
Bank's response to the Pagan Report

Introduction

The Bank of England's Monetary Policy Committee (MPC) was set up in May 1997. Its remit is to meet the Government's inflation target—currently set at 2½% for RPIX. The Committee reviews its procedures regularly to ensure they constitute best practice and are appropriate for purpose. In addition, the non-executive Directors of the Court of the Bank have a statutory duty under the Bank of England Act 1998 for the oversight of the MPC's processes. Review by informed external experts represents one mechanism whereby the Committee refines its processes and procedures and simultaneously assists the non-executive Directors of the Court in the execution of their oversight duties.

In 2000, Court invited Don Kohn of the Federal Reserve Board in Washington to conduct an external review of the MPC's procedures. His Report, and the Bank's response, was published in the Bank's *Quarterly Bulletin*, Spring 2001. That Report focused on the procedures of the MPC itself and only tangentially touched on the technical analysis and forecast material provided to the Committee by the staff of the Bank's Monetary Analysis Division. In Autumn of 2001, and acting on a recommendation by the House of Lords Select Committee on Economic Affairs that the Bank conduct an audit of its forecasting methodology and assumptions, Court decided to commission a review of that technical work. The review was intended to complement that conducted earlier by Mr Kohn.

Court invited Professor Adrian Pagan of the Australian National University and Nuffield College, Oxford, and a former member of the Board of the Reserve Bank of Australia,⁽¹⁾ to conduct the review. The Bank is extremely grateful to Professor Pagan for agreeing to undertake it and the thoroughness with which he approached his task. To facilitate his work, Professor Pagan spent a total of about two months at the Bank during the first half of 2002 reviewing the Bank's technical and forecasting activities, interviewing the staff and current and former members of the MPC, and attending a number of key forecasting meetings. He returned in December 2002 to

discuss his findings with both Court and the MPC, and with the staff of Monetary Analysis.

Professor Pagan's remit was to "...report on the statistical and economic modelling and forecasting work carried out by the staff of the Bank for the MPC and evaluate whether that work is 'state of the art.'" In particular, he was asked to:

- focus on the technical aspects of the modelling and forecasting process, rather than the procedural and presentational issues addressed by the Kohn Report, and judged against the purposes set out for the monetary policy regime;
- cover the full range of modelling and forecasting approaches presently employed by the Bank and note where these methods lag behind best practice or are capable of improvement;
- identify any additional techniques or approaches that could usefully be employed; and
- evaluate the procedures for ex-post forecast evaluation.

The Bank welcomes Professor Pagan's perceptive and insightful Report. It believes that it contains important observations about economic modelling and forecasting in general, as well as a number of recommendations as to how the current process at the Bank of England might be improved. As with the Kohn Report, the Bank has decided to publish Professor Pagan's Report. Publication serves two purposes. First, it is in the tradition of making transparent the process by which monetary policy is formulated. It also reveals some of the information the non-executive Directors are able to draw on in their oversight of the MPC. Second, as already noted, the Report discusses a number of general modelling and forecasting issues. Consequently the contents of the Report should be of interest to those outside the Bank involved in preparing economic forecasts and commentating on them.

(1) The Australian equivalent of the MPC.

Court and the MPC have discussed the Report. The response below concentrates on the most significant issues that emerge from it. Corresponding to the remit, these are: whether the current modelling process is 'state of the art' and fit for purpose; how the models are developed and what additional techniques could be employed; and forecast performance and evaluation.

Is the modelling process 'state of the art'?

The Report notes that there is a spectrum of modelling approaches, ranging from tightly specified calibrated theoretical models (dynamic stochastic general equilibrium models) through to purely empirical models with little explicit theoretical content (vector autoregressions). Models are used to aid the MPC's thinking about the forces at work in the economy as well as to produce projections, and no single model is likely to be appropriate for all purposes. A model needs a clear theoretical structure that is consistent with the MPC's vision of how the economy functions if it is to help the Committee interpret the underlying economic forces moving the data. And a model ought to provide a satisfactory explanation of the historical experience if it is to be used with any confidence to make projections, although a good econometric fit does not in itself guarantee that a model will produce accurate forecasts. As all models represent gross simplifications of a complex reality, conflicts between the two objectives inevitably arise. The Report recognises this and consequently does not advocate the adoption of a single approach for all purposes. It is thus consistent with the Bank's 'suite of models' approach, which relies on a plurality of models to inform the Committee's judgments.

There is, however, a quarterly macroeconomic model (MM) that is the primary tool employed by the staff and the Committee in the construction of the projections contained in the quarterly *Inflation Report*. After considering how the MM relates to the current spectrum of modelling approaches, Professor Pagan concludes that greater theoretical coherence and consistency with the MPC's beliefs would be achievable without any sacrifice of empirical fit. Accordingly he believes that the MM does not represent the 'state of the art'. The Committee agrees with that assessment.

Prior to the commissioning of this review, the MPC had already recognised that the MM had a number of

deficiencies that limited its utility for analysis and forecasting. In particular the underlying analytical structure is not fully articulated and there are some obvious linkages that are absent which presently have to be catered for through ad hoc adjustments. The Bank has therefore directed some of its research effort in 2001–02 into the development of a new macroeconomic model (NMM) that has a more consistent and clearly articulated structure, and which better captures the MPC's vision of how the economy functions. The Bank welcomes Professor Pagan's conclusion that, at least in intent, the NMM appears to be 'best practice and to correct many of the difficulties of the current model'. However, as the NMM is still under development, Professor Pagan felt it was too early to judge how successful it would be in practice.⁽¹⁾ The Committee expects that the NMM will become functional during the course of 2003 and has invited Professor Pagan to produce a postscript to his Report covering the NMM in due course.

The Committee believes that it is worth stressing that the NMM does not represent a significant shift in its view of how the economy functions or the transmission mechanism of monetary policy. Rather it seeks to provide the Committee with a more useful and flexible tool to aid its deliberations. Its adoption should therefore not by itself lead to any significant change in the Committee's assessment of the prospects for inflation and growth.

Diversity of models and model development

The Report recognises that there is already a diverse range of models developed for policy analysis within the Bank. Most of them were developed to illuminate particular analytical issues, but a number are also now used to generate forecasts during *Inflation Report* rounds as a cross check on the Committee's projections. Professor Pagan's report suggests that for this latter purpose there would be value in focusing on those models that contain extra information relative to that contained in the MM. He also suggests that further experimentation with some specific alternative approaches (Bayesian vector autoregressions and models with evolving parameters) might be worthwhile. The Bank intends following up both these valuable suggestions.

(1) Professor Pagan classifies the NMM as an 'incomplete dynamic stochastic general equilibrium' (IDSGE) model, perhaps with some 'Type II hybrid' features thrown in. His stylised Figure 1 may therefore seem to imply that the NMM can be expected to fit the data less well than the MM. While the Bank does not disagree with Professor Pagan's general characterisation of the NMM, the intention is to provide a more coherent and flexible analytical structure with at least as good an empirical fit as the MM, ie it involves a move up—or even up and to the right—in Figure 1.

All models are gross simplifications. It is therefore inevitable that any particular model may fail from time to time to explain some facets of the data. Constant model maintenance is therefore required to deal with new problems or puzzles. Professor Pagan provides an instructive commentary on a particular example of this—the equation for the GDP deflator in the MM—and concludes that sometimes too much effort is focused on ‘tinkering’ in order to improve the fit of an equation rather than the consideration of alternative paradigms that might provide a more fundamental solution. He also argues that such new thinking often originates outside the group of staff directly involved in production of the forecast. This criticism is well taken. The Bank will seek to make more room in the forecast process for exposure of alternative approaches. It is also seeking to facilitate experimentation by those outside the forecast group through the adoption of user-friendly modelling software and more streamlined data-management processes.

The Bank concurs with Professor Pagan's view that model development should be a continuous process. It will provide continuing resources for this type of work after the NMM is up and running.

The forecasting process and forecast performance

The models developed and used by the Bank staff are merely tools to help the Committee discuss issues in a structured and quantified way—there is no automatic link between either the MM, or any other model, and the MPC's projections for growth and inflation. Professor Pagan's Report recognises that economic forecasting is not a mechanical process and that judgments by the staff and the Committee have played a crucial role in generating sensible projections. Such judgments are required in respect of the interpretation of recent data, in the projection of exogenous variables and residual adjustments into the future, and from time to time in the explanation of why the relationship between certain variables may have shifted.

The Bank notes that Professor Pagan is broadly content with the way such adjustments have been developed and applied by the staff and the Committee. It also notes the Report's conclusion that the deficiencies of the MM have not in themselves detracted from the accuracy of the MPC's forecasts, although those deficiencies may have

reduced the usefulness of the MM and led to an enhanced need for supplementary models.

While forecasting is not a mechanical process, the analysis of past forecast errors may help to shed light on deficiencies in the models, as well as in the Committee's thinking. For this reason the Bank conducts regular analysis of its forecast errors. Professor Pagan concludes that the ‘Bank has been quite sensitive to the need to perform ex-post forecast evaluation’ and that ‘the work in this area has been of high quality and certainly of adequate quantity’.

There has been a certain amount of public commentary on the tendency, documented in the August 2002 *Inflation Report*, for two-year ahead inflation outturns to run persistently somewhat below the corresponding projections since independence, resulting in an average overprediction of around 0.5 percentage points for projections made between February 1998 and May 2001. Professor Pagan provides a simple, but revealing, analysis of the persistence and bias in the MPC's successive inflation projections. He concludes that the high degree of persistence in the inflation process itself implies that runs of over or underprediction at the two-year horizon are to be expected and that recent experience is not particularly unusual in this respect. Moreover his analysis shows how that same persistence in the inflation process can turn a quantitatively extremely small overprediction in the one-quarter-ahead inflation rate into a much larger overprediction of the annual inflation rate two years out. The Bank welcomes his conclusion that ‘...the ‘bias’ is probably as small as one could reasonably expect’ and that ‘...an observed bias in the forecast of the annual inflation rate two years out of just 0.5 percentage points is a tribute to the abilities of the Bank staff and the MPC.’ Nevertheless the Bank is not complacent about its forecasting record and will continually seek to learn the lessons from past and future forecast errors.

Finally Professor Pagan recommends that more attention be paid by the Committee to the joint distribution of inflation and growth. The Committee intends giving further consideration as to how information on the joint outcomes for growth and inflation might be best presented and exploited in its procedures. It will also consider whether presenting such information could enhance its public communications.