The role of the Reserve Bank's macro-model in the formation of interest rate projections[1]

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June 2002

The Reserve Bank of New Zealand is relatively unique in that our macroeconomic projections include a variable nominal interest rate path over the projection period. This approach is different from the constant nominal interest rate assumption used by most other central banks. In New Zealand, the interest rate projection is produced using a combination of the Bank's core macroeconomic model and policymaker judgement. The model increases projected short-term interest rates when inflation is projected to be persistently high relative to target, and lowers interest rates when inflation is projected to be persistently low relative to target. In this sense, model projections are referred to as endogenous interest rate projections.

This article explains the rationale for endogenous interest rate projections and why the Reserve Bank has adopted this approach.

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1 This paper is also going to appear in the June 2000 "Reserve Bank of New Zealand *Bulletin*".

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1 Introduction

The Bank's submission to the Monetary Policy Review outlined a number of the reasons why we prepare and publish economic projections. One of the key components of all macroeconomic projections is the projected path for monetary policy – as reflected in the short-term interest rate. Until recently, virtually all projections published by central banks were based on the assumption of a constant nominal interest rate over the projection period, where the interest rate chosen was the interest rate prevailing at the time the projections were prepared. However, there is growing international interest in formulating different ways for describing the actions of monetary policy – so called monetary policy reaction functions. The Taylor Rule is one such example of a monetary policy reaction function.[3] There is also growing interest in macroeconomic projections that incorporate interest rate responses based on reaction functions.[4] Projections that include interest rate paths drawn from such monetary policy reaction functions are referred to as *endogenous* interest rate projections, which means the projected interest rate is responding to projected movements in other macro variables within the model.

The Reserve Bank is unique in that we are currently the only central bank that prepares *and* publishes economic projections based on endogenous interest rates – an approach we adopted in 1997. In section 2 of this paper we outline the reasons why we believe endogenous interest rate projections – projections that incorporate a presumed policy response to projected inflation – are marginally preferable to a constant interest rate assumption. Section 3 presents the policy reaction function at the heart of our model projections, along with the reasons for choosing this specification. Section 4 then discusses how we use the projections in practice – both in assisting the policy decision and in terms of informing the public about the rationale for a given policy decision. Section 5 concludes.

2 Why endogenous policy projections are preferred

Before explaining the rationale for using an endogenous policy path in our projections, it is first useful briefly to explain how endogenous policy projections work in practice. Figures 1a and 1b plot the March 2002 projection for annual consumer price inflation and the 90 day interest rate respectively.[5] At the time these projections were formed, the exchange rate was providing significant stimulus to the export sector, and the domestic economy was exhibiting growing inflationary pressures. As a result, annual inflation was threatening to breach the top of the target band, and the Bank believed that it was appropriate to start unwinding much of the stimulus that had been provided by the interest rate reductions observed during 2001.[6] Consequently, the model projected that approximately 125 basis point tightening in policy over the following eighteen month period would slow the domestic economy sufficiently to return inflation towards the centre of the target band.

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[3] See Plantier and Scrimgeour (2002) for a detailed description of the Taylor Rule.

[4] See Svensson (2001) for a more extensive discussion of rule-based policy responses.

[5] See the March 2002 *Monetary Policy Statement* for further discussion of these projections.

[6] The current Policy Targets Agreement stipulates that the Bank is to maintain annual consumer price inflation in a 0 to 3 per cent range. A copy of the Policy Targets Agreement can be viewed at: http://www.rbnz.govt.nz/monpol/pta/index.html.

Figure 1a

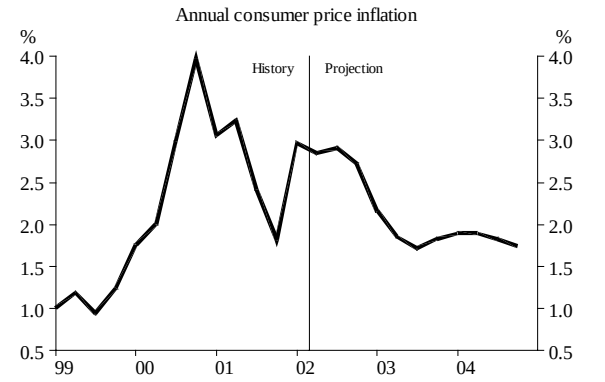
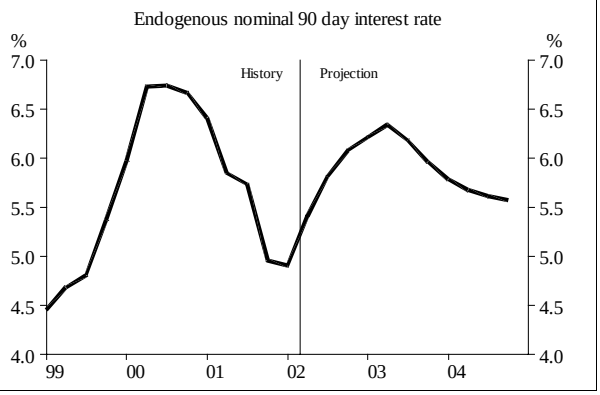


Figure 1b



Although a projection based on a constant interest rate assumption would look quite different from these endogenous projections, it would have provided similar information to the monetary policy decision-maker. For example, if nominal interest rates had been held constant in the March 2002 projection above, inflation would have been projected to breach and remain above the 0 to 3 per cent target range. This would have prompted the Bank to raise interest rates. So, although the two approaches are different in some respects, they both provide similar information and can be considered to be alternative ways of processing the available data. However, by using a reaction function to determine interest rates, a possible magnitude (and indeed path) of the required interest rate response is suggested, not just a direction as under the constant interest rate projections.

In order to understand our preference for using an endogenous interest rate path, it is intuitive to refer to the period prior to our use of the endogenous policy reaction function. Up until 1997, the projections used in policy evaluation and in the Bank's publications were conventional constant interest rate projections. Interest rates and the exchange rate were generally held constant throughout the projection horizon at the values prevailing at the time the forecasts were prepared.

One problem we experienced with the constant interest rate assumption was the potential internal inconsistency that it afforded. To demonstrate, consider the situation where an assumption of constant interest and exchange rates resulted in a projection with inflation deviating outside the target range over the projection period. This raises a number of problems. First, it is not internally consistent to assume that an inflation-targeting central bank would allow such a deviation from target to persist. In practice, if a central bank thought that a breach would persist, they would likely respond by moving interest rates in such a manner to bring inflation back within the target range. Secondly, if the constant nominal interest rate assumption was maintained, and the inflation rate was projected to change, this would result in a change in real interest rates. The movement in the real interest rate would reinforce the initial inflation movement and lead to potentially unstable or explosive paths for the projected nominal variables. Interestingly, central bank projections based on a constant interest rate policy (where the constant interest rate is the latest observed interest rate at the time the projections are formed) often show inflation near the target over the forecast horizon. One explanation why this could happen is that the forecast horizons (typically no longer than two years ahead) may not be sufficiently long to capture the full impact of assuming a constant nominal interest rate. A longer horizon would show the longer-term consequences of the constant interest rate assumption. Thirdly, it is not consistent to base a projection on a constant interest rate when other variables included in the projection (eg wages) already include an implicit expectation of future policy responses. These internal inconsistencies can be avoided by using an endogenous interest rate path.

Another advantage of using an endogenous interest rate assumption is that it assists in assessing the plausibility of the projections. Before each forecast round, the Governor and other Bank staff typically have prior opinions as to what range of policy settings would be plausibly appropriate to achieve the inflation target. If the projected nominal interest rate path produced by the model is significantly different from these priors, then the reasons for the discrepancies can be identified and discussed. After this discussion, if need be, the assumptions underlying the projection can be altered. Also, publishing the endogenous interest rate path enables financial market participants to evaluate the central bank's interest rate projections against those implied by financial market prices. This evaluation was not possible when our projections assumed a constant interest rate.

In New Zealand, estimating projections with endogenous interest rates was made easier with the advent of a new model in 1997, called the Forecasting and Policy System (FPS).[7] FPS was designed to trace through the long-term implications of various events. Over long time horizons, one cannot ignore the implications of holding interest rates constant while inflation diverges. Consequently, it became necessary to incorporate time varying interest rate paths into our projections.

The Reserve Bank is unique in that we are the only central bank that publishes endogenous interest rate projections. A small number of central banks, including the Bank of Canada, produce projections based on endogenous interest rate paths for internal discussion, but those projections are not published. Conversely, some central banks, such as the Bank of England, publish their projections, but their projections are based on a constant nominal interest rate assumption.

One potential criticism associated with publishing endogenous interest rate projections is that the public may see them as a commitment to future policy settings. Section 4 discusses why the Bank believes that the way we present the projections to the public helps guard against this risk.

3 Determining the policy reaction function

Having decided to use an endogenous interest rate path in our model-based projections, specifying the appropriate reaction function for interest rates in the model was not straightforward.

One body of literature suggests a methodology for using the structure of the model to derive an 'optimal' reaction function – that is, a reaction function that best meets the policymakers' objectives. However, such derived reaction functions are often complex and hence would prove difficult to communicate to the public. They are also subject to criticism on the grounds that an interest rate reaction function that is optimal in one model may not be optimal in other models.

On the other hand, there has been a large body of research demonstrating the efficacy of *simple* monetary policy reaction functions as an alternative to optimal policy rules. These reaction functions are simple in the sense that interest rates respond to only a few chosen variables, as opposed to the optimal reaction function, which by their nature have interest rates responding to a much larger set of variables. A majority of the research into simple

[7] See Black, Cassino, Drew, Hansen, Hunt, Rose and Scott (1997) and Reserve Bank of New Zealand (1997) for details on FPS.

reaction functions suggests that reaction functions that respond to medium-term inflation deviations achieve better output and inflation outcomes than those reaction functions that focus on a shorter horizon.

Simple reaction functions that respond only to inflation and output variability typically produce volatile projection paths for the policy instrument. In practice, however, central banks tend to move interest rates in a series of small steps in the same direction, rather than taking the larger and more volatile changes that economic models suggest. There are a number of possible explanations for the gradual approach that central banks take in adjusting interest rates. These include uncertainty about the true state of the economy, an explicit concern for interest rate volatility, or a belief that a gradual approach to interest rate adjustments may allow a central bank to provide clearer guidance to financial markets, and consequently enhance the extent to which movements in the short-term policy rate feed through into longer-term interest rates, which influence economic behaviour.[8] As a result, many monetary policy reaction functions include an interest rate smoothing component. This 'smoother' acts as a constraint as to how quickly projected interest rates can move each quarter.

This research into the desirable properties of simple reaction functions had not been completed in 1997 when the Bank decided to adopt an endogenous interest rate approach in forming our projections. Rather, the reaction function adopted at the time was based largely on two key ideas: a general understanding that it was inappropriate to target inflation at too short a horizon because it would induce unnecessary volatility in the real economy; and a broad approximation of how the Bank believed monetary policy operated in practice. Fortunately, the reaction function that the Bank started using back in 1997 was broadly consistent with most of the desirable properties outlined in the paragraph above. The reaction function is parameterised such that short-term interest rates respond to forecast deviations in annual inflation from target six to eight quarters in the future. Under this framework, the model increases short-term interest rates when inflation is projected to persist above the midpoint of the target band six to eight quarters in the future, and lowers interest rates when inflation is projected to persist below the midpoint six to eight quarters in the future. The focus on the mid-point reflects the presumption that actual policy will aim to reduce the risk that surprise events will take inflation outside either the top or bottom of the inflation target band.

Deviations of output from its potential value do not appear explicitly in the reaction function used in FPS, unlike some reaction functions such as the Taylor Rule.[9] This does not mean that there is no concern for output variance when formulating monetary policy. Rather, concerns for output variance are reflected implicitly in our monetary policy reaction function. By deliberately choosing a medium-term horizon of six to eight quarters, as opposed to a much shorter horizon, it means monetary policy responds to bring inflation back to the target gradually so as to avoid creating unnecessary volatility in output. This is consistent with the Bank's mandate in the Policy Targets Agreement, which specifies an inflation band rather than an exact target and also allows inflation to deviate outside the band in the event of one-off price shocks.

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8 See Woodford (1999) for a full description of this idea.

9 See Plantier and Scrimgeour (2002).

4 Forming projections and setting the OCR using endogenous policy

The projections are a key component of the information used to inform the actual setting of the Official Cash Rate (OCR), but they are by no means the only information. As we wrote in the November 2001 *Monetary Policy Statement* "the projection...is best treated as a benchmark against which to consider the risks and uncertainties relevant to our policy call." As time goes by, some of these risks are realised, some are not, and new ones emerge. Hence, the projections do not dictate a given OCR path for the future. Further, it has been our experience that our observers – namely the public and financial market participants – also accept the conditionality of the projections and do not see them as being a constraint on OCR settings.

The next two sub-sections briefly describe the projection formation process at the Bank, how policy decisions relate to the projections, and how we explain the rationale for policy decisions to the public.[10]

Forming projections

Whether projections are based on a constant or an endogenous interest rate profile, forming economic projections using an economic model is an iterative process. The projection process at the Reserve Bank is no exception. The first projection – the so-called 'no-judgement' projection – is formed by entering a combination of historical data and near-term forecasts[11] into FPS. However, the structure of FPS reflects average business cycle behaviour, and no two business cycles are alike. Hence, adjustments are required when the evidence suggests that the current cycle is different from the average economic cycle. To this end, the knowledge and experience of the Monetary Policy Committee (MPC), other Bank staff, and the Governor play an important role in adjusting the no-judgement projection to get a central projection that is more appropriate for the current circumstances.

Adjustments to the no-judgement projection can account for special circumstances and information that is not included in the model (for example, climatic conditions, bilateral exchange rate developments, and trading partner developments), and can incorporate circumstance-specific dynamics and known shocks. For example, one of the key judgements made during the November 2001 projection round was to make the post-September 11 forecast reduction in tourism income more persistent than the model suggested. Importantly, because FPS is a system of equations, this application of judgement may affect the projection paths of *all* endogenous variables in the model, rather than just those immediately affected by the adjusted assumption.

As noted in section 2, one of the benefits of basing projections on endogenous policy is that it helps one assess the plausibility of different projections. If certain assumptions about the economy lead to an endogenous interest rate projection that is inconsistent with the prior views of Bank staff, this can mean one of two things. First, the prior views may be wrong, and may need to be revised; or the economic assumptions embodied in FPS about the economy and how it works may be wrong. If the latter is the reason for the difference, then the assumptions within the model should be revisited, another projection formed, and the resulting interest rate projection compared with prior views. If we find that we are applying the same judgement to the same elements of the model for a number of consecutive quarters,

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[10] See Drew and Frith (1998) and Reserve Bank of New Zealand (2000) for a more detailed description of the projection formation process.

[11] Current and one quarter ahead forecasts for a number of variables are constructed using anecdotal evidence and indicator models.

this may indicate the need for further research. On occasion, this research can suggest the need to alter the structure underlying the model's fundamental behaviour.

Considering projections produced under different assumptions – or 'alternative scenarios' – helps guide the judgement used in determining the central projection, and provides further guidance on the subsequent OCR decision. These alternative scenarios are presented to the Governor and the MPC during each forecast round. They can embody such things as alternative world growth forecasts, faster monetary policy transmission, or a more muted impact of import prices on consumer prices. Alternative scenarios are useful for emphasising that the central projection, while we see it as being more likely than the alternatives, is just one of many possible paths that the economy might take. Consequently, it highlights that policy is dependent on the assumptions one makes about the structure of the economy. The alternative scenarios can also serve a useful role in identifying and highlighting the risks that exist around the central scenario. Having these alternative scenarios based on endogenous policy is very useful for comparing alternative policy rate paths. In particular, they give an indication of the possible magnitude of any interest rate response required were the alternative circumstances to materialise.

Figures 2a and 2b plot the central and alternative projections that were published in the August 2001 *Monetary Policy Statement*.[12] The central projection was based on the world GDP growth assumption taken from the latest *Consensus* forecasts available at that time. However, the MPC believed there was a significant risk of world growth turning out significantly weaker than allowed for. Hence, an alternative scenario with a weaker world outlook was also published. These graphs show that if the world output gap had fallen to around –1 per cent over the course of 2001, then FPS would have suggested that a further 100 basis points of easing would be required to achieve the inflation objective.

Figure 2a

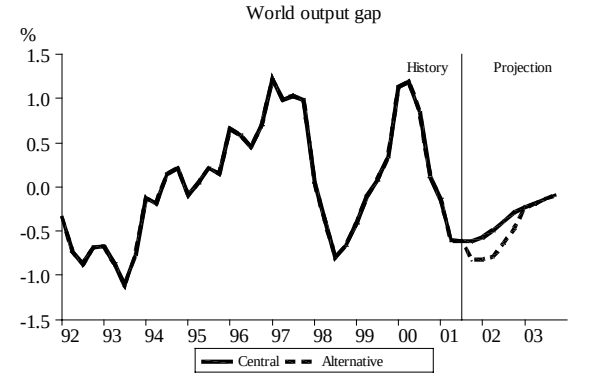
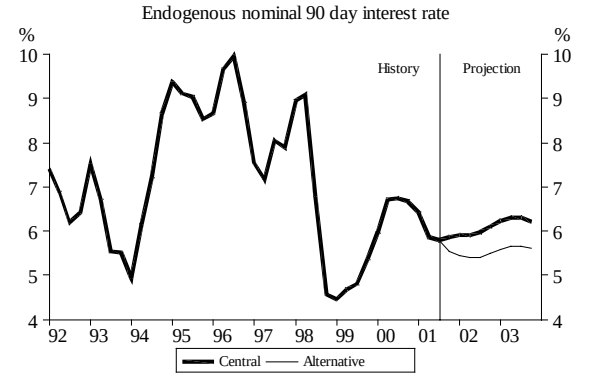


Figure 2b



The policy decision

At the beginning of this section we stressed that the projections are used mainly as a benchmark for the OCR decision. Even though the Governor determines the final interest rate projection for publication, the OCR decision may still differ from the interest rate profile suggested in the central projection. The first reason why this might happen is the fact that the central projection does not necessarily take into account the balance of risks around that projection. As the Bank wrote in the press statement that accompanied the March 2001 *Monetary Policy Statement*: "the balance of risks was currently tipped marginally in favour of easing inflation pressures but it is by no means inevitable that today's reduction will be quickly followed by further reductions."

[12] See the August 2001 *Monetary Policy Statement* for further discussion of these projections.

In a more vivid example of taking account of risks not fully captured within the published projection, the Bank lowered the OCR 50 basis points shortly after the September 11 terrorist attacks. This reduction was to help counter the potential for a significant decline in world economic growth even though the likelihood of a severe global slowdown was relatively small.

A discrepancy may also exist between the central projection and the OCR decision because there is up to a two-week delay between when the published projections are finalised and when they are released with the announcement of the OCR decision. Consequently, there is occasionally significant new information available to influence the OCR decision that was not included in the construction of the central projection. However, the new information does not invalidate the use of the central projection. Rather, the central projection continues to act as a benchmark to which the Governor adds the new information – albeit less formally – to make the OCR decision.

If the OCR decision does deviate materially from the central projection, as it may do from time to time, then it is important that the public is informed of the reasoning for the deviation. If the reasons for the deviation are not articulated sufficiently well, there is the potential to undermine the benefits of the projection as a communication device.

The publication of alternative projections along with the central projection also helps to reduce the public's focus on the central projection as a forecast. By occasionally publishing aspects of alternative scenarios, the Bank communicates some of the uncertainties that policymakers face. In addition, the predominant risks that surround the central projection are discussed extensively in every *Monetary Policy Statement*. Both of these practices reinforce the important point that the central forecast is only one of a large number of potential outcomes for the economy, albeit the Bank's central expectation.

Finally, over and above the benefits we see from publishing our projections, we believe having those projections based on an endogenous interest rate path assists us to explain the context of our policy decisions. As we wrote in the Bank's submission to the *Independent Review of Monetary Policy*:

> "In the context of the weight we give to the role of exposition in publishing policy projections, the issue of choosing between endogenous monetary policy or constant-policy-based projections becomes one of what best assists comprehension. To our mind, at the margin it is easier to explain our reasoning in terms of what interest rates might need to do in order to keep inflation on target, given the way we currently see the persistent pressures on inflation. On the other hand, it is a little harder to describe the future path in terms of a departure of inflation from target when we do not intend to let that departure happen."
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> Source: Reserve Bank of New Zealand (2000).

5 Conclusion

Since 1997 the Reserve Bank has produced and published macroeconomic projections based on endogenous interest rate paths. This approach replaced the more traditional and more commonly used assumption of a constant interest rate over the projection horizon. Reasons for the change included: 1) concerns about the potential internal inconsistency associated with a constant interest rate assumption; 2) a view that basing the projections on endogenous varying interest rate paths helps in explaining the policy decision to the public; and 3) a view that an endogenous policy reaction function helps determine the plausibility of our projections.

The reaction function used to form the projections in the model is designed to respond to potential persistent deviations in annual (forecast) inflation from target at a horizon of six to eight quarters. While output does not appear explicitly in the reaction function used in the model, it does so implicitly. The way that we target inflation, as specified in the reaction function, makes projected output more stable than it would be if we were to use a more short-term focused reaction function.

The projections are an important ingredient in the policy decision-making process. However, they are not a constraint on or pre-commitment to current or future OCR settings. The Bank sets the OCR by reference to the model projections, but also by reference to a broader assessment of the economy, taking into account a very wide range of economic and financial information and having regard to the views of the many people in the community to whom we talk as we prepare the OCR decision.

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