected change from the identical draw and quarter under the case where the interest rate is held fixed. The average absolute error between the proxy and the *ex post* unexpected change ranged from 0.1 per cent, under the 1:1 adjustment, to virtually zero as the adjustments approached the fixed-instrument case. The average absolute error, under the 2:1 benchmark MCI for New Zealand, was 0.08 per cent. There is one obvious limitation with this proxy. Part of the unexpected change in the exchange rate will be the response of the exchange rate to the change in the short-term interest rate occurring at date t+1. Some preliminary tests using just the shock term hitting the exchange rate to proxy for the unexpected change have shown that this effect is very small and makes no material difference to the simulation results.

[12] One can argue that even these informational assumptions are optimistic and that at the start of quarter *t* the monetary authority only has observations on outcomes as of quarter *t-2*. Altering the information set in this way is likely to worsen all achievable outcomes, leaving relative comparisons unaffected.

**Figure 2**




As noted earlier, a range of MCI-based inter-forecast strategies are compared to the alternative of holding the instrument fixed between forecasts. The fixed-MCI strategy means that the instrument is adjusted continually inter-forecast to keep the MCI precisely at the level contained in the most recent inflation forecast. The tightly banded-MCI strategy adjusts the instrument to keep the MCI close to that level and the loosely banded-MCI strategy allows considerable variation. For each alternative, 100 draws[13] that last for 100 quarters are conducted. Each draw can be thought of as containing a sequence of 100 inflation forecasts.

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[13] Test results presented in Drew and Hunt (1998) illustrate that the model-generated moments stabilise once more than 70 draws have been done. Consequently, 100 draws are sufficient to support statistical inference.

### 4.1 The results under the standard representation of the disturbances[14]

The results for the key macroeconomic variables under the standard characterisation of the stochastic-shock process are presented in table 1. The differences that arise between the fixed-instrument and MCI-based strategies are relatively minor. Output and inflation variability remain essentially unchanged. The impact of adjusting the instrument in response to the current exchange rate disturbance shows up in the changes in their variability relative to the fixed-instrument case. When the MCI is held fixed, exchange rate variability is the lowest and interest rate variability is the highest. This reflects the fact that the additional adjustments to the instrument are largest under the fixed-MCI strategy. Those instrument changes influence the exchange rate through the UIP condition, and that influence will be in the opposite direction to the change in the exchange rate arising from the stochastic disturbances.

**Table 1**[15]

| Inter-forecast strategy | Root mean squared deviations from equilibrium | | | |
|---|---|---|---|---|
| | **Output** (percent) | **CPI inflation** (percentage point) | **Nominal interest rate** (percentage point) | **Exchange rate** (percent) |
| **Fixed instrument** | 3.30 | 1.15 | 3.82 | 4.82 |
| **Fixed MCI** | 3.32 | 1.15 | 3.85 | 4.72 |
| **Tightly banded MCI** | 3.31 | 1.15 | 3.83 | 4.75 |
| **Loosely banded MCI** | 3.30 | 1.15 | 3.82 | 4.78 |

Some might argue that the advantages of MCI-based inter-forecast strategies are not in their implications for inflation and output variability, but rather in their implications for interest rate variability. The logic behind this argument is that the adjustments in the instrument required to fix or band the MCI anticipate the adjustments that will need to be made once the next inflation forecast has been completed. If this is true, following MCI-based strategies should smooth instrument adjustments. The statistic presented in table 1 is the root mean squared deviation from equilibrium of the average nominal 90-day interest rate over the quarter. This does not actually shed much light on this particular dimension of instrument behaviour. To examine whether MCI-based strategies anticipate where policy will be heading at the next inflation forecast, statistics describing the behaviour of the absolute value of the instrument change at

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14 Details on the standard representation of the stochastic shocks can be found in Drew and Hunt (1998).

15 Appendix 3 contains tables that present the outcomes of a wider range of interest rate responses to the unexpected exchange rate change.

each new inflation forecast are calculated. Under the fixed-instrument case, this statistic is simply the absolute value of the quarterly changes. Under the MCI-based strategies, however, the instrument is allowed to vary between forecasts. The behaviour of the required change associated with the inflation forecast is described by the difference between the end-of-period value and the next period's initial value determined by the inflation forecast. Table 2 contains four statistics describing the behaviour of the absolute value of the change in the 90-day nominal interest rate across the 100 draws.

These statistics suggest that the MCI-based strategies tend to increase rather than decrease the magnitudes of instrument changes associated with inflation forecasts. The average magnitude of the required change, its maximum value and, consequently, its variability all rise under MCI-based strategies, relative to the fixed-instrument case. This result suggests that, on average, factors other than the need to offset exchange rate surprises like that presented in section 3 are dominating the instrument adjustment required to return inflation to the target. Adjusting the instrument to fix or band an MCI between inflation forecasts leaves the monetary authority (on average) in the position of wanting to recant on those inter-forecast adjustments once the next inflation forecast is completed.

**Table 2**

| **Inter-forecast strategy** | **Behaviour of the change in the instrument at the next inflation forecast** (percentage points) | | | |
|---|---|---|---|---|
| | **Average change** | **Minimum change** | **Maximum change** | **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 |

The results presented in table 1 indicate that MCI-based strategies do not reduce inflation or output variability relative to holding the instrument fixed. This result is conditional on the assumption that there are no constraints on the size of the change in the instrument once the next inflation forecast is done. Considerable evidence exists suggesting that monetary authorities prefer to smooth interest rate adjustments.[16] If there are constraints on the magnitude of the changes in the instrument, then the simulation results in table 1 may not reflect the macroeconomic outcomes that will be achieved if policymakers follow MCI-based strategies. To illustrate qualitatively what might occur if there are constraints on instrument changes, the experiment was

[16] For example see Clarida, Gali and Gerlter (1997).

repeated constraining instrument adjustments under the fixed-MCI strategy to be the same, on average, as under the fixed-instrument case.[17] The results are presented in table 3. If interest rate changes associated with inflation forecasts are constrained to be of the same magnitude as they are under the fixed instrument rule, 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.[18]

**Table 3**

| **Inter-forecast strategy** | **Root mean squared deviations from equilibrium** | | | |
|---|---|---|---|---|
| | **Output** (percent) | **CPI inflation** (percentage point) | **Nominal interest rate** (percentage point) | **Exchange rate** (percent) |
| **Fixed MCI constrained** | 3.14 | 1.49 | 3.35 | 4.35 |
| **Fixed MCI unconstrained** | 3.32 | 1.15 | 3.85 | 4.72 |
| | **Behaviour of the change in the instrument at the next inflation forecast** | | | |
| | **Average change** | **Minimum change** | **Maximum change** | **Standard deviation** |
| **Fixed instrument** | 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 |

## 4.2 The results under an alternative representation of the disturbances

It is argued that MCI-based strategies will be more effective the more important are investor sentiment shocks relative to the other real shocks that hit the exchange rate. To test this hypothesis, an alternative specification of the disturbances is used. Under the alternative characterisation, the standard deviation of own shocks to the exchange rate is roughly 2.5 times larger than in the standard representation.[19] This is the shock

[17] The model's reaction function was recalibrated to examine this question. The weight on the model-consistent expectation of the deviation of inflation from target was reduced until the average change in the instrument at inflation forecasts under the fixed MCI strategy matched the average change achieved under the fixed-instrument strategy with the base-case reaction function.

[18] 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.

[19] The alternative representation is derived from a VAR that uses a trade-weighted combination of United States and Australian GDP as the proxy for foreign demand rather than the trade-

that represents shifts in investor sentiment and is not related to the other fundamental disturbances hitting the economy. Results are presented in table 4 and in table 5.

The alternative representation of the shocks results in an overall increase in macroeconomic variability. However, the basic result that inflation and output variability are unaffected by the choice of inter-forecast strategy is unchanged. The implication that the required change in the instrument associated with the inflation forecasts is larger under MCI-based strategies is even more pronounced. This result mirrors the result obtained in section 4.1. It appears that sources of macroeconomic variability other than the sentiment shocks to the exchange rate are dominating the direction that the instrument needs to be adjusted in once the next inflation forecast has been completed. Therefore, the MCI-based strategies, on average, send interest rates in the opposite direction to how they will be adjusted once the implications of all the period's forecast errors have been factored into the medium-term inflation outlook. The MCI-based inter-forecast strategies appear to provide a misleading indication how the interest rates will be adjusted at the next inflation forecast. Consequently, the larger are unexpected exchange rate movements, the more misleading will be the MCI-based strategies.

**Table 4**

| **Inter-forecast strategy** | **Root mean squared deviations from equilibrium** | | | |
|---|---|---|---|---|
| | **Output** (percent) | **CPI inflation** (percentage point) | **Nominal interest rate** (percentage point) | **Exchange rate** (percent) |
| **Fixed instrument** | 3.38 | 1.31 | 4.11 | 5.86 |
| **Fixed MCI** | 3.40 | 1.31 | 4.40 | 5.65 |
| **Tightly banded MCI** | 3.38 | 1.31 | 4.09 | 5.78 |
| **Loosely banded MCI** | 3.38 | 1.31 | 4.09 | 5.83 |

weighted, 14-country, industrial-production measure used in the initial VAR. Aside from the increased importance of own shocks to the exchange rate, the broad properties of the two VARs are quite similar, as can be seen in the impulse responses graphed in Appendix 4.

**Table 5**

| Inter-forecast strategy | Behaviour of the change in the instrument at the next inflation forecast (percentage points) | | | |
|---|---|---|---|---|
| | **Average change** | **Minimum change** | **Maximum change** | **Standard deviation** |
| **Fixed instrument** | 1.31 | 0.03 | 4.34 | 0.97 |
| **Fixed MCI** | 2.05 | 0.04 | 7.05 | 1.56 |
| **Tightly banded MCI** | 1.65 | 0.03 | 5.60 | 1.24 |
| **Loosely banded MCI** | 1.32 | 0.03 | 4.43 | 0.99 |

## 4.3 Ignoring the cross correlations in the shocks

To test further the notion that the proportion of investor sentiment shocks will influence the efficacy of MCI-based strategies, the case where investor sentiment shocks are the only shocks to the exchange rate is also considered. The standard technique for simulating FPS under stochastic disturbances includes both serial and cross correlations in the shocks impacting the economy.[20] This implies that the shocks hitting the exchange rate are composed of shifts in investor sentiment (own shocks) as well as several other real disturbances such as foreign demand and terms of trade shocks (cross correlations). To further test the hypothesis that it is the proportion of investor sentiment shocks that matter, the experiment is repeated removing the cross correlations in the stochastic disturbances. This is assuming the polar case that the only shocks to the exchange rate are investor sentiment shocks that are completely unrelated to the other real disturbances hitting the economy. The results are presented in tables 6 and 7.

Although the increases in the instrument changes under the MCI-based strategies are smaller than in the previous case, the same qualitative story prevails. Output and inflation variability is unchanged and the magnitude of instrument changes associated with inflation forecasts rises. These results provide additional evidence that the effectiveness of MCI-based strategies does not depend on the proportion of shocks to the exchange rate that reflect only investor sentiment. It appears that the required response to the other shocks that hit the economy dominates the instrument setting, even when the exchange rate shocks are completely uncorrelated with those shocks.

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[20] The robustness testing presented in Drew and Hunt (1998) illustrates that ignoring the cross correlations in the VAR impulse responses results in model-generated moments that are quite different from the historical experience.

**Table 6**

| Inter-forecast strategy | Root mean squared deviations from equilibrium | | | |
|---|---|---|---|---|
| | **Output** (percent) | **CPI inflation** (percentage point) | **Nominal interest rate** (percentage point) | **Exchange rate** (percent) |
| **Fixed instrument** | 1.65 | 0.72 | 2.15 | 1.68 |
| **Fixed MCI** | 1.65 | 0.71 | 2.16 | 1.67 |
| **Tightly banded MCI** | 1.65 | 0.71 | 2.15 | 1.67 |
| **Loosely banded** | 1.65 | 0.72 | 2.15 | 1.68 |

**Table 7**

| Inter-forecast strategy | Behaviour of the change in the instrument at the next inflation forecast (percentage points) | | | |
|---|---|---|---|---|
| | **Average change** | **Minimum change** | **Maximum change** | **Standard deviation** |
| **Fixed instrument** | 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 |

### 4.4 A world of exchange rate shocks only

Inter-forecast MCI-based strategies are motivated by a desire to respond quickly to unexpected exchange rate developments that arise from shifts in investor sentiment. The results to this point suggest that macroeconomic performance under MCI-based strategies is virtually identical to that achieved by following a inter-forecast fixed-instrument strategy. The obvious question becomes 'when do MCI-based strategies improve macroeconomic performance?' To investigate this question, the simulation experiment of section 4.1 is repeated, but with stochastic disturbances hitting only the exchange rate. The results presented in table 8 indicate that, in this case, macroeconomic variability is reduced under MCI-based strategies relative to a fixed-instrument strategy.

**Table 8**

| Inter-forecast strategy | Root mean squared deviations from equilibrium | | | |
|---|---|---|---|---|
| | Output (percent) | CPI inflation (percentage point) | Nominal interest rate (percentage point) | Exchange rate (percent) |
| Fixed instrument | 1.08 | 0.70 | 2.53 | 4.06 |
| Fixed MCI | 0.98 | 0.63 | 2.45 | 3.93 |
| Tightly banded MCI | 1.01 | 0.65 | 2.45 | 3.98 |
| Loosely banded MCI | 1.06 | 0.69 | 2.50 | 4.03 |

**Table 9**

| Inter-forecast strategy | Behaviour of the change in the instrument at the next inflation forecast (percentage points) | | | |
|---|---|---|---|---|
| | Average change | Minimum change | Maximum change | Standard deviation |
| Fixed instrument | 0.53 | 0.01 | 1.76 | 0.40 |
| Fixed MCI | 0.77 | 0.01 | 2.57 | 0.58 |
| Tightly banded MCI | 0.42 | 0.01 | 1.39 | 0.32 |
| Loosely banded MCI | 0.35 | 0.01 | 1.18 | 0.27 |

In terms of the magnitudes of the change in the instrument at the next inflation forecast (table 9), an interesting point emerges. Holding the MCI fixed still results in larger changes than under a fixed-instrument rule, even under exchange rate shocks only. However, in this particular case holding the MCI fixed is not providing a misleading indication of where policy needs to go. Rather, this result occurs because the fixed-MCI instrument setting at the end of the quarter is a more “efficient” instrument adjustment than that given by the model’s endogenous reaction function. Simulation results that illustrate this point are presented in appendix 3.

The results presented in appendix 3 also indicate that MCI-based strategies can never fully anticipate the next inflation-forecast based instrument adjustment perfectly. The magnitudes of the changes, even under efficient endogenous policy rules, do not appear to converge towards zero. This reflects the point made in section 3: interest rate adjustments cannot fully offset exchange rate movements in terms of their impact on inflation. This occurs because of the different timing of interest rate and exchange rate effects on aggregate demand and because of the direct price effects of exchange rate movements on inflation expectations. Because interest rates and exchange rates are not perfect substitutes in the monetary policy transmission mechanism, following an MCI-based strategy even in a world of only exchange rate shocks still results in real disequilibria. There are times when new exchange rate shocks will actually help resolve the disequilibria generated by previous exchange rate shocks because they work through channels that interest rates cannot utilise. Those exchange rate movements should not be leaned against. The instrument adjustments based on inflation forecasts take this into account, but the simple MCI-based responses do not.

## 5 The implications of uncertainty

Considerable uncertainty exists as to the exact relative importance of the short-term interest rate and the exchange rate in determining the level of aggregate demand. As pointed out in Ericsson *et al* (1998), in addition to all the potential econometric pitfalls involved with estimating reduced-form IS curves, estimates of the MCI ratio can be quite uncertain. For example, using the model for New Zealand reported in Dennis (1997), Erriccson *et al* (1998) reports confidence bands around the 2:1 point estimate. At the 95 per cent level, the reported range is 0.3:1 to 7:1. It is 0.5:1 to 5:1 at the 90 per cent level and 1:1 to 3:1 at the 67 per cent level. Though one might be inclined to dismiss the very extreme values implied for the impact of the exchange rate at the 90 and 95 per cent confidence levels, the range at the 67 per cent level appears quite plausible.

To examine the implications of the uncertainty about the true relative impact of the interest rate and the exchange rate, two misperceptions experiments are conducted. To do this, two alternative versions of the FPS core model have been calibrated. In the first one, the interest rate and the exchange rate each have an identical impact on aggregate demand (an MCI ratio of 1:1). In the second one, the interest rate has three times the impact that the exchange rate has (an MCI ratio of 3:1). The monetary authority believes that the relative impact is 2:1 and behaves accordingly. This belief is reflected in both its inflation-forecasting model and its inter-forecast fixed-MCI strategy. The true relative impact of the interest rate and the exchange rate is either 1:1 or 3:1, the edges of the 67 per cent confidence band. Only the cases holding the instrument fixed and the MCI fixed are considered. The case where the error arises on the interest rate elasticity and the case where it arises on the exchange rate elasticity are examined individually.

Recall that the simulation technique involves a multi-step procedure. In the first step the monetary authority sets the instrument based on an inflation forecast that uses information on lagged outcomes, the current level of the exchange rate and its model of the economy. Next, the initial setting is adjusted in response to the unexpected change in the exchange rate that occurs between forecasts. In the experiments in this section, the monetary authority misperceives the interest rate and exchange rate elasticities of demand in both its forecasting model and its inter-forecast strategy. The instrument setting and the period's stochastic disturbances are then sent to the actual economy and the period's outcomes are solved for. The monetary authority never learns that it is making an error about the relative importance of the short-term interest rate and the exchange rate in the monetary policy transmission channel. The only adjustments to its behaviour arise through the impact on its current inflation forecast of lagged outcomes differing from what it had forecast the previous period.

The results from the misperceptions experiment are presented in tables 10 and 11. Although making errors about the true interest rate and exchange rate elasticities of demand affects the monetary authority's ability to stabilise inflation, the effect of holding an erroneous MCI fixed between forecasts is roughly the same as holding the true MCI fixed. Output and inflation variability are largely unchanged and the magnitudes of required instrument changes associated with inflation forecasts increase.

**Table 10**

| **Inter-forecast strategy** | **Root mean squared deviations from equilibrium** | | | |
|---|---|---|---|---|
| | **Output** (percent) | **CPI inflation** (percentage point) | **Nominal interest rate** (percentage point) | **Exchange rate** (percent) |
| | ***Believe 2:1 actually 3:1, error on interest rate elasticity*** | | | |
| **Fixed instrument** | 3.59 | 0.95 | 3.50 | 4.62 |
| **Fixed MCI** | 3.71 | 0.96 | 3.60 | 4.56 |
| | ***Believe 2:1 actually 1:1, error on interest rate elasticity*** | | | |
| **Fixed instrument** | 3.32 | 1.32 | 4.12 | 5.11 |
| **Fixed MCI** | 3.30 | 1.32 | 4.13 | 4.97 |
| | ***Believe 2:1 actually 3:1, error on exchange rate elasticity*** | | | |
| **Fixed instrument** | 2.86 | 1.12 | 3.43 | 5.25 |
| **Fixed MCI** | 2.91 | 1.14 | 3.54 | 5.17 |
| | ***Believe 2:1 actually 1:1, error on exchange rate elasticity*** | | | |
| **Fixed instrument** | 4.57 | 1.29 | 4.97 | 4.40 |
| **Fixed MCI** | 4.50 | 1.26 | 4.88 | 4.28 |

**Table 11**

| Inter-forecast strategy | Behaviour of the change in the instrument at the next inflation forecast (percentage points) | | | |
|---|---|---|---|---|
| | Average change | Minimum change | Maximum change | Standard Deviation |
| | *Believe 2:1 actually 3:1, error on interest rate elasticity* | | | |
| **Fixed instrument** | 1.37 | 0.03 | 4.52 | 1.03 |
| **Fixed MCI** | 1.85 | 0.03 | 6.16 | 1.39 |
| | *Believe 2:1 actually 1:1, error on interest rate elasticity* | | | |
| **Fixed instrument** | 1.30 | 0.03 | 4.30 | 0.97 |
| **Fixed MCI** | 1.77 | 0.03 | 5.92 | 1.35 |
| | *Believe 2:1 actually 3:1, error on exchange rate elasticity* | | | |
| **Fixed instrument** | 1.32 | 0.03 | 4.37 | 0.99 |
| **Fixed MCI** | 1.73 | 0.03 | 5.80 | 1.32 |
| | *Believe 2:1 actually 1:1, error on exchange rate elasticity* | | | |
| **Fixed instrument** | 1.60 | 0.03 | 5.38 | 1.21 |
| **Fixed MCI** | 2.03 | 0.04 | 6.95 | 1.54 |

## 6 Summary

The work presented in this paper examines the macroeconomic stabilisation properties of an inflation-forecast-targeting monetary authority pursuing MCI-based and fixed-instrument inter-forecast implementation strategies. The results suggest that when the economy is subjected to a wide range of macroeconomic disturbances, the variability of output and inflation are largely unaffected by the choice of inter-forecast strategy. It appears that MCI-based strategies can deliver lower variability in inflation and output only in a world where shocks to the exchange rate are the sole source of unexpected macroeconomic variability. Some might argue that the virtue of MCI-based strategies is not in improved macroeconomic performance, but rather in smoother instrument adjustments. The expectation is that the adjustments in the instrument required to fix or band the MCI anticipate where policy will be heading once an inflation forecast has been completed. However, the simulation results suggest that smoother interest rate adjustments can be achieved only if unexpected macroeconomic variability is driven by exchange rate shocks alone.

These results also illustrate the importance of correctly accounting for the information constraints that the policymaker faces. If the analysis had been conducted assuming that the policymaker knew the current shocks affecting all macroeconomic variables except the exchange rate, this would be similar to the case where the exchange rate shock is the only shock hitting the economy. In other words, the only source of macroeconomic surprise in the period ahead would arise from the exchange rate. In this case, in the simulations presented here, the MCI-based strategies achieved superior macroeconomic outcomes.

If one considers MCI-based strategies as implying that the monetary authority is behaving as if the MCI is its instrument rather than the short-term interest rate, one can see how these simulation results are consistent with Poole (1970). The simulation results presented here have shown that the stochastic properties of the shocks that the economy is subjected to are critical for determining the optimal instrument for monetary policy. The restrictions on the economy's stochastic properties that are required to make the MCI the optimal instrument appear implausible. This does not suggest that the impact of the exchange rate in a small open economy can be ignored. Rather it implies that responding to unexpected exchange rate movements using a simple mechanical approach will not improve macroeconomic outcomes and may, in fact, worsen them.

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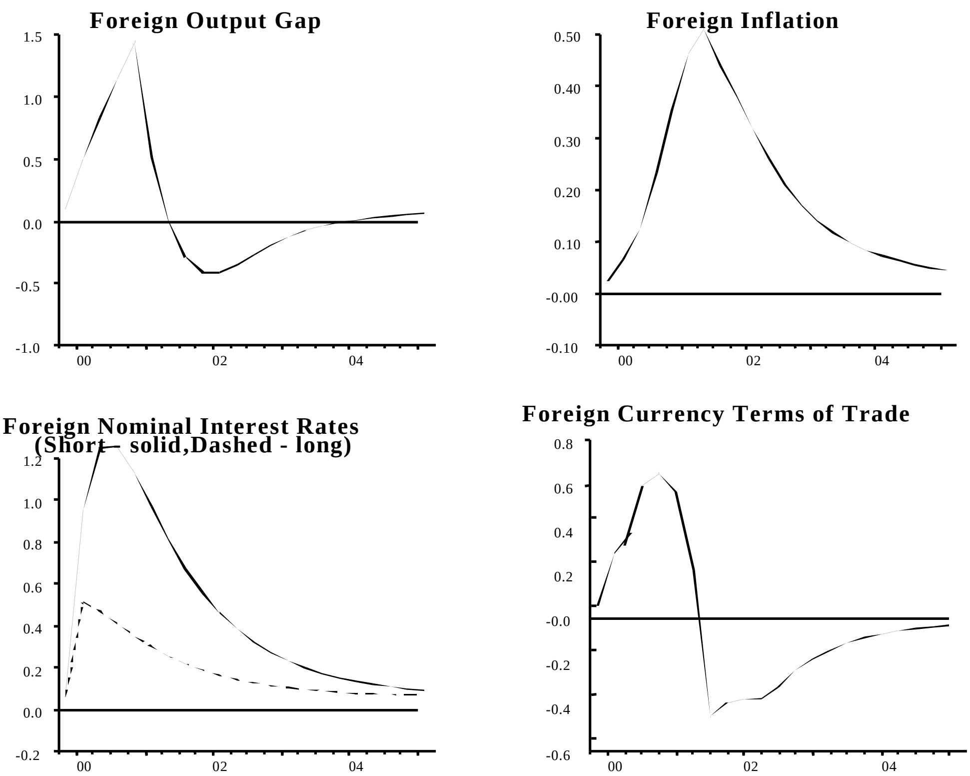
## Appendix 1: The endogenous foreign sector

For the analysis presented in this paper, an extension has been made to the FPS core model to capture more adequately the stochastic behaviour of the New Zealand economy. The original technique for stochastic simulation of FPS outlined in Drew and Hunt (1998) is based on a VAR model for generating the stochastic disturbances. In that framework, foreign demand and commodity price shocks are a key sources of stochastic uncertainty. However, the data would not support a large enough VAR to capture foreign interest rate and inflation effects. Consequently, these important dimensions of macroeconomic variability were not captured. To rectify this, the core model now contains an endogenous foreign sector consisting of an aggregate IS curve, a Phillips curve, a policy reaction function specified in terms of the short-term nominal interest rate, a long-term interest rate equation and a terms of trade relationship. Now the implications of foreign demand and commodity price shocks flow through into foreign inflation and foreign interest rate behaviour.

The properties of the foreign model are illustrated by its response to a temporary demand shock traced out in the figure below. All responses are in shock-minus-control terms. A couple of points are worth noting. Unlike the FPS core model, the foreign Phillips curve is symmetric in goods market disequilibrium. The sacrifice ratio has been calibrated to be 2. This is roughly the mid point of the range of sacrifice ratios (1.3 to 2.6) that result in FRB/US under the alternative structures for expectations and disinflation credibility assumptions presented in Brayton and Tinsley (1996). A forward-looking, inflation-targeting policy reaction function determines the short-term nominal interest rate and the behaviour of the foreign long-term interest rate is given by the expectations theorem. The behaviour of the foreign-currency terms of trade relevant for New Zealand has been calibrated to match the behaviour of New Zealand's terms of trade suggested by the VAR.[21] When the alternative VAR is used for stochastic simulations, the response of the terms of trade is recalibrated to match the alternative VAR.

21 This relationship was taken in part form evidence contained in Hunt (1995).

**Foreign Demand Shock**
(shock minus control)




The changes in the stochastic properties of the New Zealand economy that result from endogenising the foreign sector under the standard FPS reaction function are evident in the table below. The variability of real output remains virtually unchanged. However, the variability of inflation and the real exchange rate falls and the variability of the nominal short-term interest rate rises. The direction of these changes is really quite intuitive. Because the foreign short-term interest rate is now variable over the cycle, the domestic interest rate must do more of the work. Given the positive correlation between foreign and domestic business cycles, movements in the domestic short rate and the foreign short rate are positively correlated (on average) producing less variability in the exchange rate via the UIP condition. Additionally, the response of the foreign monetary authority to return foreign inflation to control also helps to return domestic inflation to control via import and export prices.

**Root Mean Squared Deviations**

| | Output | Exchange rate | Nominal interest rate | CPI inflation |
|---|---|---|---|---|
| Exogenous foreign sector | 3.19 | 5.24 | 3.59 | 1.19 |
| Endogenous foreign sector | 3.22 | 4.97 | 3.89 | 1.05 |

# Appendix 2: Summary statistics from the full range of inter-forecast strategies examined

## 2.1 The standard representation of the disturbances

**Table 1A**

| Inter-forecast strategy | Root mean squared deviations from equilibrium | | | |
|---|---|---|---|---|
| | **Output** (percent) | **CPI inflation** (percentage point) | **Nominal interest rate** (percentage point) | **Exchange rate** (percent) |
| **Fixed instrument** | 3.30 | 1.15 | 3.82 | 4.82 |
| **2:1** (Fixed MCI) | 3.32 | 1.15 | 3.85 | 4.72 |
| **1:1** | 3.35 | 1.16 | 4.02 | 4.63 |
| **3:1** (Tightly-banded MCI) | 3.31 | 1.15 | 3.83 | 4.75 |
| **4:1** | 3.31 | 1.15 | 3.82 | 4.77 |
| **5:1** | 3.30 | 1.15 | 3.82 | 4.78 |
| **10:1** (Loosely-banded MCI) | 3.30 | 1.15 | 3.82 | 4.78 |

**Table 2A**

| Inter-forecast strategy | Behaviour of the change in the instrument at the inflation forecast (percentage points) | | | |
|---|---|---|---|---|
| | **Average change** | **Minimum change** | **Maximum change** | **Standard deviation** |
| **Fixed Instrument** | 1.32 | 0.03 | 4.37 | 0.99 |
| **2:1** (Fixed MCI) | 1.79 | 0.04 | 6.00 | 1.36 |
| **1:1** | 2.79 | 0.06 | 9.33 | 2.13 |
| **3:1** (Tightly-banded MCI) | 1.54 | 0.03 | 5.16 | 1.16 |
| **4:1** | 1.45 | 0.03 | 4.83 | 1.09 |
| **5:1** | 1.40 | 0.03 | 4.66 | 1.05 |
| **10:1** (Loosely-banded | 1.34 | 0.03 | 4.45 | 1.00 |

| MCI) | | | | |
|---|---|---|---|---|

## 2.2 An alternative representation of the disturbances

**Table 3A**

| **Inter-forecast strategy** | **Root mean squared deviations from equilibrium** | | | |
|---|---|---|---|---|
| | **Output** (percent) | **CPI inflation** (percentage point) | **Nominal interest rate** (percentage point) | **Exchange rate** (percent) |
| **Fixed instrument** | 3.38 | 1.31 | 4.11 | 5.86 |
| **2:1** (Fixed MCI) | 3.40 | 1.31 | 4.40 | 5.65 |
| **1:1** | 3.38 | 1.31 | 4.12 | 5.75 |
| **3:1** (Tightly-banded MCI) | 3.38 | 1.31 | 4.09 | 5.78 |
| **4:1** | 3.38 | 1.31 | 4.08 | 5.80 |
| **5:1** | 3.38 | 1.31 | 4.08 | 5.81 |
| **10:1** (Loosely-banded MCI) | 3.38 | 1.31 | 4.09 | 5.83 |

**Table 4A**

| **Inter-forecast strategy** | **Behaviour of the change in the instrument at the inflation forecast** (percentage points) | | | |
|---|---|---|---|---|
| | **Average change** | **Minimum change** | **Maximum change** | **Standard deviation** |
| **Fixed instrument** | 1.31 | 0.03 | 4.34 | 0.97 |
| **2:1** (Fixed MCI) | 2.05 | 0.04 | 7.05 | 1.56 |
| **1:1** | 3.54 | 0.07 | 12.26 | 2.71 |
| **3:1** (Tightly-banded MCI) | 1.65 | 0.03 | 5.60 | 1.24 |
| **4:1** | 1.49 | 0.03 | 5.06 | 1.12 |
| **5:1** | 1.41 | 0.03 | 4.78 | 1.07 |
| **10:1** (Loosely-banded MCI) | 1.32 | 0.03 | 4.43 | 0.99 |

## 2.3 Removing the cross-correlations in the disturbances

**Table 5A**

| **Inter-forecast strategy** | **Root mean squared deviations from equilibrium** | | | |
|---|---|---|---|---|
| | **Output** (percent) | **CPI inflation** (percentage point) | **Nominal interest rate** (percentage point) | **Exchange rate** (percent) |
| **Fixed instrument** | 1.65 | 0.72 | 2.15 | 1.68 |
| **2:1** (Fixed MCI) | 1.65 | 0.71 | 2.16 | 1.67 |
| **1:1** | 1.65 | 0.71 | 2.22 | 1.65 |
| **3:1** (Tightly-banded MCI) | 1.65 | 0.71 | 2.15 | 1.67 |
| **4:1** | 1.65 | 0.71 | 2.15 | 1.67 |
| **5:1** | 1.65 | 0.71 | 2.15 | 1.67 |
| **10:1** (Loosely-banded MCI) | 1.65 | 0.72 | 2.15 | 1.68 |

**Table 6A**

| **Inter-forecast strategy** | **Behaviour of the change in the instrument at the inflation forecast** (percentage points) | | | |
|---|---|---|---|---|
| | **Average change** | **Minimum change** | **Maximum change** | **Standard deviation** |
| **Fixed instrument** | 0.80 | 0.02 | 2.70 | 0.60 |
| **2:1** (Fixed MCI) | 0.92 | 0.02 | 3.04 | 0.69 |
| **1:1** | 1.27 | 0.02 | 4.30 | 0.96 |
| **3:1** (Tightly-banded MCI) | 0.84 | 0.01 | 2.79 | 0.64 |
| **4:1** | 0.81 | 0.02 | 2.71 | 0.62 |
| **5:1** | 0.81 | 0.02 | 2.68 | 0.61 |
| **10:1** (Loosely-banded MCI) | 0.80 | 0.02 | 2.67 | 0.60 |

## 2.4 A world of exchange rate shocks only

**Table 7A**

| Inter-forecast strategy | Root mean squared deviations from equilibrium | | | |
|---|---|---|---|---|
| | **Output** (percent) | **CPI inflation** (percentage point) | **Nominal interest rate** (percentage point) | **Exchange rate** (percent) |
| **Fixed instrument** | 1.08 | 0.70 | 2.53 | 4.06 |
| **2:1** (Fixed MCI) | 0.98 | 0.63 | 2.45 | 3.93 |
| **1:1** | 0.92 | 0.55 | 2.56 | 3.83 |
| **3:1** (Tightly-banded MCI) | 1.01 | 0.65 | 2.45 | 3.98 |
| **4:1** | 1.03 | 0.67 | 2.46 | 3.99 |
| **5:1** | 1.04 | 0.67 | 2.47 | 4.01 |
| **10:1** (Loosely-banded MCI) | 1.06 | 0.69 | 2.50 | 4.03 |

**Table 8A**

| Inter-forecast strategy | Behaviour of the change in the instrument at the inflation forecast (percentage points) | | | |
|---|---|---|---|---|
| | **Average change** | **Minimum change** | **Maximum change** | **Standard deviation** |
| **Fixed instrument** | 0.53 | 0.01 | 1.76 | 0.40 |
| **2:1** (Fixed MCI) | 0.77 | 0.01 | 2.57 | 0.58 |
| **1:1** | 1.91 | 0.01 | 6.34 | 1.44 |
| **3:1** (Tightly-banded MCI) | 0.42 | 0.01 | 1.39 | 0.32 |
| **4:1** | 0.31 | 0.01 | 0.98 | 0.23 |
| **5:1** | 0.28 | 0.01 | 0.89 | 0.21 |
| **10:1** (Loosely-banded MCI) | 0.35 | 0.01 | 1.18 | 0.27 |

## Appendix 3: A more efficient endogenous policy rule

The results present in Section 4.4 illustrate that a fixed MCI inter-forecast strategy results in more efficient policy responses that the base-case FPS reaction function. Work at the Reserve Bank[22] and at the Bank of Canada[23] has shown that the policy rules used for economic projections in FPS and similar models are not efficient. Policy rules that respond more strongly to projected deviations of inflation from target result in lower inflation and output variability. The base-case policy rule used for all the experiments presented in this paper is the same policy rule that is used to prepare economic projections. The results from table 8 in section 4.4 show that following a fixed-MCI strategy under exchange rate shocks reduces both inflation and output variability. This suggests that the fixed-MCI strategy is more efficient than the base-case rule. Consequently, it is misleading to attempt to infer from the relative magnitudes of the required changes in table 9 in Section 4.4 what the instrument-change-minimising degree of banding of the MCI is, in this restricted world of exchange rate shocks only.[24]

To confirm that the larger change in the instrument under the fixed-MCI arises because this strategy is more efficient, the experiment was repeated with a more activist endogenous reaction function. The results presented in table 9A and table 10A indicate that the larger change under the fixed-MCI strategy presented in Section 4.4 arise because the fixed-MCI setting is more efficient than the base-case endogenous policy rule. This result indicates that as the endogenous policy rule converges towards an efficient one, the magnitudes of the required instrument changes associated with forecasts is minimised under a fixed-MCI strategy.[25] However, as the endogenous rule converges to an efficient one, the improvement in macroeconomic variability from holding the MCI fixed declines.

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22 See Conway, Drew, Hunt and Scott (1998).

23 See Black, Macklem and Rose (1998).

24 It is worth noting that because inflation and output variability do not decline in all the other shock configurations considered, the increase in the change in the instrument associated with an inflation forecast is not arising because the MCI-based strategies are more efficient responses than the base-case policy rule.

25 One could solve for the efficient rules under only exchange rate shocks and then solve for the degree of MCI banding that minimises the magnitudes of quarterly resets. However, since we believe there are many other important sources of macroeconomic variability in addition to exchange rate shocks its not clear what the value of this would be.

**Table 9A**

| **Inter-forecast strategy** | **Root mean squared deviations from equilibrium** | | | |
|---|---|---|---|---|
| | **Output** (percent) | **CPI inflation** (percentage point) | **Nominal interest rate** (percentage point) | **Exchange rate** (percent) |
| **Fixed instrument** | 1.15 | 0.48 | 3.05 | 4.05 |
| **2:1** (Fixed MCI) | 1.15 | 0.44 | 3.11 | 4.01 |
| **1:1** | 1.20 | 0.41 | 3.31 | 3.99 |
| **3:1** (Tightly-banded MCI) | 1.15 | 0.46 | 3.08 | 4.02 |
| **4:1** | 1.15 | 0.46 | 3.07 | 4.03 |
| **5:1** | 1.15 | 0.46 | 3.06 | 4.03 |
| **10:1** (Loosely-Banded MCI) | 1.15 | 0.47 | 3.06 | 4.04 |

**Table 10A**

| **Inter-forecast strategy** | **Behaviour of the change in the instrument at the inflation forecast** (percentage points) | | | |
|---|---|---|---|---|
| | **Average change** | **Minimum change** | **Maximum change** | **Standard deviation** |
| **Fixed instrument** | 1.42 | 0.03 | 4.73 | 1.06 |
| **2:1** (Fixed MCI) | 1.12 | 0.02 | 3.78 | 0.84 |
| **1:1** | 1.70 | 0.03 | 5.57 | 1.28 |
| **3:1** (Tightly-banded MCI) | 1.12 | 0.03 | 3.76 | 0.84 |
| **4:1** | 1.16 | 0.03 | 3.89 | 0.87 |
| **5:1** | 1.19 | 0.03 | 4.00 | 0.90 |
| **10:1** (Loosely-banded MCI) | 1.29 | 0.03 | 4.32 | 0.97 |

## Appendix 4: An alternative VAR

The figure below compares the alternative VAR impulse responses (solid) to the standard VAR impulse responses (dashed). Although most of the broad properties of the VAR impulse responses are quite similar (particularly over the first four quarters that are used to specify the shocks) there are two differences worth noting. First, foreign demand shocks appear to be larger using the alternative measure, but their implications for domestic demand are actually smaller. The relative importance of exchange rate shocks increases using the alternative measure of foreign demand.