# ISSUES IN MODELLING MONETARY POLICY

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## Abstract

This paper reviews issues in the econometric modelling of monetary policy in the light of recent experience and research. Two main sets of issues are covered: first, the operation of policy including the specification of the instrument and objectives; and second, the transmission of monetary policy effects to the wider economy. There is also a discussion of the inherent limitations on the ability to quantify the role of monetary policy in econometric models.

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# ISSUES IN MODELLING MONETARY POLICY[1]

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## 1. Introduction

Macroeconomic models embody two important sets of hypotheses about the role of monetary policy. The first concerns the operation of policy, or how the policy instrument reacts to wider economic developments. This aspect of model design involves assumptions about the choice of instrument, the form of decision-rules relating instruments to objectives and the operational meaning of a 'no policy change' assumption with respect to monetary policy. Secondly, models embody a range of hypotheses about how changes in policy-related variables influence the economy as a whole. The purpose of this paper is to give an overview of issues related to these two aspects of policy modelling, drawing on recent macroeconomic developments and on research conducted mainly at the RBA.

In Section 2 we discuss the monetary policy framework in Australia, and how it might relate to the policy assumptions built into macroeconomic models. In particular we discuss the role of money supplies and interest rates as policy variables, and advocate model specifications that fully recognise the short-term interest rate as the monetary policy instrument. This leads to a suggested emphasis on studying policy rules that differ in important ways from standard money-growth rules. Section 3 then gives a review of evidence, mainly from RBA sources, on the monetary transmission process, in order to draw some general conclusions about how monetary policy affects the economy and how this might be reflected in modelling strategies. The themes are drawn together in Section 4 with some general observations concerning pitfalls and limitations of model-based policy analysis.

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1 This paper was originally prepared for a conference of the Economic Modelling Bureau of Australia, held on 23 May 1996. The aim was to provide an introduction and background for a discussion of econometric model results, drawing on available Reserve Bank research.

## 2. Modelling the Policy Framework

Essentials of the policy framework that need to be understood for the purposes of model-building can be briefly outlined in terms of instruments, objectives and decision criteria.

The instrument of monetary policy is the short-term interest rate – really, the overnight cash rate although, for the purposes of a quarterly or annual econometric model, this might be regarded as largely interchangeable with the 90-day bill rate. Since January 1990, changes to the desired cash rate have been publicly announced, a system that has been conducive to keeping cash rates in a tight range around the desired level (Figure 1). Cash-rate announcements have been accompanied on each occasion by public statements setting out the reasons for the change.

The objectives of monetary policy in terms of inflation and output performance have been described in detail in a number of public statements and publications by the Bank over recent years[2], and were formally set out in the recent Statement on the Conduct of Monetary Policy[3]. That statement notes that the policy objectives defined in the *Reserve Bank Act* 'allow the Reserve Bank to focus on price (currency) stability while taking account of the implications of monetary policy for activity and, therefore, employment in the short term'. The Statement also sets out the Bank's inflation objective in numerical terms:

> 'In pursuing the goal of medium term price stability the Reserve Bank has adopted the objective of keeping underlying inflation between 2 and 3 per cent, on average, over the cycle. This formulation allows for the natural short run variation in underlying inflation over the cycle while preserving a clearly identifiable benchmark performance over time.'

A number of points can be emphasised concerning the implications of this formulation. These concern both the inflation objective itself, and the relationship between objectives for inflation and output. With regard to the inflation objective, it should be noted that the specified 2-3 per cent range does not represent a hard-edged target band within which the inflation rate is to be confined in every

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2 See in particular Fraser (1994), Debelle and Stevens (1995), Grenville (1996).

3 Full details are set out in 'Statement on the Conduct of Monetary Policy' (1996).

period. The range has instead been described as a 'thick point', an indicator of central tendency rather than a target band, and the use of a range rather than a point is intended to recognise the imprecision with which inflation can be controlled and to avoid the spurious accuracy of point targets. Also important is that the objective is to be achieved on average over time rather than in every period, so it is a medium-term rather than fixed-period objective, where 'medium-term' is broadly defined as the length of a business cycle. The inflation objective is specified in underlying terms, using a measure of prices (the Treasury's underlying rate) which abstracts from the effects on the CPI of erratic factors such as government charges and interest-rate movements. These features of the inflation objective leave room for flexibility for policy to take into account short-run developments in output and employment and to consider both the real economy and inflationary short-run consequences of shocks when formulating policy responses. This sort of flexibility is in fact built in, in varying degrees, to the systems of other inflation-targeting countries. Over longer periods when monetary policy cannot be expected to have lasting effects on output and employment, the policy objective anchors inflation in the 2-3 per cent range.[4]

Given the instrument and objective of policy, it remains to comment on the decision criteria linking policy decisions to information about the objective variables. Here two points can be made. First, because of information and impact lags, the objective requires monetary policy to be explicitly forward-looking: thus the policy instrument will be adjusted in response to *expectations* of price and output variables in a way consistent with keeping inflation on the desired medium-term path. This will in practice mean looking at a range of variables that provide useful forward information about price and output trends. This is not a 'look at everything' rule but a criterion for interpreting information from a potentially large number of sources. Second, there is no formal commitment to a policy role for any particular intermediate variables such as monetary or financial aggregates. These and other variables are evaluated pragmatically for their usefulness as forward indicators and are in no sense to be regarded as 'intermediate objectives'. In practice the monetary aggregates in Australia have been highly unstable in their behaviour over at least the

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[4] It should be noted in passing that there is nothing illogical about having both prices and output in the objective function. This kind of formulation is a standard feature of literature on the theory of monetary policy, as for example in the textbook treatment of Blanchard and Fischer (1989).

past decade or so and their information content is regarded as small.[5] An implication of this discussion is that there is no obvious definition of an 'unchanged policy' stance in terms of a constant interest rate or money-supply growth rate. In a modelling context, 'unchanged policy' needs to be defined in terms of a given decision rule relating the short-term interest rate to information about prices and output in a way consistent with achievement of the medium-term objective.

In qualitative terms the conceptual framework outlined above is broadly consistent with those operating in a variety of countries, including those with formally legislated inflation targets and others with somewhat broader objectives. In a recent survey Haldane (1995) argues that the basic features of this framework – ie the use of an interest rate instrument to directly target final objectives for output and inflation over a period of time – are applicable to a wide range of countries, with cross-country differences arising mainly on more secondary matters such as time frames, tolerance bands and the like. This role for interest rates is also increasingly recognised in the academic literature, as for example in studies by Bernanke and Blinder (1990), Taylor (1993) and Fuhrer and Moore (1995) which empirically represent US monetary policy decisions by changes in the federal funds rate. Blinder (1996) provides a neat summary of this view which is worth quoting in detail:

> Today, the real short-term interest rate is the logical replacement for the money growth rate. Its 'neutral' value can be estimated from history and/or from econometric models, although it can never be known with certainty. 'Tight' monetary policy can then be defined as keeping the real interest rate higher than neutral. Such a policy can be expected to contract the economy, after a lag, and reduce inflation, after an even longer lag.
>
> There has been much talk in recent years of the problem posed by the loss of the so-called nominal anchor for monetary policy when monetary aggregates are bandoned in favour of interest rates. The new 'anchor' I am tacitly proposing has three pieces:
>
> 1. the central bank's long-run inflation target;
>
> 2. its commitment to keep real interest rates higher than neutral when inflation is above target, other things equal;

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[5] See de Brouwer, Ng and Subbaraman (1993), and also the discussion in Section 3.2 below.

3. understanding that nominal interest rates must not be held fixed, but must be adjusted for inflation because it is real interest rates that matter.

Despite these trends, one gets the impression that it is still not quite academically respectable to replace money supplies with interest rates in formal models.[6] This appears to stem from theoretical results such as reported by Sargent (1979) to the effect that exogenous interest-rate-setting policies are unstable or leave prices indeterminate.[7] It should be noted, however, that these results apply only under the extreme assumption that interest-rate setting is unrelated to nominal policy objectives. McCallum (1986) and others have shown that well-specified rate-setting policies are fully capable of providing a suitable nominal anchor, provided the rate-setting rule is specified as a function that includes a nominal target variable, a requirement that would clearly be met by inflation targeting systems or by a range of other possible systems such as nominal income targets.

Full recognition of the role of interest rates as the policy instrument in a modelling context cannot be achieved simply by inverting money-demand functions to produce what might be interpreted as rate-setting policy rules. This procedure does not really get around the problem of identifying a given policy setting with an exogenous money-growth path. To illustrate, suppose a simplified money-demand function of the following form (ignoring dynamics):

$$m - p = ay - br \tag{1}$$

where variables have the obvious definitions and are measured relative to steady-state values. This can be inverted to give an expression for the interest rate conditional on the other variables:

$$r = \frac{ay + p - m}{b} \tag{2}$$

6 For example, Mishkin's (1995) summary of a recent symposium on the monetary transmission mechanism repeatedly defines a monetary policy shock as 'M↓'.

7 In the simplest case, that of a fixed nominal interest rate, inflationary shocks reduce the real interest rate and are therefore self-reinforcing.

For the purposes of policy simulation it is possible to think of an exogenous money-growth path in this equation as being akin to a kind of target index for an appropriately weighted average of prices and output, so the approach can be argued to have some validity for policy analysis irrespective of the poor historical performance of monetary aggregates as policy indicators. On this interpretation the interest-rate equation would just represent a reaction function to deviations of the price and output index from target. Since this is broadly what has been advocated in the preceding discussion, it might be thought that this kind of policy assumption would yield reasonable results. Our point however is that the parameters and dynamics of the inverted money-demand function do not necessarily have anything to do with those of a sensible policy-reaction function, except to the extent that it is legitimate to think of the monetary authority as adhering to a strict money target.[8] An alternative way of making this point would be to add to the above equations a money-supply function that smooths the interest rate, say:

$$m = ar + bp + cy \tag{3}$$

This can in principle be combined with equation (1) to eliminate money and arrive at a policy reaction function whose parameters would differ from those of equation (2). If we wish to analyse policy behaviour under reasonable assumptions about the policy framework, there is thus no reason to think it would look like a variant of equation (2) with exogenous money.

In our view a more promising approach is found in recent studies by Bryant, Mann and Hooper (1993) and by Taylor (1993, 1995), which bypass the money-demand function altogether and specify interest-rate policies as simple functions of price and output variables with simple dynamics. This approach has a number of advantages in that it puts the focus on comparative stabilising properties of alternative rules, within a class of rules that has appealing properties, rather than on the dynamics of responses to shocks under any one particular rule.[9] Taylor (1993) obtains the useful result that interest-rate setting in the US since the mid 1980s is well approximated

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8 Edey (1990) presents a general argument that policy under an interest-rate reaction function with freely-chosen parameters dominates money targeting in terms of stabilisation of prices and output.

9 Edey (1989, 1990) gives a discussion of theoretical principles that might guide the design of simple rate-setting policy rules with desirable stabilisation properties.

by simple functions of price and output movements, and his empirical model suggests that this class of policy rules is capable of approximating the stabilisation properties of an optimal rule.

# 3. The Monetary Policy Transmission Process

Our second broad task in this paper is to review empirical evidence on the monetary policy transmission process. As noted at the outset, this review draws mainly on research originating at the Reserve Bank. The topic can usefully be divided into three parts: the influence of cash rates on other financial prices; the role of money and credit; and the effect of financial variables on activity and inflation.

## 3.1 The Influence of Cash Rates on other Financial Prices

Changes in the cash rate can be expected to influence the entire structure of interest rates and yields on financial assets. A useful starting point is to consider the effect of cash rates on other interest rates relevant to private-sector decisions. Lowe (1995) examined the extent and speed of 'pass-through' from cash rates to sixteen interest rates of securities markets and financial institutions. In general, the pass-through to short-term money-market interest rates is rapid and complete, while most deposit and lending rates are much less responsive, particularly for low-balance deposit accounts, housing and consumer loans. The business indicator rate is the most responsive lending rate, but pass-through is nonetheless found to be incomplete. Since intermediaries' interest rates are likely to be the most important ones for private-sector decisions, this general pattern of slow pass-through would help to account for part of the overall transmission lag from cash rates to the economy.

The relationship with longer-term interest rates can be thought of as reflecting two effects: a 'liquidity effect', essentially representing the impact of cash-rate changes on near-term expectations of future cash rates; and an effect on longer-term inflation expectations. The expectations hypothesis of the term structure suggests an overall impact representing the expected net effect of these factors on future short rates averaged over the life of the security. Broadly consistent with this, results of simple level-regressions by Lowe indicate positive pass-through from cash rates to various longer-term securities rates, but that the size of the coefficients declines the longer is the maturity of the bond. Results from regressions using changes in interest rates are less clear, particularly for longer term bonds, with significant cash-rate effects only found on security yields out to a maturity of two years.

Formal tests of the expectations hypothesis of the term structure, by Macfarlane (1988) and by Whitelaw, de Roos and Groeger (1995), suggest that the hypothesis can be rejected with Australian data, though the rejections are not dramatic. These studies find some evidence of predictable excess returns in bond markets related both to prior movements in foreign bond yields and to domestic short-term rates. The first of these results might be consistent with models of financial risk premia, while the second can be interpreted as evidence of an 'excess' sensitivity of long-term interest rates to current short-term rates. Regarding international linkages, there is clear evidence of significant cross-country co-movements in levels of bond yields (Fahrer and Shori 1990; Orr, Edey and Kennedy, 1995) arguably due to a combination of correlated shifts in inflation expectations and common factors influencing real interest rates internationally. The highly internationally-correlated rise in bond yields during 1994 provides a powerful illustration of these linkages, but research by Gruen (1995) and by Orr *et al.* suggests that it is hard to find a fully convincing explanation for these movements in terms of observable fundamentals.

The study by Orr *et al.* uses a panel regression to estimate a model of long-term interest rate determination in 17 OECD countries. The authors distinguish between slow-moving or 'fundamental' explanatory factors and dynamics largely driven by interactions among interest rates in different countries. It is the latter that largely account for the 1994 episode while the fundamental factors (principally fiscal and current account positions and a measure of policy credibility) explain longer-term trends and cross-country differentials. An important result is the significance of a policy-credibility variable based on countries' past inflation record, which includes lags of inflation of up to 10 years. The implication is that credibility takes a long time to establish, and the detrimental effects of a poor track record of inflation-control take a long time to drop out of market expectations of inflation. This is a result that is at odds with strong presumptions of forward-looking behaviour made by theorists, but one that rings true with policymakers.

Taken together the sources cited point to strong and fairly consistent effects of cash rate changes on security-market rates out to around two years maturity, which might be thought of as the period over which markets can form reasonably well-based expectations of policy responses to foreseeable developments. Results on the determinants of long-term bond yields do not really provide a coherent picture but suggest that these are best characterised as reflecting a combination of forward and backward looking factors along with significant international influences. The backward-looking elements should not be underplayed, and in particular it seems that the lags in the effect of past inflation on nominal bond yields can be quite long. Effects of cash rates on key borrowing and lending rates are also subject to variable lags attributable to interest-rate smoothing by financial institutions, but there is some evidence of these lags shortening as markets become more competitive and contestable.

The influence of interest rates on the exchange rate represents an important component of the transmission process, but one where empirical analysis has not been very successful in linking theory to actual behaviour. A standard assumption in macroeconomic theory is that of uncovered interest parity, which relates expected exchange rate movements to interest differentials. This assumption allows a neat conceptual framework for exchange-rate determination whereby the steady-state exchange rate is thought of as being tied down by variables determining the long-run equilibrium, and the path of adjustment to that equilibrium is determined by the expected path of future interest differentials. Unfortunately, however, empirical evidence consistently rejects the joint hypothesis of rational expectations and uncovered interest parity, often finding that interest differentials have insignificant or wrong-signed coefficients as predictors of exchange rate movements.[10] A recent example for Australia is a study by Gruen and Kortian (1996) which finds that predictable terms-of-trade movements generate predictable excess returns with respect to the $A exchange rate.

Notwithstanding these results it would seem undeniable that exchange-rate determination is strongly forward-looking and influenced by monetary policy settings, raising the question of whether or not the uncovered interest parity assumption might nonetheless be a useful approximation for the purposes of model-building. It is hard to give a categorical answer to this, since there is a lack of

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[10] Studies by Gruen and Gizycki (1993) and Gruen and Menzies (1995) argue that these failures could be consistent with 'near-rationality' or with the presence of a subset of less-than-fully rational participants in the foreign exchange market.

obvious alternatives despite the poor empirical performance of the hypothesis. Gruen and Wilkinson (1994) estimate a model of Australia's real exchange rate over the post-float period which they find to have good fit both within and out of sample, using the terms of trade and real interest differentials as explanatory variables.[11] They report that long-term interest rates dominate short-term rates in the equation. Despite the good statistical properties reported, the implications of their results for a structural model are not clear, since the estimated equation is essentially a reduced form relationship among endogenous variables. In particular, interest rates and exchange rates are likely to be closely inter-related contemporaneously, making cause and effect relationships between them difficult to disentangle. For the purposes of policy analysis it makes sense to think of the exchange rate as being influenced by short-term interest rates, even though such effects may well be difficult to estimate empirically given the severe problem of simultaneous causation. As noted by Friedman (1995), this is part of a general problem of identifying the effects of monetary policy actions where those actions are largely systematic responses to movements in other macroeconomic variables that they also affect.

### 3.2 The Role of Money and Credit

A formal policy role for monetary aggregates (in the form of a 'conditional projection' for M3) was abandoned in Australia in 1985. This reflected an assessment that the aggregates were too unstable in their relation to final objectives to serve as a policy anchor. As noted above in Section 2, this does not necessarily preclude a role for money and credit as indicator variables, but their information content with respect to final policy objectives needs to be continually re-assessed.

The most comprehensive recent study on this topic was by de Brouwer *et al.* (1993) who tested the stability of a variety of money-demand functions and assessed the sensitivity of these relationships to alternative definitions of the key variables and to different testing procedures. Evidence of cointegration between money, income and interest rates was not particularly strong, and the results were sensitive to changes in the definition of activity and interest rates and to the testing procedure used. No evidence was found of cointegration between M1 and income, and only scant evidence for the money base. Of 192 feasible combinations of the real money base,

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[11] Other work by Blundell-Wignall, Fahrer and Heath (1993) and Tarditi (1995) built on these results.

real activity, nominal interest rates, and estimation techniques that were considered, evidence supported cointegration in only 11 cases. Results were similarly negative in the cases of M3 (4 out of 60 combinations) and Broad Money (5 out of 30). The strongest evidence was found for currency (8 out of 24 combinations) but this relationship has since deteriorated, with the ratio of currency to income shifting markedly beyond the sample period used for the formal tests. These results confirm the impression of instability apparent from eyeballing the data in Figure 2. Since cointegration is a minimal requirement for a stable money demand function, the results are not supportive of a stable role for money aggregates in the transmission process.

Alternative methods applied in earlier studies gave qualitatively similar results. A study by Bullock, Morris and Stevens (1989) using graphical evidence and correlation analysis emphasised the leading and coincident negative relationship between short-term interest rates and private demand, and found relationships involving the monetary aggregates to be generally unstable. VAR analysis by Stevens and Thorp (1989) looking at relationships between financial and activity variables found the role of money aggregates to be weak and highly sensitive to model specification and to the sample period.

An issue that has received increasing attention in international literature recently is the possible role of a 'credit channel' in monetary transmission.[12] Theories of the credit transmission channel focus on market imperfections such as information and monitoring costs which limit borrowers' access to credit. These imply that access to credit for financing investment is likely to be affected not only by the risk-adjusted profitability of a given project, but also by factors such as the borrower's available collateral, cash flow, reputation, and other indicators of credit-worthiness, with credit rationed in equilibrium on the basis of a range of such criteria. This has two important implications. First, changes in interest rates and in business cycle conditions could be expected to have distributional and efficiency consequences related to systematic variation in borrowers' access to credit. A rise in interest rates will tend to reduce investment in projects that are least profitable, other things being equal, but the effect will be strongest in sectors where credit-enhancing factors such as collateral are scarce. Second, because the severity of credit rationing is likely to be an increasing function of the general level of interest rates, the credit channel

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[12] For recent surveys see Bernanke and Gertler (1995) and Cecchetti (1995).

represents a potential amplifying factor in the transmission of monetary policy. It is also likely to interact with macroeconomic developments, such as asset-price swings and trends in balance-sheet strength, which influence assessments of borrowers' credit-worthiness.

Tests of these propositions reported in the international literature do not focus strongly on the role of credit aggregates in macroeconomic outcomes; proponents of the 'credit view' argue that the role of these aggregates is not central to the story, since the stock of intermediaries' credit outstanding does not really measure variations in the impact of credit rationing. Rather, the emphasis in empirical work has been on examination of factors affecting the availability of credit at the firm or industry level. Results summarised by Bernanke and Gertler (1995) for the US are supportive of a role for credit-availability factors in explaining borrowing and investment at this level, and are thus consistent with the operation of a credit channel in monetary transmission.

Recent Australian studies are also supportive of such a channel. At an aggregate level, Lowe and Rohling (1993) find significant effects from various measures of balance-sheet strength on the availability of finance to business and, in particular, that rises in asset prices and in corporate equity tend to make finance easier to obtain. Panel data studies by Shuetrim, Lowe and Morling (1993) and Mills, Morling and Tease (1994) give a more detailed picture of the role of credit-factors in business behaviour at the firm level. They find that, in addition to macroeconomic influences, firms' borrowings and investment are influenced by a number of plausible indicators of credit availability. Most important among those are firm size, growth, collateral and cash flow. The influence of these factors on investment behaviour is found to be particularly strong for small firms. All these channels are probably difficult to capture in macroeconomic models, but a key lesson seems to be that interest rate changes interact with other macroeconomic factors in a way that potentially reinforces their impact on investment. The recent asset-price cycle is a leading example.

## 3.3 Effects of Financial Variables on Activity and Inflation

A recent review by Grenville (1996) identifies five main channels by which monetary policy affects activity and inflation:

- 'intertemporal substitution', broadly defined as the effect of interest rates on the incentive to postpone expenditure;
- effects operating through the exchange rate on the tradeable sector;
- cash-flow effects on liquidity-constrained borrowers;
- a wealth channel operating via the effect of interest rates on asset prices; and
- credit supply effects.

Further to these could be added an expectations channel, referring to the direct influence of policy decisions on expectations of inflation and growth. The discussion that follows cites evidence concerning the overall magnitude and timing of monetary transmission.[13]

Two recent studies give estimates of the overall impact of interest rates on activity. Gruen and Shuetrim (1994) estimated a model of the Australian business cycle which specified real growth as a function of a weather indicator, the terms of trade, foreign output and real cash rates, finding a significant impact of real cash rates on GDP with lags of 6 to 18 months. The estimates imply the peak effect of a temporary 1 percentage point decrease in real cash rates (sustained for one year) raises four-quarter-ended GDP growth by about 0.4 per cent, and the level of GDP by about 0.65 per cent. Unpublished analysis by the authors suggests that similar results are obtained using alternative interest-rate maturities but that the two-year bond rate gives perhaps the best explanatory power. No independent role is found for the exchange rate in this aggregate equation, although effects of the exchange rate on the tradeable sector are well documented elsewhere.

Broadly similar results concerning the impact and timing of interest-rate effects on activity were obtained by Lowe (1992) in a study of the predictive power of the yield curve. Consistent with international evidence it was found that the slope of the yield curve (proxied in this study by the difference between yields on 10 year Treasury bonds and 180 day bank bills) has predictive power for a wide range of real variables including GDP, consumption, investment, a production index,

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[13] Grenville (1996) gives a detailed discussion of the separate channels identified above.

dwelling approvals and car registrations. Predictive power for most variables is significant in the range of 9 to 18 months ahead, with somewhat shorter lags evident in the case of dwelling approvals. At its peak, a 1 percentage point increase in the yield spread predicts increased GDP growth by 0.6 percentage points. If it is presumed that policy influences the slope of the yield curve mainly by moving the short end, these results suggest effects of similar magnitude to the Gruen-Shuetrim equation. Investment and dwellings are found to be the most interest-sensitive sectors, although significant predictive power for consumption is also obtained.

Lowe also tested for information in the yield curve about future inflation. Significant predictive power was found although the estimated lags were perhaps implausibly long, the strongest effects occurring at around 24 to 36 months out.

Econometric studies of the inflation process by Stevens (1992), Cockerell and Russell (1995) and de Brouwer and Ericsson (1995) have adopted the general approach of modelling inflation as a function of domestic labour costs, import prices and measures of demand pressure, implicitly incorporating the view that policy affects inflation indirectly through its impact on these variables. Although the specifications adopted in these studies differ in important ways, the results emphasise a number of common points. First, the inflation process is subject to considerable inertia, as represented by the adjustment lags built into the estimated wage-price dynamics. Second, the estimated equations show a strong role for import prices in overall inflation, substantially bigger than the import share of expenditure (de Brouwer and Ericsson report a long-run coefficient on import prices of 0.4). This represents a powerful channel by which monetary policy can influence inflation via the exchange rate. Third, significant demand effects are captured by output gap measures, which generally enter with lags of one or two quarters. This is qualitatively consistent with Lowe’s result, described above, that policy lags are longer on prices than on activity.

It is possible also to imagine monetary policy having a direct effect on inflation by influencing expectations. To the extent that the policy framework does influence inflation expectations directly, it seems sensible to think of this as working through the numerical objective itself, rather than through any intermediate variable such as money growth. Hard evidence on the importance of an expectations channel is difficult to come by, but the apparent inertia in inflation rates and sluggishness of expectations suggests the effect is not particularly strong. This seems to be confirmed by econometric evidence for Australia, New Zealand and Canada which could not find a role for the effect of policy targeting regimes on expectations independent of their effect on inflation itself.[14]

### 3.4 Summary

The preceding discussion suggests a reasonably clear *qualitative* picture of the working of the policy transmission process. This can be broadly summarised as operating, in the first instance, via the effect of short-term interest rates on private expenditure, both directly and through effects on the exchange rate and on credit supply. Inflation is viewed as being influenced by monetary policy primarily through effects on the output gap and through the exchange rate. The inflation process appears to be subject to considerable inertia but, over time, the policy framework may also play a direct role in shaping inflation expectations. This description leaves no special role for monetary aggregates except as part of a menu of variables that might convey information to policy-makers about price and output trends. Plausible efforts can be made to quantify some, though not all, of the various parts of the transmission process and to estimate the length of the relevant lags. The areas where quantification seems to be relatively plausible (though the accuracy should not be overstated) include the transmission of cash rate changes along the yield curve, the effects of interest-rate changes on expenditure and the mechanics of the inflation process. Much greater uncertainty applies in other areas such as the effect of monetary policy on the exchange rate and the role of expectations in private sector decisions.

## 4. General Observations

In a review of the RBA experience with macroeconomic modelling, published in 1980, Jonson and Norton drew a series of lessons, the first of which was, ‘it is hard to build a good model’. We conclude by outlining a number of reasons why that observation remains valid, at least as it applies to the problem of quantifying the effects of monetary policy. There are four points.

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[14] See Debelle (1994).

The first point concerns the problem of disentangling cause and effect. Most monetary policy actions are both causes and consequences of developments in the wider economy, and empirical separation of the two is unlikely to be straightforward. At the simplest level, this is the problem that (for example) interest-rate increases are contractionary but are often correlated with the high growth and inflation outcomes that induce them. Econometric analysis obviously has tools to deal with this standard simultaneity problem, but Friedman (1995) argues that these techniques might not always be very effective in practice. If monetary policy actions are mainly systematic responses to the broad macroeconomic forces affecting prices and output, it may be hard to get good instrumental variables for those actions. Use of lags in econometric equations to overcome this problem will not necessarily be effective, since monetary policy actions are, by nature, anticipatory and might reflect non-modelled information about future inflation and output. Friedman argues that this characteristic can lead to artificially low, or even incorrectly-signed, estimates of the effects of policy: in particular, if monetary policy is aimed at only partially offsetting future price and output shocks (as is optimal under plausible assumptions), policy actions will be correlated with subsequent price and output movements in the opposite direction to their true causal impact. Or, if monetary policy were fully successful in stabilising prices and output, it would appear *ex post* to have had no effect because the supposedly affected variables would not have moved. All this points to the conclusion that, even where econometrically stable relationships exist, it might nonetheless be hard to get good estimates of the effects of policy actions. It is also possible that the lengths of transmission lags are over-estimated.

A second problem concerns the unexplained behaviour of the exchange rate, a key variable in the policy transmission process. Policy analysis requires estimates or assumptions concerning all the channels of transmission and results are dependent on the full set of such assumptions. In this context the exchange rate poses serious empirical problems. The standard theoretical assumption linking exchange rates to short-term interest rates is the uncovered interest parity equation. As discussed earlier, this theoretical relationship is convincingly rejected by the data with a number of anomalies apparent, including wrong-signed coefficients and, in Australia, excessive sensitivity of the exchange rate to the terms of trade. Attempts to rationalise these sorts of results by expanding the framework to incorporate models of financial risk premia have not been successful. A related strand of literature, initiated by Meese and Rogoff (1983) emphasises the poor performance of macroeconomic models in tracking exchange rates out of sample. These sorts of results are essentially negative in the sense that they do not show how to obtain an alternative model of the structural interactions between policy and exchange rates that is empirically convincing.

Thirdly, there is a set of issues that might be summarised as the problem of non-mechanical linkages. This refers to a wide range of one-off factors, shifts in unobservable variables like expectations and business confidence, and 'long and variable lags' of policy transmission, that are not easily amenable to mechanical modelling. Econometricians might be tempted to classify all such problems as components of model error terms. But the point is that many of these influences can be big enough and persistent enough to shape the characteristics of an entire cycle. Examples include the effects of financial deregulation, the role of the Accord, and the recent asset-price cycle, or a major structural shift like the transition to low inflation. Another example is the apparently differing severity of reactions of the economy to episodes of monetary tightening in the mid and late 1980s. What these sorts of events illustrate is that good explanation of any medium-term episode is likely to involve a significant role for factors special to the period, and an understanding of these factors is needed to complement more mechanistic approaches to quantifying the role of policy.

Finally, there is the problem of model uncertainty – that is, uncertainty about the structure and parameters of the economic model. It seems clear that models can give predictions and policy messages that differ from one another to an economically significant degree. Because models differ in basic design features like size, data periodicity and theoretical underpinnings, there is no straightforward criterion for determining which is 'the' correct model or which is, in some overall sense, most useful for policy analysis. This source of uncertainty is argued to have important implications for policy.[15] In particular, if policymakers are risk averse, model uncertainty will generally be an argument for reduced 'activism' in policy relative to the certainty case, in the sense of reducing the degree of responsiveness of the policy instrument to a given shock. Intuitively this is because, when the model is uncertain, the results of a policy action are more uncertain the bigger the action. Since any individual model assumes away this source of uncertainty, models are

[15] The argument set out here is elaborated by Blinder (1995).

likely to overstate the attractiveness of policy activism and the degree of macroeconomic control that can reasonably be attained.

All of the points raised here are really aspects of inherent uncertainty about how the economy works. They are not intended as arguments against the use of large scale econometric models, since these uncertainties apply in one way or another to any form of policy analysis, but they do argue for modesty about how much accuracy can be achieved. They also suggest an important role for sensitivity analysis of model results, and evaluation of policy rules across a range of alternative model specifications.

## 5. Figures

**Figure 1: Cash Rate**

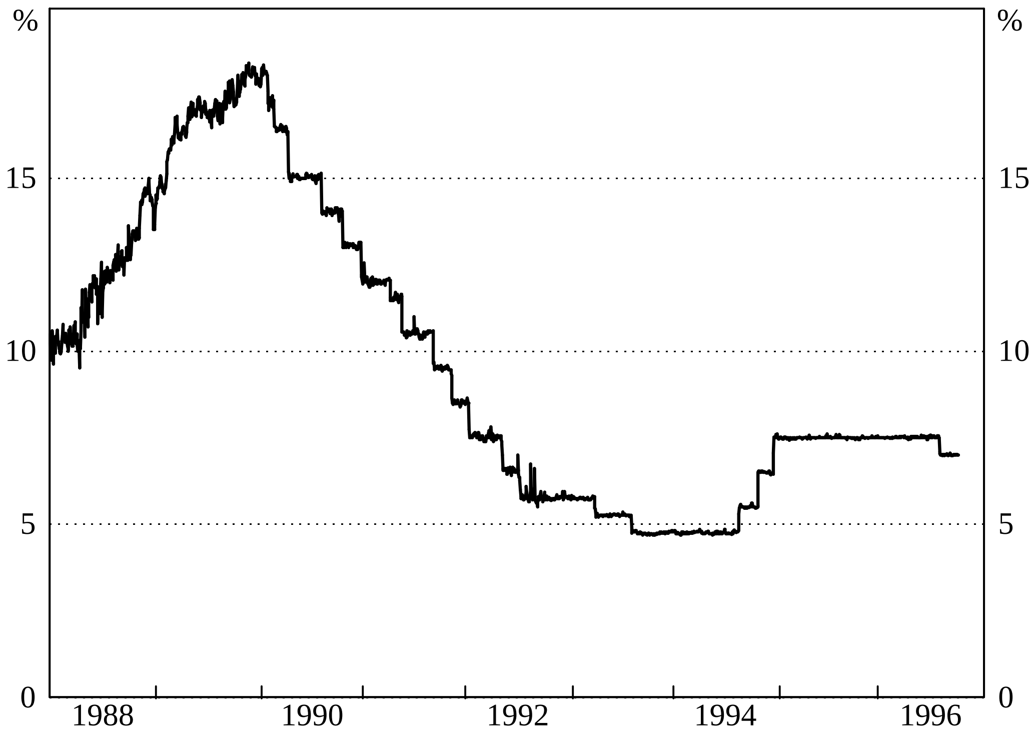
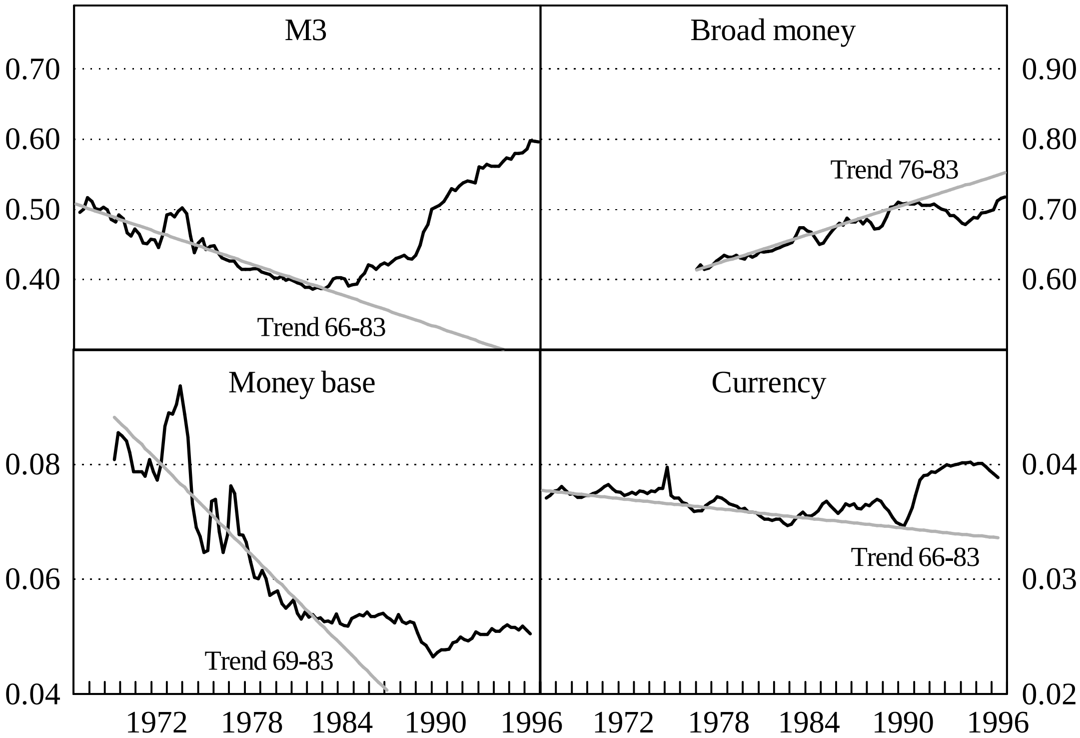


**Figure 2: Monetary Aggregates**

Ratio to GDP



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