ON DEVELOPING A STRUCTURED FORECASTING AND POLICY ANALYSIS SYSTEM DESIGNED TO SUPPORT INFLATION-FORECAST TARGETING (IFT)[1]

Douglas Laxton and Alasdair Scott

I. INTRODUCTION

Countries that have had a long history with flexible exchange rates and implementing independent monetary policies have had considerable advantages making the transition to explicit inflation-forecast targeting (IFT) frameworks. This is because they had already had most of the systems and expertise in place to support IFT. However, for countries that have made a much faster transition from fixed exchange rates to IFT, developing the internal monitoring and forecasting process has been more difficult.

In response to this situation, this document provides a basic plan and critical path to develop a simple forecasting and policy analysis system (FPAS) to support inflation-forecast targeting (IFT) in countries that are considering creating (or have recently adopted) an IFT regime. The arguments in the paper are based on our view of 'best practice' for IFT, and an assessment of how that practice can be feasibly transplanted to the monetary institutions that potentially face challenges of limited resources and fast-changing economies. To this end, we deliberately avoid reference to specific institutions, because we feel that no one institution anywhere has a monopoly on what constitutes best practice. Instead, while institutions that are new to IFT or looking to move to such a framework undoubtedly face a challenge, they also possess the advantage of being able to consider the whole picture of what is required for IFT. This paper is intended to assist those institutions in that situation.

[1] The views expressed in this paper are those of the authors and do not necessarily represent those of the IMF or IMF policy. The authors would like to thank Warren Coates, Guy Debelle, Aaron Drew, Tibor Hledik, Ben Hunt, Peter Isard, David Mayes, Guy Meredith, Katerina Smidkova, Lars Svensson, Bob Tetlow and Mark Zelmer for many helpful comments and discussions. We also thank Victoria Ashiru and Dawn Heaney for providing excellent assistance in preparing the paper. The authors remain responsible for any errors and omissions in the text.

The proposed development strategy in this paper is based on a belief that many of the difficulties associated with developing the systems and expertise required for IFT are usually a result of two fundamental problems:

- First, there may be an attempt to develop the perfect system too quickly, at the expense of not achieving a minimum acceptable degree of functionality in the short run.
- Second, an effective IFT system requires considerable integration of its parts—the reporting system, human capital development, information technology, database management etc. Hence, there may be considerable time and resource costs associated with attempting to develop parts of the system independently of other parts. For example, until an effective database, intelligence and reporting system has been created to support monitoring and near-term forecasting, it may be premature to devote a lot of resources to building the perfect model of the economy.

Hence, while the system proposed here borrows greatly from the forecasting and policy analysis systems that have been developed over the years in independent central banks, it has been kept deliberately simple. The system can and should be extended as dictated by the needs of the policymakers, but always with a view to the resources available.

The goal of the paper is to outline systems and processes that help the staff of the economics departments in central banks achieve a coherent view of what is happening in the economy, what the key policy implications of that are, and what that implies for research and further investigation.

More concretely, the proposed system involves the following parts.

1. **Developing a reporting, database, and near-term forecasting system based on a limited but key set of macroeconomic variables so that everyone who is involved in the forecast and policy process can share the same information.**

2. Updating the database, monitoring and reports on a timely (weekly) basis so that everyone involved in the process will be informed about how new high-frequency information affects the very near-term inflation forecast (and implications, if any, for the longer-term inflation outlook).

3. Developing a simple quarterly projection model of the economy that embodies policymakers' views about the monetary policy transmission mechanism and the standard set of shocks that affect the economy. The

model may be very simple at first; the important objective is to begin to formalize the manner in which policymakers perceive that key macroeconomic variables respond to their policy instruments. The model should be extended over time as dictated by experience, but the core projection model should not be allowed to turn into a "black box" by becoming excessively complicated.

4. Developing a consistent model-based macroeconomic forecast every quarter. This includes assessing the risks to the previous official baseline forecast and using that to propose changes to the official baseline forecast.

5. Developing measures of uncertainty in the forecast, such as model-based confidence intervals. These measures should be used to communicate the extent of this uncertainty, both internally and to the public.

6. Studying specific risks in the baseline forecast and developing contingency plans for reacting to new information that is released between official forecasts.

The rationale for this proposed plan depends on a number of observations. Inflation-forecast targeting involves using a wide range of information in order to obtain the best forecasts for inflation and the economy. The staff therefore face a "signal extraction" problem, where they must tease out the underlying pressures on inflation and the economy from data that may be conflicting and noisy. In order to efficiently meet this problem, there must be an effective system in place that allows all participants to share information and for each to see how new information—from themselves and their colleagues—affects the official forecasts.

This is critical because successful inflation forecasts are not mechanical; the principal role of models is to see what implications these judgements about the state of the economy have for policy. In fact, in the very early stages of an IFT regime, forecasting and policy analysis may be based entirely on judgement, without the use of any formal macro model. The development of the FPAS can be greatly advanced simply by developing a process for regular meetings and reports, where the bank's staff present recent economic developments and provide an assessment of the risks to the previous baseline forecast. However, as the IFT regime evolves over time, there may be a strong desire within the central bank to impose more discipline and structure on the policy debates by developing a core macro policy model explicitly designed to support IFT. The model may therefore be a natural extension of an existing process, but introducing a macro model into a situation where there is no process for interpreting and reporting data outturns is not likely to be very helpful.

Similarly, it will be difficult for staff to successfully introduce the changes proposed here unless their 'clients' – the upper management who make key policy decisions – are receptive to the need for such a structured process. In what follows we assume that this exists, but there may need to be a preliminary process in which upper management are introduced to the processes described here and persuaded of their benefits. This may take some time, but it is nonetheless absolutely necessary that staff and upper management approach building a structured forecasting and policy analysis process with a clear shared view of what is to be put in place and the ultimate goals.

The remainder of the paper is organized as follows. Section II explains the basic benefits associated with a successful IFT framework and the specific benefits associated with developing a structured forecasting and policy analysis system. Section III discusses the steps that are critical in developing such a system. Section IV describes how the quarterly projection exercise could be organized. Section V provides an outline of a simple model structure that could be used for small open economies and explains some of the technical aspects about the forecast. Section VI explains what would have to be done to develop the internal expertise to develop more sophisticated macroeconomic models to support the forecasting and policy analysis system.

II. Potential Benefits Derived From a Successful IFT Regime and a Structured Forecasting and Policy Analysis System

There are several real benefits that can be derived from a successful IFT regime. These include:

1. Less uncertainty about the future price level and inflation.
2. More efficient allocation of resources because of better price signals.
3. Lower levels of unemployment and higher levels of productive economic activity.
4. Lower real interest rates and higher levels of investment (and permanent income).
5. Improved transparency and policy credibility.

However, the ultimate success of an IFT regime depends on how well the monetary authorities do at avoiding large boom and bust cycles and providing an anchor for inflation expectations. In a fixed exchange rate regime, the performance of the central bank can be monitored – both internally and externally – by reference to well-defined targets which are continually observable in real time. However, in a

floating exchange rate regime with IFT, a central bank needs to rely on internal assessments to determine the appropriate policy stance. Moreover, a clear logical policy framework is needed to support the dissemination of policy to the outside world. This emphasises the need for an internal structure which can provide the basis for internal assessments of the state of the economy and the nature of the underlying pressures challenging the achievement of the target. In our view, the decision-making process inside central banks can be facilitated considerably by the development of a structured forecasting and policy analysis system. Indeed, in our view, there are at least six types of benefits that can be derived from a structured forecasting and policy analysis system. These benefits include.

1. **Improved communication between all the people that are involved in the forecast and the policy debate, leading to important synergies and the continual improvement of the best collective view.**

2. **A more structured debate about the risks in the forecast, allowing policymakers to more easily pick out and communicate the key policy issues.**

3. **The development of a database to assess the historical forecasting record, informing staff where new research effort is required.**

4. **The development of highly specialised human capital.**

5. **The development of institutional knowledge about the monetary transmission mechanism and the effects of disturbances that affect the economy.**

6. **The possibility of greater transparency about the systematic component of monetary policy and how the forecast is developed.**

The challenge for the institution is how to allocate its resources and structure the decision-making process in order to achieve these benefits. In what follows, we assume that the institution has a team of economists on staff, serving a central decision maker such as the governor, president or an MPC.[2] Our plan will involve organising these staff into forecast teams, reporting to the MPC, that can produce and maintain various inputs into a projection process: databases; regular reports; conjunctural assessment; and of course the forecast itself. Our proposed structure is derived from the argument that a carefully structured process will be

[2] For the sake of brevity, from now on we will use the term MPC to signify the decision-making authority, whether that is a committee or solely the governor.

required for the staff to be able to provide the requisite internal advice to the MPC on how the economy is evolving and the appropriate policy response. This will involve being able to reassure the Committee that staff have all relevant information at their disposal, and that the staff are able to extract the key messages from this information. The next section describes the building blocks for this process in more detail.

III. A CRITICAL PATH FOR DEVELOPING A STRUCTURED FORECASTING AND POLICY ANALYSIS SYSTEM

This section provides a critical path for developing a structured forecasting and policy analysis system and the necessary expertise associated with it. An important assumption of the proposed path is that there must be a strategic vision by management of what the system looks like: who is involved; what resources they have; and how the information flows within the institution. If this is well-known and communicated to all staff, then the system is able to exploit the synergies associated with reliance on a shared common paradigm and philosophy, enhanced data integrity, improved communication between staff and management, and the productive exploitation of information technology. Furthermore, there must be recognition by all parties involved in the process that approaches which attempt to develop a perfect system too quickly, or parts of the system independently of other parts of the system, may be doomed for failure.

The initial system (and subsystems) that are proposed here are, by construction, deliberately simple and should be extended as dictated by experience.

Step #1: Creation of a Small Forecasting Team with Well-Defined Responsibilities

The main two responsibilities of the forecast team are to ensure that the forecast process is internally consistent and that the near-term and medium-term forecast is based on all relevant information. To achieve these two objectives, it is critical that the forecasting team has the support of management and can mobilise any resources within the central bank to engage in fact-finding missions.

The responsibilities and focus of members of the Forecasting Team can be usefully separated into two types; those that focus on developing near-term forecasts for the economy (2-quarters-ahead) and those that focus on developing medium-term projections (as well as conducting alternative scenarios that are generated to highlight risks).

We make a distinction between near-term and medium-term forecasts for several reasons. First, in order to build up and maintain credibility, the institution

will usually need to be seen to be able to forecast the near-term reasonably well, both externally and by the MPC. Much of what determines near-term outcomes is often quite idiosyncratic, and therefore difficult to forecast by a macroeconomic model designed to capture stylised business cycle dynamics. In short, expert staff using detailed (often anecdotal) information will have a comparative advantage in forecasting the short run. Second, macro variables are usually quite persistent, which implies that an assessment of pressures underlying the economy will need to include an assessment of those pressures over the near term as well. It therefore makes better sense for a model-based medium-term analysis to begin from when macro variables are more free to move in response to underlying pressures. While it is difficult to be precise about just when this is, we think that treating the two quarters as the near term will work well in practice.

This implies that the near-term and medium-term forecasters have quite different roles. The role of the near-term forecasters is to assess the current state of the economy and to develop near-term forecasts based on all available information. By contrast, the role of Macroeconomic Projections Team (MPT) is to assess how the estimated disequilibria (or imbalances) in the economy will play out (and hence what pressures there will be on policy).

Within the first group, each forecaster should have a well-defined "portfolio", such as monitoring a particular sector. This might be usefully organised along the lines of national accounts expenditure groups, balance of payments, prices and inflation, money and credit, financial markets, and external conditions, hence achieving economy-wide coverage.

While this demarcation of responsibilities is necessary for the team members to work effectively, each member of the team should be aware of their responsibilities to the other team members. An essential part of this is providing constant feedback when it is required to ensure that the forecast process and scenarios are internally consistent.

While there should be well-defined roles, people should not be attached to these roles indefinitely. There should be an ongoing training program in place to ensure that staff can take on other portfolios if and when portfolio holders leave.[3]

[3] Because the required human capital necessary to support an efficient FPAS can be very specific and highly specialized most of the training is best done informally by more experienced staff, or by the staff that manage the small groups. It is very important that management not just reward staff that are good at fighting fires, but they must also reward staff that spend a lot of time training and coaching staff to learn new tasks. This is critical to improve the system over time. Effective

This is necessary to guarantee the integrity of the system over time and to ensure that motivation is kept high. Indeed, in each group that supports the members of the forecast team, it is critical to have positions that are set up explicitly for longer-term projects, training, or to serve as a backup for someone involved in the IFT system. For the purpose of developing human capital, it would be useful if the staff in these groups had strong links with highly qualified research staff in another division that was assigned to execute longer-term research projects. Furthermore, to exploit the benefits of information technology, all staff involved in the IFT system should have direct access to human resources (programmers, research assistants and database managers) that are there to directly assist them with their tasks.

Appendix 1 provides an example of how the responsibilities of the Forecast Team could be defined and organised for a small open economy and how they could report to the Monetary Policy Committee. As mentioned above, while the Forecasting Team should have well-defined responsibilities, the exact composition and responsibilities of the individual team members should depend on the expertise of the available personnel and the other trained resources that the FPS system has its disposal.

Step #2: Development of a Database System Designed to Support Monitoring and Near-Term Forecasting

The first step of the Forecast Team should be to develop a Historical and Near-Term Forecasting (HNTF) database. This database forms a common point of reference for discussions between staff and management. It also obviously forms the basis for trying to assess trends and make judgements about what is signal and what is noise in the latest data outturns. Until it is completed, it will be very difficult to develop a reporting system to management, or to impose consistency and transparency in the forecast process.

This database should include the key macroeconomic aggregates that are used to monitor and forecast the economy. For a forecasting and policy analysis system designed explicitly for IFT, it should also include a significant amount of data to provide the basis for assessing and forecasting trends in the real economy and core measures of inflation. Appendix 2 discusses database management issues

---

managers in the system will recognize that everyone's value will rise if information flows freely both within and across groups. Upper management may need to make it clear that they believe in the philosophy that if you give a man a fish you may feed him for a day, but if you teach him how to fish you will feed him for a lifetime.

in more detail and the relationship between the HNTF database and other databases that need to be created to support IFT. The HNTF database should include the sector-specialists' near-term forecasts for the first two quarters of the forecast as well as historical time series.

The database should be updated weekly and be accessible to everyone who is involved in the forecast and decision-making process. The process of weekly updates forms the basis for continual "filtering" of new information, providing staff with the ability to systematically account for how and why a new outturn affects their view of the state of the economy. This involves discussions of data problems, special factors, and many of the technical aspects that are critical for extracting trends from data. The output is information that can be used in formal reports to management and the public (such as *Situation Reports* and *Inflation Reports*). These discussions also lead to the important "stylised facts" – the staff view of how the economy works—which a formal macro model should be able to mimic.

It is critical that there be clear lines of responsibility about who is responsible for updating each part of the database; for explaining and documenting how the data are constructed, why the data have changed, and any special factors that might have affected them. The databases should also be stored permanently so that they can be analysed periodically. This will help determine if the near-term forecasting system can be improved over time and provide real-time measures of the extent of uncertainty in the near-term forecast.

Step #3: Development of a Weekly Reporting and Intelligence System

The HNTF database serves as a foundation for a weekly reporting system. A weekly report to management or the MPC ensures that new outturns can be assessed systematically, and should reassure the MPC that they have a command of ongoing developments in the economy. This weekly reporting system will produce a standardised set of tables and charts; and will provide the basis for discussing risks associated with the last official forecast.[4] Indeed, within hours of the database update, the chief economist (or a designated backup) should chair a short meeting with the staff and forecast team to discuss possible revisions to the near-term forecast. Shortly after this meeting the chief economist should then report this information to the MPC and explain how the recent data and other anecdotal evidence have suggested changes to the near-term forecast. If the process is

[4] It is important to note that this database system is not intended to replace existing systems for managing the reporting and release of even higher frequency data.

working well, it will just as easily help to ensure that *no* action is taken in those situations when the outturn is in fact truly noise, but where the policymakers might feel compelled to react to an apparently extreme development.

These meetings are intended to provide a regular forum for upper management to ask specific questions to the staff and to question the staff's interpretation of the data (and any related implications for the near-term forecast and monetary policy). All members of the Forecast Team should therefore be present at the meeting with MPC in order to facilitate communications. The chief economist should also invite other staff that were present in the earlier meeting if questions might be posed by MPC members that require their specific expertise.[5] **It is important to note that suggested changes to the near-term outlook should be based on the staff's weekly analysis and that they should not be considered to be the MPC's official forecast. We believe that it is important to distinguish between official weekly forecasts, which must be owned by the MPC, from the near-term forecasts that are used by the staff as a means of communication with the MPC.** Indeed, during the weekly MPC meeting, members of the MPC may request a note to be written that provides a more detailed and structured analysis behind the staff's judgement.

In addition to aiding the liaison between staff and the MPC, the reporting system should provide benefits for the staff themselves. First, it should provide a forum in which staff can understand how new information leads to changes in the very near-term forecast. Second, it will help focus attention on the links required between the actual consumers and producers of data—that is, part of the reporting process is to provide incentives for ongoing contact between staff at the central bank and at the statistical agencies.

We have described weekly meetings as a default option, which raises two issues. First, depending on staff and MPC structure, this may prove to be quite demanding on resources. There is some flexibility here to work with meetings at lower frequencies, and we hope it goes without saying that if resource demands mean that the quality of the information to the MPC suffers then changes would be made. Second, there is the risk that staff and the MPC may become focussed on immediate concerns or very recent data, causing them to focus on the noise rather than the signal. This is an ongoing risk with economic forecasting. We are inclined to think that it will be easier for staff to stay on top of recent outturns with more short meetings rather than fewer longer ones, since at the higher frequency there

[5] This will also have the benefit of giving the staff some exposure to the deliberations of the MPC.

will be fewer outturns to consider. Whether the meetings are weekly or less frequently, the most important question is whether there is any new information that would lead staff to change their view.

We also see these meetings as somewhat independent of the policy decision cycle. The frequency at which the MPC changes the monetary instrument will generally not be a staff decision—in some countries, the MPC may not be bound by a fixed decision calendar at all. In advanced economies, the underlying shocks will tend to be 'economic' in nature, whereas in emerging market economies the policymakers will have to deal with confidence shocks and potentially large swings in asset prices as the result of portfolio shocks. For this reason, we favour the weekly frequency for reports to the MPC, as much of the relevant information will be informal in nature and the MPC will need to feel well-informed about potentially fast-changing circumstances. Indeed, part of the transition process to IFT will involve building up the credibility of the institution and framework via responsive and well-informed communications with private sector commentators.

Step #4: Creation of a Repository for Written Documents

It is important to learn from past experiences and incorporate available information as efficiently as possible. In order to develop this sort of institutional knowledge, it is critical that staff document data problems, special factors, changes in procedures, revisions to data, models etc. In addition, these written documents provide an invaluable resource for new staff as they attempt to learn new tasks or improve on existing ones. The repository system should be simple and the notes should be accessible to everyone in the process. A very simple system is proposed where internal research notes (RNs) are distinguished from memos (MEs), but both are stored in a specific location that staff and upper management can access. This process can be facilitated by computer technology, but it is important to keep the system that manages the repository simple initially when the quantity of written documents is fairly small. As with other aspects of the system, it is more important to get something working as quickly as possible rather than spending too much time and resources trying to develop the perfect system.[6]

[6] For central banks that have a small number of documents the simplest system would be to simply create searchable WEB pages that staff assistants can easily update.
For example, see http://www.imf.org/external/np/res/mmod/biblio/multimod.cfm for an example. Interested users should feel free to contact us at multimod@imf.org for the code that is used to generate these pages automatically after the staff assistants enter new data.

Step #5: Development of a Simple Model of the Economy

As discussed above, the natural extension of the system when these elements are in place is to express the institution's view of the way the economy works in the form of a formal model. It is critical that the model reflects the views of policymakers as well as staff in order for it to be used in policy discussions. In the early stages of working under an IFT regime, it will probably be much easier to achieve this consensus with a small model, with a view to developing the model over time. Moreover, it is much better that a simple model is introduced earlier, rather than aiming to move to a very complex model in one step. Carefully structured and considered model-based analysis with a simple model will prove to be far superior to badly-coordinated and under-resourced analysis with a complex model.

Regardless of how complex the core model is, however, the purpose of the model is to aid staff in interpreting the characterisation of the state of the economy provided by the near-term forecasters. Its insight and usefulness comes from ensuring some degree of macro consistency in the projection process. It should not, however, be treated as a "black box"—in particular, staff should always be aware that there are important uncertainties in the model's assumptions and should attempt to understand the implications of these uncertainties for policy. The model should be improved over time as dictated by experience, but always with the requirement that it retains clarity and is widely understood.

Step #6: Exploring the Implications of Risk and Uncertainty in the Forecast, and Highlighting this Uncertainty to the MPC and Externally

One of the main advantages of using a core macroeconomic model to help organise the projection process is that it can provide a logical foundation for studying the policy implications of uncertainty. Indeed, the potential strength of models designed to support IFT is not that they can forecast the economy very accurately, but that they can be used as organisational devices for developing strategies for dealing with uncertainty.

One useful step may be to compute confidence levels around the forecast. This serves to remind both participants in the Bank and market observers that the forecasts are not exact, and hence in turn that policy decisions should not be swayed by small errors. In essence, the monetary policymaker lives to fight another day, by re-assessing new information and re-setting policy accordingly. On the other hand, this process can also be used to illustrate specific risks around the official baseline forecast in order to warn market participants in advance about how

monetary conditions might need to change in response to new information. By highlighting the risks and uncertainties surrounding the forecast, the Bank will find it easier to communicate these points to observers and to deal with the effects of larger shocks as they arise.

IV. THE QUARTERLY PROJECTION EXERCISE

The quarterly projection exercise has a number of objectives. These include: (1) producing an internally consistent medium-term baseline forecast; (2) assessing risks and uncertainties in the forecast; and (3) providing a regular forum for the deliberations that are necessary for the MPC to develop strategies for implementing monetary policy. The quarterly projection exercise should be completely open and transparent to all people that are involved in the process, and this can be facilitated by a series of meetings and written documents that are circulated before and after the meetings.

The role of the Leader of the Forecast Team is to manage the projection process and to organise the meetings that will inform all participants in the process about how the forecast is being constructed. The quarterly projection exercise should be organised as follows.

Step #1: Production of the Forecast Calendar

The first step in the quarterly projection process is to produce and circulate the forecast calendar. The Leader of the Forecast team should circulate a preliminary version of the forecast calendar to the MPC and the staff at least 8 weeks prior to the release of the national accounts, to be finalized within a week.[7] This means that all of the critical meetings can be scheduled well in advance, so that both staff and management can plan accordingly.

The first date in the forecast schedule—the Issues Meeting—should typically be about two or three weeks before the release of the national accounts. The quarterly projection exercise finishes when the MPC signs off on the baseline forecast and risk assessments. This final, "big picture" forms the basis for the forecast book.

---

[7] This paper assumes that the release date of the national accounts is the critical date for anchoring the quarterly forecast schedule. Obviously, for central banks that do not have a regular quarterly updating of the national accounts they will need to choose a different anchor that is based on the expected release dates of key pieces of data and information.

Step #2: Production of the Issues Paper (2 Days Before the Issues Meeting)

Three days before the Issues Meeting, staff and members of the MPC should submit issues to the Leader of the Forecast Team in the form of written memoranda. The Leader of the Forecast Team should then assemble these smaller issues notes into a complete Issues Paper. We can usefully think of the material in the Issues Paper under three headings:

- changes in the staff's view of how the economy is working, covering proposed changes to the model structure and its properties;
- long-run or equilibrium issues, such as structural imbalances, the trend real exchange rate, the NAIRU, potential GDP etc.; and
- implications of recent data for the near-term forecast.

The Issues Paper should be circulated at least 2 days before the Issues Meeting. After reading it, staff and members of the MPC should be aware of the concerns of all people involved in the Quarterly Projection Exercise.

Step #3: The Issues Meeting (2 or 3 weeks before the release of National Accounts)
(Attended by MPC, Forecast Team and Sectoral Specialists)

The exact date of the Issues Meeting will depend on the time required to consider the topics in the Issues Paper, but would usually be two or three weeks before the release of the national accounts. The Issues Meeting should be chaired by the chief manager of the FPAS, or the person on the MPC who is responsible for the management of the Forecasting and Policy Analysis System. This person has the responsibility that the points from the Issue Paper are worked through. When it is clear that some issues require further analysis, members of the MPC may request further analysis to be conducted and documented by the staff. After the Issues Meeting, everyone involved in the projection exercise should have a good mental picture in their mind about how the quarterly projection exercise will proceed and what the critical assumptions will be. However, they will also be aware of differences in views, and this information will be critical for preparing the risk assessments that will be included in the forecast book.

Step #4: National Accounts Meeting (The day the National Accounts are released)
(Attended by Forecast Team and Sectoral Specialists)

Shortly after the release of the national accounts there should be a meeting with the people responsible for producing the national accounts. This meeting is to assess data quality and to collect any background information that people in the statistical agency might have on special factors that have influenced the data. A short document should be written that summarises these discussions.

Step #5: The Near-Term Forecast Meeting (1-2 Days After The Release of the National Accounts)

(Attended by MPC, Forecast Team and Sectoral Specialists)

Shortly after the national accounts meeting, staff should update the near-term forecast and present the implications of new data and anecdotal information to the MPC. At this meeting there should also be a discussion of the risks to the near-term forecast, and any related risks that these near-term risks might pose for the medium-term forecast. This meeting and the update of the HNTF database provide two of the essential building blocks for the first round of the quarterly projection exercise. It is important to emphasize that the purpose of this meeting is to lay the foundation for the rest of the quarterly projection—that is, to assess the current state of the economy. Members of the MPC should be able to question the staff's judgment and to suggest changes to the basic assumptions that will be used to generate the near-term part of the official forecasts. The intent here is to make near-term forecasts only for those variables that can be assumed to be unresponsive to changes in monetary conditions. For variables such as interest rates and exchange rates, these variables should be allowed to adjust in response to changes in the official short-term policy rate.

Before the official forecast is finalised, there should be an update of the near-term forecast based on any new information that has been released following the near-term forecast. In normal circumstances, this update should be relatively minor. However, in extenuating circumstances, the update may require a slight extension of the forecast schedule. Hence, after the near-term forecasting meeting, everyone involved in the process should have a clear picture of the basic assumptions behind the near-term outlook and therefore be aware of what sorts of new developments would cause a change in view.

Step #6: The First Medium-Term Projection Round (Round 1)

In what follows, it is assumed that a good forecast is not produced in one step but requires several iterations. Each iteration, or round, should serve to highlight inconsistencies in the forecast and build a consensus view about the pressures on the economy and the response of policy. Unless there are extenuating circumstances, it should take about five working days of projection rounds for the forecast to converge. This is obviously not a fixed rule but if the quarterly projection rounds take much longer than five working days to complete it may be that there are potential problems that need to be rectified to make the process more efficient.

The first round serves the purpose of building on the near-term forecast and pulling together all the information required to derive implications from that forecast and the exogenous forecast assumptions for the medium term. This cannot be expected to be fully consistent—that will be ensured by subsequent rounds—but at this stage the objective is simply to gain a "first impression" of the medium term. Hence, the emphasis is upon making sure that all information is brought to the attention of everyone involved in the process.

Formally, directly after the HNTF database has been updated, the Macroeconomic Projections Team (MPT) updates the estimates of the equilibrium measures that are used in the Quarterly Projection Model and then employs the accepted forecasting rules (agreed upon in the Issues Meeting) to derive the first round of the medium-term projection. The results of this round and all future rounds should be available when the staff and members of the MPC arrive each morning.

The reports that are generated and circulated with each quarterly projection round should be transparent about what assumptions have been used to generate the results. Indeed, not only should the system and quarterly projection rounds be perfectly transparent, but each person involved in the process should be able to access a system that will allow them to incorporate changes to the assumptions and to produce scenarios based on their own judgement.[8] After discussing concerns with staff and members of the MPC based on the results in the previous projection round, the Forecast Team should meet at 11:00 a.m. for approximately 60 minutes to discuss any suggested changes that they should make to the baseline forecast. Because one of their key roles is to also make sure that the projection exercise is internally consistent, the baseline scenario should not be changed unless that represents a clear consensus on the part of the MPC. **If suggested changes make the forecast internally inconsistent with other maintained assumptions, then these new changes can be considered as potential starting points for (completely separate) alternative scenarios.** These scenarios will highlight and quantify risks in the official baseline scenario by showing the implications of an alternative assumption for policy. By 1:00 p.m. each day, the MPT should have clear directions from the Forecast Team about the types of judgement that they wish to impose in the next projection round. The job of the MPT is to then construct and circulate the results for the next projection round so that it is

[8] A complete model-based prototype system is being developed at the Fund based on the proposed model discussed later and can be accessed shortly by contacting the authors at MULTIMOD@IMF.ORG.

available the following morning.[9]

Step #7: Imposing Judgment in Subsequent Projection Rounds

In subsequent projection rounds it is the role of the Model Operator (MO) from the MTP to incorporate judgment through the residuals (or the add factors) of the model. This judgement usually arises from the need to refine the aggregate picture produced in earlier rounds—that is, the model should show up inconsistencies between assumptions, leading sectoral experts to adjust their own assumptions in the light of their impacts on the broader picture.

Judgement should be added in small increments. After the daily meeting with the Forecast Team, the Model Operator should prepare a series of mini-projection rounds (Round 1a,1b…) that add judgement incrementally so that it can be quantified and its impact understood. When these rounds have been signed off by the Leader of the Forecast Team, they should then be circulated so that they are available when the staff arrive the following morning.

After each projection round (Round 1, 2, 3…) a set of standard reports should be circulated along with a summary of the changes made to the forecast round and the reasons for these changes. Each daily report on the development of the medium-term projection should show how the current round has changed from the previous round, as well as provide information that shows how it differs from the last official forecast.

While generally the case for judgement comes from looking at the aggregate, "top-down" perspective coming out of the forecast, in some cases it will be useful to take a "bottom up" perspective. Satellite models designed to provide details about specific sub-components should be used to check the consistency of the aggregate picture. For example, if the core projection model contains an aggregate Phillips Curve that is based on the CPI, it would be important to check the consistency of this forecast with other models that include explicit interactions between wages, producer prices and the CPI. If the core projection model contains an aggregate equation for output gap, it would be necessary to check the consistency of the projection with models that attempt to disaggregate the GDP

[9] To ensure that each round is ready in the morning so that the forecast cycle is not allowed to drag on it may involve some overtime (or shift work) by a couple members of the MPT. If it is overtime, it should be compensated for in some way in order to prevent burnout and to make the positions attractive enough that someone can be convinced to do it.

forecast into smaller expenditure components. The choice of how disaggregated these components should become depends on how useful they are judged for monitoring the state of the business cycle, accounting for special factors, or linking the forecast to specific assumptions about external demand conditions. Appendix 3 provides a flow chart that shows the interactions between the core projection model and the satellite models.

Step #8: Forecast Presentation to Staff and MPC

(Attended by MPC, Forecast Team and Sectoral Specialists)

It should take about 5 working days of projection rounds for the forecast to converge. At the end of this period there should be a final meeting with the staff and the MPC. At this meeting they should address the following issues: What changes are necessary for the forecast to become an official forecast? What risks do they wish to highlight in the Risk Section of the Forecast Book? The MPC may actually invite specific individuals on the staff to present their own individual assessment of the risks in the official forecast in order to kick-off these discussions.

After the meeting with the MPC it should take no more than 2-3 days to lock in the official baseline forecast and to prepare the alternative scenarios.

Step #9: Documenting the Forecast Process and the Scenarios

The next step is to write a short forecast book that explains the assumptions used to generate the forecast. This book should provide a short summary and presentation of the forecast. If the model has been revised the model documentation should be updated. These are two areas where Information Technology can streamline these processes and allow the staff to complete these tasks in a timely manner. In addition, the document that explains the objectives of the forecast process should be revised if any changes were implemented during the projection process or any new changes have been approved by the MPC.

Step #10: Post Mortem Meeting

(Attended by MPC, Forecast Team and Sectoral Specialists)

The last step is to have a meeting that discusses what went well and what needs to be done to improve the FPAS in the future. Concrete action plans should be presented at these meetings that are intended to improve the system over time. The issues discussed in this meeting could range in complexity from simple changes in procedures, model structure, additions to the database and management information system to much larger issues such as the development of the next generation of models that are being designed explicitly to support IFT.

V. THE CORE MODEL

Up to this point, we have been deliberately vague about what kind of core model we are assuming for the FPAS. The process described in the previous section and the steps outlined in Section IV will remain essentially unchanged no matter what sort of model is used. In this section, however, we describe in more detail what sort of models could be used for the proposed system.

We stress that the staff will not be able to create the perfect model, or even the model they would ultimately like to use at the first attempt. The staff should not therefore let a preoccupation with the perceived perfect model stop them from establishing the other elements that make up the FPAS (the database, reporting systems, and so on). It is far more important in these early stages to establish a relationship with the MPC and ensure that the MPC is comfortable with the forecast process. The key concern of management should be to establish a forecast process that provides the MPC with the reassurance that they will not be caught out by information that was not properly processed. (Typically, policymakers are much more comfortable and realistic about the idea of making a series of small mistakes, but become decidedly uncomfortable at the idea of making large serially correlated errors.) The core model is only a part of this.

Two further points bear emphasising. First, it is important to keep in mind that any core model should be well directed towards the basic task of inflation-forecast targeting. In this respect, the key value gained from such a model is its ability to help the MPC proceed from the assessment of the state of the economy to the implications for the desired stance of monetary policy. Second, a core model should reflect the collective view of staff and the MPC about the workings of the economy. Hence, we emphasise that the system can and should be kept very simple in the early stages. In the early stages of a regime based on inflation-forecast targeting, it will be easier to come to a consensus view on the nature of the economy when the model is small, probably with only a handful of behavioral equations linked to some key accounting identities.

Given a measure of the output gap or the NAIRU, and a near-term forecast for the next two quarters, the core model could therefore simply be small "gap" model—as outlined in Appendix III—that attempts to provide consistent projections for real GDP, unemployment, inflation, market-determined interest rates and the exchange rate.[10] Such a model completely abstracts from issues about

[10] As noted, it is important to just get started. If a small gap model is not possible, in the very beginning the core model could even be just a benchmark inflation-forecast-based reaction function, such as

the supply side, fiscal solvency, private wealth, and the equilibrium levels of the real exchange rate and interest rates. These are no doubt important. Nonetheless, the use of a model like this would immediately help to start a dialogue between the staff and the MPC about such issues as how aggressively monetary policy should react to the inflation forecast, and what the pros and cons of various scenarios were. It would also allow the staff to discuss uncertainty in the inflation forecast, and the risks to any proposed policy decision.[11]

Because a small gap model abstracts from so many issues and deals only in broad aggregates of inflation and output, demand will probably quickly arise for an expanded version. This can present a number of dangers. Usually, there is a tendency for the projection model to evolve in an ad hoc manner, which usually results in a model that is expensive to operate and maintain. More damagingly, the addition of detail usually comes at the cost of clarity and insight, so that the model becomes something of a "black box". Not merely is this a problem for staff—all but a few staff will effectively become excluded from the forecast process—it is potentially very damaging to relations with the members of the MPC, who, when unable to find a clear story from the model-based forecast, will be inclined to resort to their own judgements and anecdotal evidence, with no guarantee of any sort of consistency in the published forecast.[12]

$rp_t = [1-\lambda][rr* + \pi 4^e_{t+4} + \alpha(\pi 4^e_{t+4} - \pi 4^*_{t+4}) + \beta\, ygap] + \lambda\, rp_{t-1}$, where *rp* is the policy rate, rr* is a measure of the equilibrium real policy rate, $\pi 4^e_{t+4}$ is year-on-year inflation expected 4-quarters ahead, $\pi 4^*_{t+4}$ is the inflation target 4-quarters ahead, *ygap* is the output gap and (α, β, λ) are parameters to be calibrated. Indeed, for emerging market economies it might be wise to set $\beta = 0$ when there is a great deal of uncertainty about the output gap, as when the economy was undergoing rapid structural change and the potential growth rate was highly uncertain.

[11] In short, the effort in the early stages should be on building a relationship with the MPC that emphasizes the value added from being able to talk through counterfactuals.

[12] Indeed, it is strongly suggested that the MDG create a WEB-based system that allows users to modify the assumptions used in the official projection process in order to generate their own scenarios. This will increase awareness of the model's properties, help individuals outside the MDG to engage in risk assessments, and hopefully prevent the model from becoming like a black box to outsiders.

Hence, if there is to be a larger model, it should not be simply to provide more dissaggregation. This can be handled separately by "satellite" models, while preserving the simplicity and clarity of the core model (see Section VI). Instead, it should be because of a demand for more structure by which to provide insight to the data.

The shift from a gap model to dynamic general equilibrium models with such features as stock-flow dynamics and forward-looking expectations is nontrivial, however. It requires highly specialised human capital, powerful solution software and very large demands on data sources. It will also take some time to build such a model, even at the best of times. As an intermediate solution, it may be useful to develop addfactors to the aggregate demand and supply schedules that have a structural reasoning behind them. As an example—one which could be very relevant in transition economies undergoing large fiscal adjustment—is to use the gap model in conjunction with an added composite indicator of fiscal stance. This would measure not just the expenditure component of government spending, but provide an estimate of the likely demand effects that arises when households' intertemporal assessment of government policy is made. That is, any change to aggregate demand as a result of a change in government spending will depend on not just the initial expenditure, but also how households assess the impact on the present value of their labour income (i.e., what taxes are likely in the future) and the extent to which government debt is net wealth. This will depend on the extent to which households have finite horizons, how impatient they are, and the anticipated pattern of future taxes and deficits. In general, there will be important questions involving future potential growth that can only be answered in a more complicated general equilibrium setting, but nonetheless a simpler composite indicator would enable a first pass to be taken at the appropriate counterfactual experiments.

The use of such indicator variables also provides some practice at working with more structural issues. This can make the transition to larger general equilibrium systems easier for staff. The advantage of the larger models in the context of an IFT regime is that they can provide a more careful articulation of the relationship between private agents and monetary policy. This implies moving to models with careful specifications for the motivations of private agents, their intra- and intertemporal constraints, endogenous policy reaction rules, forward-looking expectation structures, and appropriate arbitrage conditions. In a small open economy, there may be important issues relating to tradable and nontradables sectors. Staff will therefore need to be careful that they have the necessary data to work with a model with tightly-specified fiscal accounts and stock-flow relationships.

VI. THE ROLE OF MODELS IN THE FPAS

As was hinted at in Section V, there is a potential role for more than one model in the FPAS. This section contains a proposed structure for using several models to assist in the preparation of inflation forecasts. The approach emphasises the benefits of using many models, each carefully tailored to specific purposes. Indeed, once a small gap model is established, there are probably greater potential gains to be made by adding the sorts of models described here than by moving to a more complex core model.

Behind this argument is the view that no one model will be able to do everything. Any model designed with that intention in mind would be hopelessly complicated and intractable, and therefore would not add any value whatsoever to the forecast process. To put it starkly: models do not add value by mimicking the data, but by providing insight into the economic phenomena that might be behind the recorded data. Models should be treated as tools that allow economists to systematically address issues that they might otherwise miss. In order to provide this sort of insight, they must be as simple as possible; the most obvious way of bringing simplicity to models is for them to be carefully designed with specific criteria in mind.

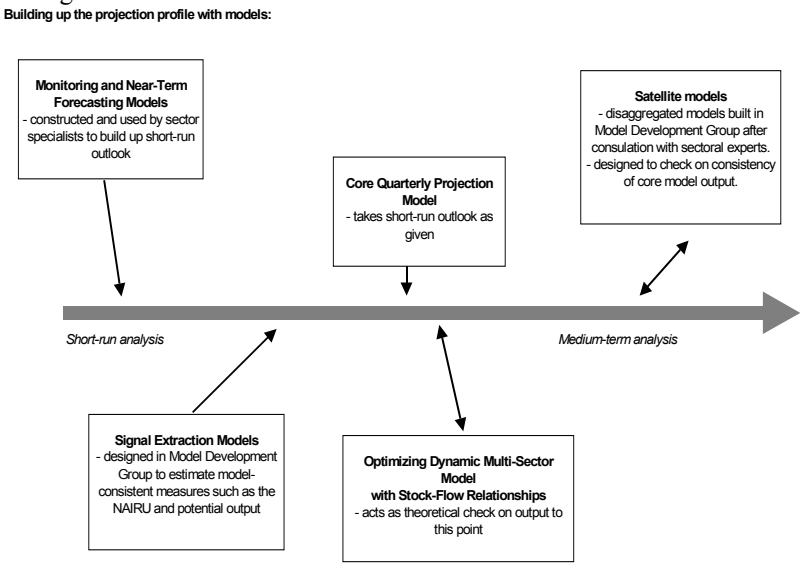
This approach, when taken to heart, means that the model builder may happily ignore some features of the data for a given model. This is in contrast to traditional approaches to econometric model building which emphasise fitting the "true" Data Generating Process above all else. Indeed, when designing models to support an inflation targeting framework one of the easiest traps to fall into is to model features of the data that are in fact purely spurious. This usually guarantees many unproductive hours spent re-estimating the model in a futile quest to uncover the "true DGP".[13]

[13] One of the best examples of such a mug's game would be to ignore the Lucas critique completely by assuming that historical estimates of inflation persistence embodied in reduced-form Phillips curves are structural and then using these estimated models to evaluate the benefits and costs of providing a successful anchor for inflation. Since the underlying objective of an IFT regime is to change the process by which agents form expectations, model builders that design models explicitly to do IFT must make some attempt to address the Lucas critique by separating those dynamics that arise because of expectation formation and other intrinsic dynamics that are less likely to change after the introduction of the IFT regime—see Appendix III and V.

With that in mind, we can think of using a collection of models that allow us to build up the forecast profile. That is, we want to paint a broad picture that starts with the question "Where is the economy now?" and moves to "Where does it need to go to?" In doing that, the Forecast Team will need to answer a variety of questions, such as how much inertia there is in current trends and how close to equilibrium various sectors and markets are. This process helps the MPC answer the most important question of all: What does monetary policy need to do to accomplish its inflation and stabilisation objectives?

We can usefully arrange this in the form of a timeline, running from the short run to the medium term (see Figure 1). **Monitoring and near-term forecasting models** are designed to capture short-run trends. The basic premise behind this idea is that there are important real and nominal rigidities in the economy that imply that the data have a certain amount of momentum from their current short-run trends. These rigidities help us to forecast the near term. The degree of inertia will vary from sector to sector; asset markets are famously volatile and able to reverse trends quickly, while labour markets tend to adjust more slowly. The models used for capturing these aspects of the data will typically be small time series models—often univariate—that are cheap to estimate and maintain. They provide an important insight into the likely path of the economy in the near term, but, lacking any structure, provide no insight at all about the reaction of the economy to economic imbalances or to how the economy might respond to economic policies.

Figure 1: The Role of Models in the Forecast Process



Given a picture of likely short-run trends, we need to form a view on what this implies for the state of the economy. Here we use **signal extraction models**, which might be used to provide insight as to how the current part of the cycle compares to a typical business cycle, or what part of the current short-run trend represents a permanent trend (which we might associate with supply) as opposed to what represents a mean-reverting component (which we could think of as a cyclical demand effect). Because an important objective should be to impose consistency in the projection scenarios, the correct methodology for measuring the NAIRU and the output gap should involve developing the most efficient and robust measures of these unobservable variables that are consistent with the underlying structure of the core Quarterly Projection Model.[14]

Now that the staff have a picture of the likely short run and the key pressures in the economy (such as the state of excess demand in the goods market, as measured by an output gap), they are in a position to use the core **Quarterly Projection Model (QPM)**. This model should be designed to help the staff draw a link between the current pressures in the economy and the implications for monetary policy. To this end, as noted, the QPM can actually be quite small and compact.

Of course, if there are issues in the forecast that relate to permanent real shocks (such as implied by changes in fiscal policy) or if there are important sectoral differences, the staff might want to have a more elaborate model. As noted, added complication brings with it the risk that issues become harder rather than easier to address clearly. One way of ensuring that the core Quarterly Projection Model does not lose consistency and that any new developments add economic insight (rather than simply more detail) is to build and maintain an **optimizing dynamic multisector model**. This sort of model can provide a theoretically tight framework which can be used as a check on the consistency of the core QPM. If the core model was the sort mentioned above, then the optimizing model would provide a check on intertemporal constraints (wealth issues), the effects of real side shocks (such as changes in fiscal policy), and any other issues relating to structural adjustment and long-run equilibria.

---

[14] For a brief discussion about how model-consistent estimates of these unobservable variables can be developed using a constrained-maximum-likelihood approach see Appendix IV. It can be shown that such measures are much more efficient for forecasting than the measures that have been derived by simple univariate models that ignore the links between inflation, unemployment and output. However, more importantly, such measures will result in more robust policy analysis.

This sort of model can also act as a working prototype for developments to the core model. The issue here is that a theoretically "pure" optimising model, while it can provide insight into issues as discussed above, will typically produce quite unrealistic dynamics. These dynamics can often have unfortunate implications. For example, a model with purely model-consistent expectations where all variables are "jump" variables may imply that there is no short-run trade-off between output and inflation, or further that there are no costs associated with disinflation or volatile policy. The challenge when expanding the QPM is to retain the appropriate short-run nominal and real rigidities when incorporating the features of the optimising models. This can be an ambitious undertaking, hence it may be more practical to work with a simpler model as the core QPM in the interim and use the optimising model as a check on theoretical consistency. Nonetheless, the optimising model provides a way forward for expansion of the QPM, which for small open transition economies might usefully make a distinction between tradables vs. non-tradable goods, incorporate intermediate goods into the production process, model a large proportion of households as income-constrained, and pay careful attention to the nature and scope of government in the economy.

None of this implies that the core QPM should be disaggregated for the sake of it. Instead, disaggregation into national accounting components can be accomplished more easily and cheaply by **satellite models**. These are small subsystems which would use simple rules of thumb, based on observed historical patterns, to decompose the output from the core mode into various subcomponents. Hence, a household consumption satellite might take the path for model consumption and break that down into paths for consumption of services, non-durables, durables, and "super-durables" such as expenditure on housing stock. This breakdown can be accomplished based on a knowledge of long-run ratios and estimated dynamic patterns for each of the subcomponents.[15] The satellite models will therefore provide output that may be more accessible and easily understood, and can be checked by sectoral analysts for consistency with previous experience. In some cases, there may be quite idiosyncratic events for subcomponents known

[15] Note, however, that in the case of a transition economy, these historical patterns should be treated with caution. A good example is when financial and housing markets are deregulated, which can be expected to cause large shifts in the ratio of housing expenditure to overall household consumption. Under these circumstances, the model builders may find it more useful to look at the corresponding evidence for more developed economies.

in advance, and this could mean that the staff may wish to revise the aggregate path.[16]

These models therefore form part of a process for the forecast. The benefit of this proposed structure is that the aggregate QPM forms a general overview of the economy, and can therefore be kept very simple and transparent. This is important for the forecast process. It also has the benefit that the core QPM can be easily used for policy analysis.[17] As for the forecast process, it makes no sense to expect that one model will always be suitable for all policy questions.[18] However, it can be very useful for internal communications with the MPC to be able to ask

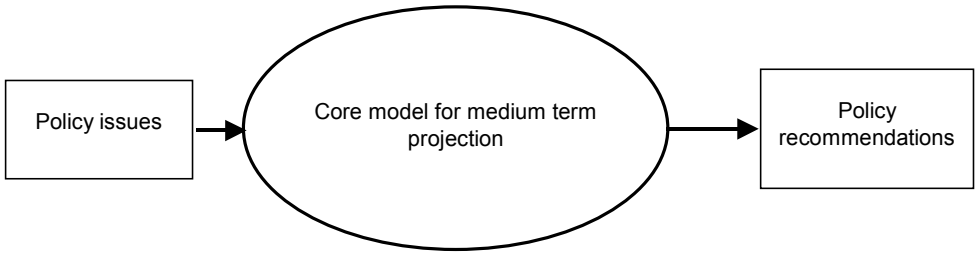
[16] In small economies, this can happen quite easily when there is "lumpy" expenditure on large items or projects. For example, the purchase of an individual airliner or new military expenditure can make a large difference to the aggregate national accounting profile.

[17] In our experiences one of the risks of attempting to build large models for policy analysis is that institutions in many cases miss some of the important insights that can be obtained from smaller models. These include developing consistent scenarios where bond market's expectations of future policy rates are assumed to gradually converge to be consistent with the underlying policy and macroeconomic assumptions embodied in any particular scenario. This does not mean that the central bank's scenarios are always dominant over the market participants' forecasts and indeed one task of the Forecast Team should be to ask what underlying macroeconomic assumptions would be consistent with the assumptions of market participants. A key aspect of the Quarterly Projection Process is to eliminate logical inconsistencies that assume one set of assumptions in one part of the model and another set of assumptions in another part.

[18] Individuals that have inherited the responsibilities with large-scale, empirically-based models to do IFT have sometimes described the forecasting process as equivalent to attempting to teach a dinosaur to jump though hoops. This is because in many cases the testing-down procedures that have been relied upon have either eliminated the monetary transmission mechanism completely, or diminished the role of monetary policy so that it is presumed to only have second-order effects on welfare. It is well-recognizedthat there are uncertainties in the monetary transmission mechanism, but to presume that such links do not exist in reality based on some weak empirical test may result in costly policy errors if it results in excessive changes in monetary conditions to do IFT. That being said, there is also a significant risk of making costly serially correlated policy errors by relying upon models with speedboat versions of the monetary transmission mechanism.

general hypothetical questions of the same model that they see used for the forecast round. By keeping the core model as simple and transparent as possible, we can pose questions directly to it:

Figure 2: From Policy Issues to Policy Recommendations



The forecast process, however, is made possible by supplementing this core model with the other models we have just discussed. The process looks something like the picture in Figure 3. This shows how the sectoral staff would start by interpreting the data, using the short-run indicator models, and then use that—in conjunction with a set of starting assumptions about exogenous paths for fiscal and external variables—to build up a near-term profile. From this near-term profile, we will typically need to extract key unobserved variables such as the output gap, for that and the rest of the near-term profile to be fed into the core model. As noted, the core model helps the staff arrive at an overview. Part of this process involves decomposing the aggregate picture via the satellite models, and this can lead to the staff wanting to revise the aggregate picture. The staff have two basic sorts of control over the aggregate picture. The first is to revise their starting assumptions. The second is to use "add-factors" directly on the core model (such as when a large investment expenditure is known in advance) in order to alter a particular variable's path. This procedure will typically iterate. As a further check, the use of a theoretically tight optimising model may also imply alterations to the model's projection paths (such as if accumulating debt implied a more suppressed path for consumption than would have been projected in a model without such constraints.)

The final output, of course, is a projection profile which forms the basis of advice to the MPC. By this stage, the staff should be in a good position to explain what they think the pressures facing the economy are, and what that implies for monetary policy. Using this process and the models involved, the staff should also be in a position to explain their choices for starting assumptions, their interpretations of recent data outcomes, and projections for idiosyncratic events.

The MPC may wish to have some options explored some more, so that some more iterations are added to the process. However, the structure here should be suitable for dealing with issues that may be raised in a controlled and systematic manner.

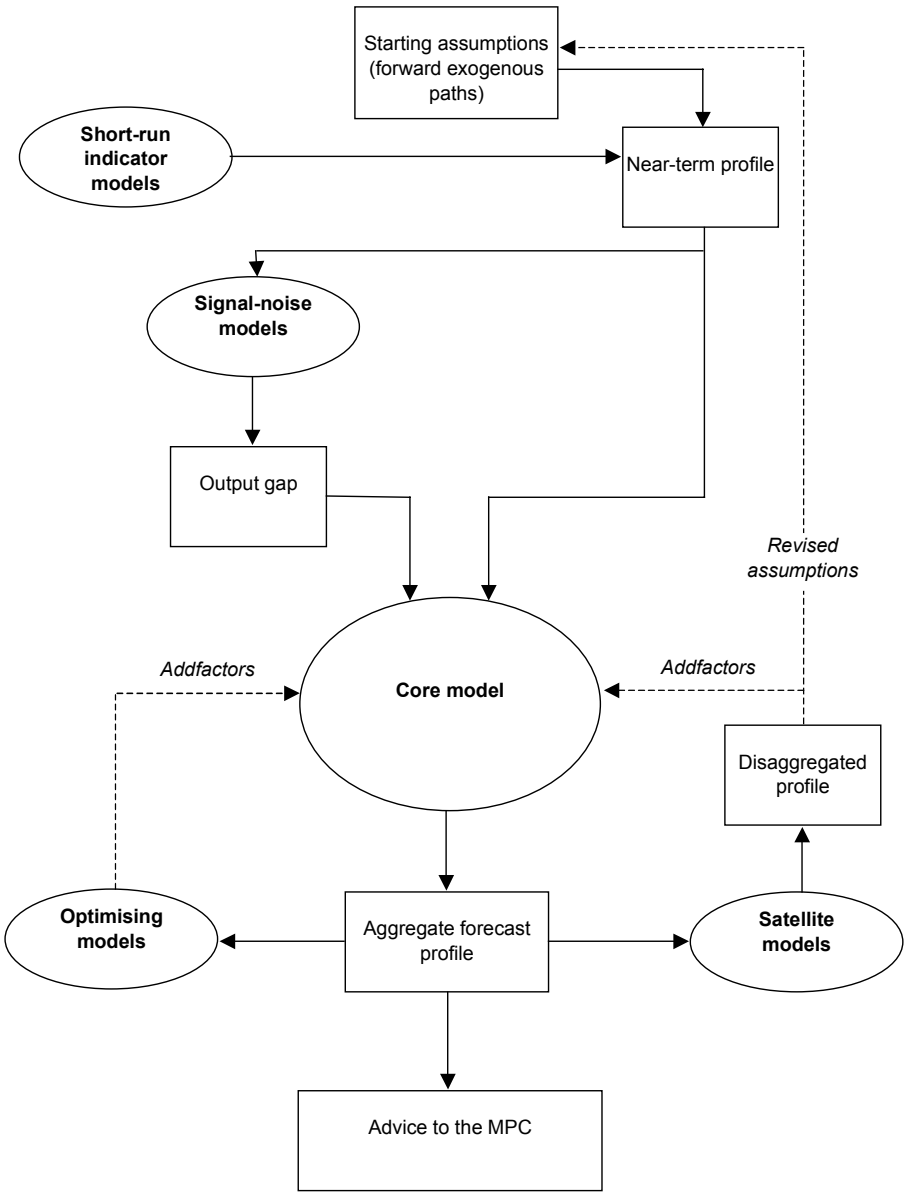
VII. On the Evolution and Development of the Forecasting and Policy Analysis System

This section concerns itself with strategies for ensuring that the FPAS can be taken from its first beginnings to a successful and established system. These strategies can be related to four specific areas:

- model development;
- information technology and systems (IT) development;
- staff development; and
- the creation of a forecast and model culture.

When the essential elements of the system are in place, management can start thinking about their development. It is probably easiest to plot a course for **model development**, with the staff aiming to move over time to more and more sophisticated structural models. We emphasize again, however, that the emphasis in the core QPM should be on the link between developments in the economy and the implications for monetary policymakers. Operationally, the value of the model will come from the ability to perform counterfactuals and experiments that provide insight into recent data outturns. This implies that management should be very careful that any proposed developments do not make the model harder to understand, and hence to use and communicate to the MPC. The relationship with the MPC, so important for the functioning of the system, breaks down when the staff are unable to explain their projections. It is helpful, therefore, to aim for a model that is well within the "comfort zone" of the staff.

Figure 3: How Several Models can be Combined to Impose Consistency



Information technology is easily overlooked when thinking about developing the system. It is, however, very important. Automating tasks has the obvious benefit that there is less room for human error, and it is a prerequisite for the effective use of the forecasting model. Effective IT also has the hidden benefit that it allows the staff more time to think economics, rather than being taken up with data-processing tasks. Several specific steps can be taken:

1. There are obvious economies of scale and scope in deploying resources for Information and Computer Technology but it is important to avoid the pure service bureau approach.

2. Make sure that the staff have direct access to programmers and IT experts so that these resources can be used effectively to improve the productivity and support the needs of the staff.

3. Avoid the attitude that "one size can fit all"! Staff should be able to specify what they need to help them with their work, rather than only having generic solutions imposed upon them.

4. If a member of the MPC has some expertise in this area, they should be given the responsibility for ensuring that the Bank's available resources are being used effectively to support the FPAS, as well as the other needs of the central bank. It should also be recognized that this is not a part-time job and that major productivity gains for the institution can be realized if available resources can be deployed effectively.

The most challenging development issue for management will probably concern **human capital resources.** The maintenance and improvement of the FPAS over time will depend on well the central bank can protect and develop its internal human capital. It is important to recognise that many of the skills of the individuals involved in the FPAS are highly specialised. This raises a number of issues:

1. The importance of training for these specialised tasks. In the early days of the system, it may be possible and useful to use external consultants from other institutions who have experience in the issues involved. This can accelerate the development of expertise of the staff. However, management should be very careful that expertise is in fact developed as part of this process. If possible, contracts with external experts that are designed to help setup the FPAS should have a duration of at least one year. After a certain point, this training will often have to be done in-house, as so much

human capital will depend on the accumulation and transmission of experience with the FPAS.

2. The importance of safe-guarding against the departure of staff. Once some expertise is gained, it will be important for more experienced staff to mentor new staff and ensure that other staff are in a position to take their place in the event of that staff member leaving. It is important for management to recognise that this can be time-consuming, and also to create incentives so that staff do not guard or restrict their own human capital. Recording procedures in the system will be very important. Much, however, comes down to the attitude of management—the entire system will function more efficiently if everyone involved in the process realises that there can be important synergies from openness and transparency.

3. The importance of external contacts. As mentioned, there are obvious benefits if the institution can benefit from procedures and systems developed elsewhere. Management should also work to develop contacts with educational institutions in order to ensure that people in these institutions are aware of the types of human resources and skills that are required for the FPAS.

4. Staff contact with the MPC. It is beneficial for staff motivation if they feel that they are able to make an impact and to receive credit for initiative and good work. This can be achieved by making sure that staff are able to be present at some MPC meetings. This approach has the added benefit that the staff are able to directly see the concerns and thinking of the MPC, which should make them better able to anticipate what kind of material the MPC finds helpful.

5. Staff motivation and incentives. As discussed, rotation should be facilitated and planned. In addition to spreading a general knowledge of how the system works, this is one way by which management can ensure that staff do not become stale or burnout in a particularly stressful position. In general, staff should be closely supervised, but also given the freedom to be autonomous and undertake new initiatives.

6. Facilitation of a cooperative team atmosphere. The synergies that arise from a widespread understanding of the system should be evident. Small initiatives can be very helpful here. For example, if model builders and forecasters sit near each other, that regular informal contact can greatly aid communication and understanding. Similarly, informal in-house seminars,

such as “brown paper bag” lunchtime seminars which give an opportunity for staff to discuss problems and issues, can be very useful.

Many of these points touch on the general issue of creating a **forecasting and model culture**. This is hard to define precisely, but the important realisation for management is that it is not possible to create a properly-functioning FPAS by simply importing models, IT, or temporary external consultants. Staff will need to feel connected to the process, involved in the final outcome, and credited for successful innovation and work. The management should aim to build up a group culture of using models and understanding their limitations. This can be important when questions from the MPC need to be qualified or reinterpreted in order to produce sensible results in a formal model. In particular, the notion of a culture speaks to the ability to be able to undertake model development work in-house; the best racing car is not much good without skilful drivers. This can be aided by specifically investing in an active model development and research program—a separate division of economists that are engaged in longer-term but well-focused research projects—which should aim to improve the quality of the staff and the FPAS over time. The culture can also be facilitated by a regular review process immediately after each quarterly projection exercise, where the staff can ask themselves what changes could be introduced to make the process more efficient or what model developments would make sense.

APPENDIX I

Key Resources, Responsibilities and a Possible Reporting Structure for the Forecast Team and Support Resources.

This appendix provides a description of the critical human resources that are necessary to create a structured forecasting and policy analysis system (FPAS) to support Inflation-Forecast Targeting. The responsibilities of the groups are separated into two distinct types; those that focus on the very near-term outlook (2-quarters into the future) and those that focus more on medium-term macroeconomic dynamics. The basic assumption of this approach is that sector-specialists have considerably more information at their disposal for very near-term forecasting than what could ever be summarized efficiently by a pure model-based forecast. However, generating medium-term forecasts within a model-based framework leads to a more coherent discussion of the implications for policy and assessments of the key risks.

The following Figure 4 outlines the main areas of responsibilities and provides a possible reporting structure that is based on a 7-member forecasting team (highlighted by shading). The reporting structure assumes that each member of the forecast team manages a small group of economists and research assistants. While each person should have well-defined responsibilities, there should also be considerable interaction between members of the groups for the system to function effectively. Furthermore, each group should have one position for training and projects that are intended to improve the system over time.

While members of the forecast team have some responsibilities that are specific to their areas of specialisation (described below), all members of the team are responsible for ensuring consistency in both the near-term and medium-term projections. Furthermore, because the development and integrity of the system depends critically on database management issues, all members of the forecast team must take an active role in designing the methodology and updating procedures for the variables that will be included in the databases that are used to support the FPAS.

The following outlines key tasks and responsibilities for staff connected with the projection.

Chief Manager Responsible for the Forecast:

1. Member of the MPC, responsible for managing the FPAS.

2. Ensures that all of the central bank's resources are used efficiently to support the FPAS.

Head Leader of the Forecast Team

1. Coordinates all aspects of the Quarterly Projection Exercise.
2. Documents all aspects of the Quarterly Projection Exercise.
3. Ensures that all of the central bank's resources are used efficiently to support the FPAS.
4. Responsible for ensuring database integrity.
5. Responsible for supervising the development of the Management Information System.

Head of the Macroeconomic Projections Team (MPT)

1. Member of the Forecast Team.
2. Medium-term focus but should have considerable input into official near-term assumptions.
3. Head of group responsible for producing the forecast.
4. Works very closely with the head of Model Development to prepare different versions of the model to produce the forecast.

Head of the Model Development Team (MDT)

1. Member of the Forecast Team.
2. Medium-term focus.
3. Head of group responsible for model development.
4. Works very closely with the Macroeconomic Projections Team and should be a suitable backup for the head of MPT.
5. Prepares the models for the forecast rounds and provides support to the Macroeconomic Projections Team.
6. Develops the human capital responsible for building macroeconomic models and other tools designed explicitly to support IFT and the FPAS.

Head of the External Sector (Foreign Demand and Rest of World Assumptions)

1. Member of the Forecast Team.
2. Responsible for providing weekly updates of near-term staff forecasts for key external variables.

3. Manages a small group of economists and research assistants that provide assistance in supporting all the tasks and doing high quality research in this area.

Head of the Team that Forecasts Domestic Demand and Imports

1. Member of the Forecast Team.
2. Responsible for providing weekly updates of near-term forecasts for C, I, G and M.
3. Manages a small group of economists and research assistants who provide assistance in supporting all the tasks and doing high quality research in this area.

Head of the Team that Forecasts Inflation and Labor Markets

1. Member of the Forecast Team.
2. Responsible for weekly updates of near-term forecasts for inflation, unemployment, etc.
3. Manages a small group of economists and research assistants that provide assistance in supporting all the tasks and doing high quality research in this area.

Head of Team that forecasts Financial Markets and Foreign Exchange Markets

1. Member of the Forecast Team.
2. Monitors financial markets and foreign exchange markets
3. Responsible for updating near-term forecasts for interest rates, exchange rates etc.
4. Manages a small group of economists and research assistants that provide assistance in supporting all the tasks and doing high quality research in this area.
5. Monitors how market participants react to central bank communications (*Minutes, Inflation Reports* etc.)

Head of Management Information Systems and Database Management Group

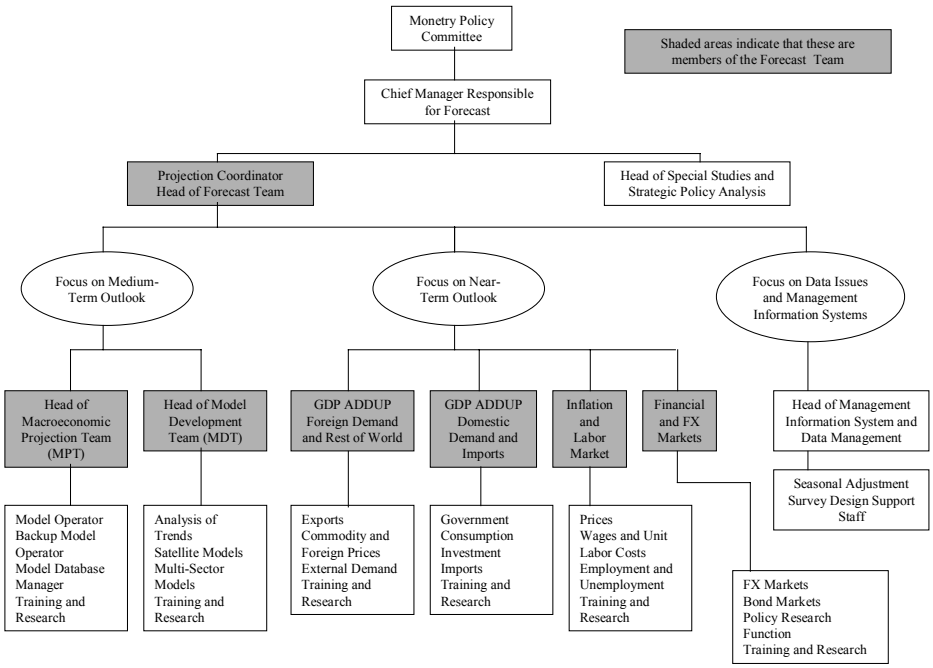
1. Not a member of the Forecast Team but has strong links to them.
2. Responsible for the technical aspects of managing and updating the historical databases, the HNTF database, the Repository System for

written documents, and the archiving of daily projection rounds and official forecasts.
3. Responsible for managing the Management Information System.
4. Manages a small division of support and research staff.
5. Group should include experts in seasonal adjustment, survey design, and information technology.
6. Responsible for ensuring the integrity of the databases.

Head of Special Studies and Strategic Policy Analysis

1. Not a member of the Forecast Team but encourages strong links between staff in this division and the staff that directly support the FPAS.
2. Should sit in on FPAS meetings to be aware of issues where this division might be able to contribute something.
3. Responsible for managing highly-trained research staff.
4. Provides human resources for special requests from the MPC.
5. Provides good entry positions to attract new staff.
6. Executes long-term research projects.
7. Provides support to the FPAS.
8. Supplies staff to the FPAS.
9. Works with staff involved in the FPAS to assist them with their research and analysis.

Figure 4: A Possible Reporting Structure



APPENDIX II

Database Management Issues

Effective database management practises are critical for supporting the needs of a structured Forecasting and Policy Analysis System. Indeed, until a system has been developed that produces timely and reliable updates of all the essential historical data, considerable time and resources will be wasted hunting and gathering data. If an effective database management system has not been developed, one of the first priorities of the Forecast Team should be to ensure that one is created as quickly as possible.

Both staff and members of the MPC who are responsible for the FPAS must take a keen interest in the data. The databases themselves must be organised explicitly to satisfy the needs of users. Indeed, without strong links between the "consumers" (the MPC) and "producers" (staff) of these databases, there will be no clear incentives for producers to deliver timely and reliable data. (See Figure 5 below for an outline of the links between producers and consumers of data.).

Management should have easy access to the data and should be able to view them through an efficient Management Information System. Analysts and model builders should also have easy access to historical data to facilitate analysis and model building. The choice of software for managing the database may be a difficult one. While user-friendly and powerful software has been developed to manage time-series databases and would definitely improve the efficiency of the FPAS, the cost of such software in many countries would have to be weighed against the benefits associated with using scarce resources.

As can be seen in the figure, the Management Information System draws on three distinct types of official FPAS databases: a Historical Database, a Historical and Near-Term Forecasting Database, and the Quarterly Projection Database. Each of these types serves a particular need.

The Historical Database

In the Historical Database, we can think of three basic types of data.

The first type of data is taken directly from external sources such as the official statistical agency. In this case, the job of the Database Management Group (DMG) is to extract those data from these external sources that are required for the FPAS and to update the Historical Database and Management Information System **as quickly as possible.** As is the case with all databases, the choice of variables in

the Historical Database must be based on the needs of the consumers of the data (the MPC and staff involved in the FPAS).

If the updating process does not occur within a few minutes, or does not cover all of the needs of the users in the FPAS, there may be a tendency for people involved in the process to revert back to the original source.[19] In order to prevent this from happening, management of the DMG should develop special relationships with the statistical agency so that the Historical Database and Management Information System can be updated extremely quickly. Indeed, in some cases it may be wise to make arrangements to do this before the data are officially released to the public by the statistical agency. This ensures that the historical databases and Management Information System can be updated quickly, hence providing the MPC with an option to comment on the data shortly after their release to market participants and the public.

The second type of data in the Historical Database contains data that are based on data released by the statistical agency but may be transformed in some way. For example, the statistical agency may choose not to seasonally adjust certain data, or it may not release the desired disaggregations that are deemed necessary for the FPAS. If requested by a member of the Forecasting Team, the DMG should derive such estimates and then update them according to the methodology that has been suggested in a written request supplied to the DMG. Once again, it is critical to update these data as quickly as possible so that people come to rely upon these data rather than the original source.

The third type contains data series constructed from raw data that are created inside the central bank. In this case, the DMG may provide aggregations of raw data that may be published directly by the central bank. Again it is important that members of the Forecasting Team be responsible for determining the needs of the FPAS and ensuring that the databases are updated on a systematic basis by members of the DMG.

Each time series should be documented within the database so that any potential user of a series can understand how the data have been constructed. Each time series should also be assigned a specific "owner". This person should be responsible for documentation and suggesting improvements to the methodology that is followed to construct it. For example, if the FPAS is organised along the

[19] For a database to have integrity there must be strong interaction between consumers and producers of the data and both groups must be involved in improving the data and its documentation over time. Consumers of data will avoid databases that suffer from low integrity, sloppy documentation, and tardiness.

lines suggested in Appendix I, the wage and unit labour cost specialist might be assigned ownership of measures of data on wages. While the updating of these data would be done in the DMG section, the Wage Specialist should be responsible for understanding the methodology that is being used to construct them and would act as a contact person if any questions were posed from other potential users of these data. The argument for assigning ownership to specialists that are responsible for monitoring certain sectors is that these people should have an intimate understanding of the potential problems with the data that they monitor. They will therefore be in a position to develop expertise that would suggest better methods for deriving data and spotting errors.

The Historical and Near-Term Forecasting Database (HNTF)

Unlike the Historical Database, which would be updated as and when the data become available from original sources, the HNTF database would only be updated weekly in advance of the regular weekly meetings. The historical part of this database would be linked to the historical database produced in the DMG. By contrast, the near-term forecast component of the HNTF database would be supplied to the DMG by those members of the Forecast Team who are directly responsible for the data in their specific sectors. After updating the HNTF database, reports should be generated and circulated to all participants involved in the IFT process. **These reports should be designed to show how, based on the staff's interpretation of new information, the near-term forecast has changed.** These HNTF databases should be stored permanently in order to evaluate the forecasting performance of the staff and as a benchmark to evaluate if new methods could improve forecasting performance.

The updating of the HNTF is critical for signalling to management how **the staff** see the potential risks evolving with the latest official forecast. There should be strict rules about when this database is updated and who exactly is responsible for updating each part.

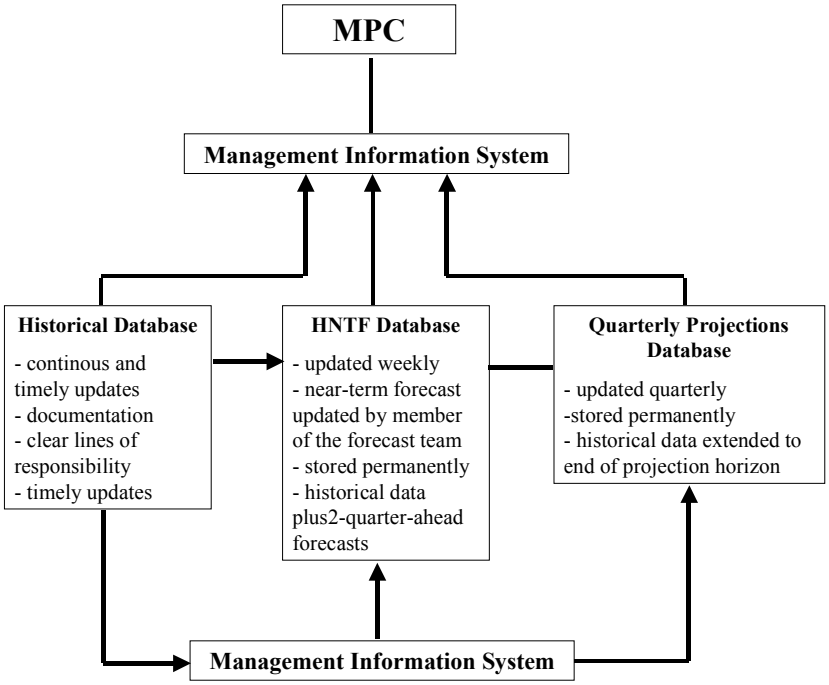
In order to get the system up and running as quickly as possible, the number of variables in the HNTF database should be limited initially, and then can be expanded based on the perceived needs of management and staff.

The Quarterly Projection Database

The Quarterly Projection Database provides all of the data that are used and reported in the quarterly projection rounds (see Section IV). Archiving these databases will allow a review process to take place that identifies systematic errors in the forecasts and aims for improvements in the forecast process and procedures

that are relied upon. Depending on the capacity of the computer system, the staff and MPC will find it useful to have each iteration of the forecast round specifically and separately recorded.

Figure 5: Links Between Different Databases



APPENDIX III

Develop a View of the Monetary Transmission Mechanism

One of first steps when implementing a structured FPAS is to develop a view of the monetary transmission mechanism and the fundamental role of the monetary authorities. Indeed, a prerequisite for inflation-forecast-based targeting is that there must be a reasonably clear view about the monetary transmission mechanism as well as the major shocks that influence the economy and inflation.

The analytical frameworks that have been developed for addressing monetary policy issues for an open economy are usually predicated on the view of the monetary policy transmission mechanism depicted in Figure 6.

The monetary authorities control a short-term interest rate with the objective of influencing the rate of inflation and unemployment. As shown by the arrows, changes in the policy instrument are transmitted to the policy target variables through several channels.

Adjustments in the policy rate can trigger movements in the nominal exchange rate, which are transmitted fairly directly to tradable goods prices and inflation. Indirectly, there is an effect on unemployment through their effects on the real exchange rate and the gap between actual and potential output. Changes in the policy rate can also affect market-determined long-term interest rates, depending on how it affects bond market participants' expectations of the path of the future policy rate. The policy rate also affects real interest rates, through their effects on market-determined rates, but they may also affect them through changes in the time profile of inflation expectations. Changes in the real interest rate in turn influence unemployment through their effects on aggregate demand and the output gap; and changes in the output gap and unemployment rate influence the inflation rate through channels summarised by the Phillips curve.

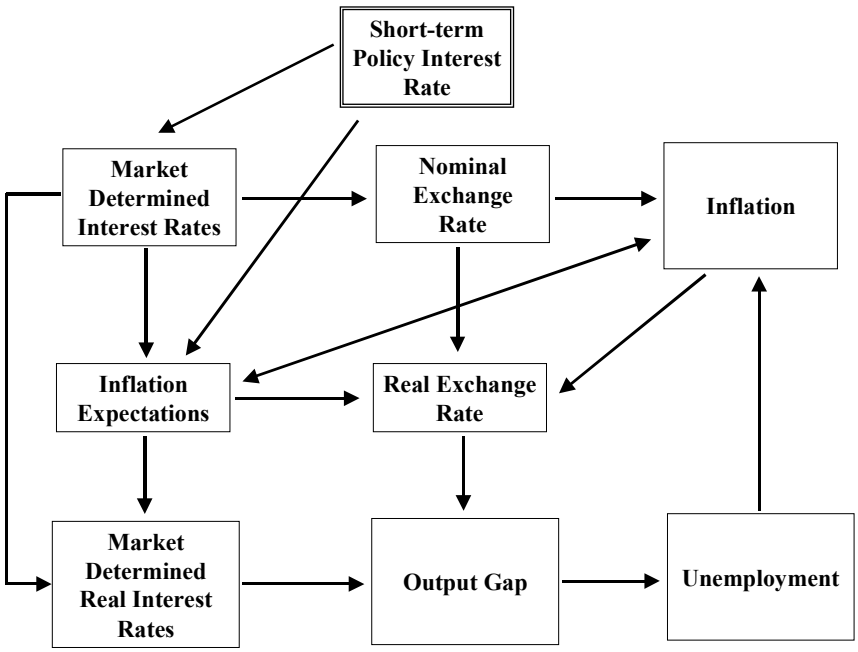
In addition, important feedback mechanisms are at work over time, with inflation expectations responding in part to the history of inflation and inflation influenced in turn by changes in inflation expectations.

Figure 6 does not show any feedback mechanisms from the policy target variables to the policy instruments. The task of identifying and implementing this feedback mechanism is the responsibility of the monetary authorities. In particular, the role of monetary policy is to react to observed and anticipated changes in unemployment, inflation, and other macroeconomic variables, taking account of

the behavioural relationships among these variables to achieve the policy objectives.

In reality, the operation of monetary policy is greatly complicated by three types of uncertainties: imperfect information about the magnitudes of the various transmission effects shown in the diagram; difficulties in identifying the effects on macroeconomic variables

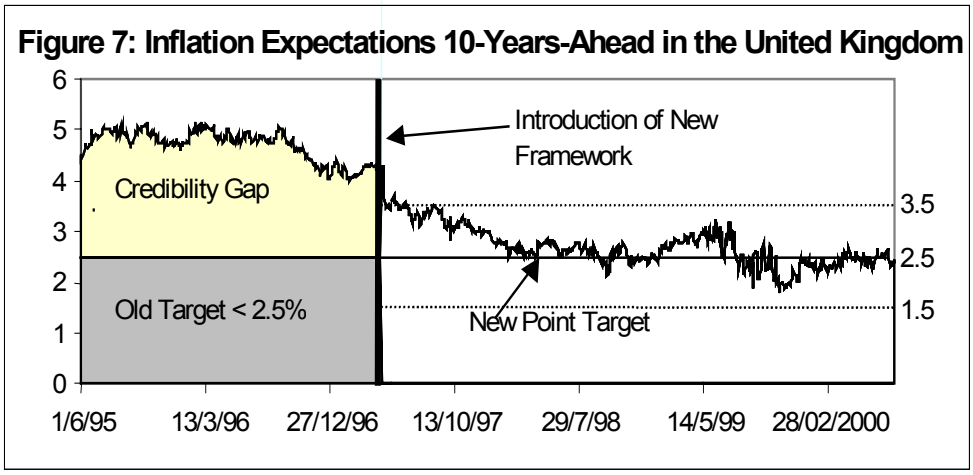
Figure 6. The Monetary Policy Transmission Mechanism



of various types of economic shocks; and the problem of measuring key variables in the transmission mechanism that are not directly observable (such as inflation expectations and the output gap). The operation of monetary policy is also complicated by the fact that policy credibility is imperfect and can vary with the effectiveness with which monetary authorities achieve desirable outcomes for policy target variables. The endogenous behaviour of policy credibility and its role in the monetary policy transmission mechanism has not yet been adequately incorporated into the models that have been used to analyse monetary policy issues. However, there is considerable evidence that suggests that such links exist

in countries that have been successful in providing an anchor for inflation expectations.

At a minimum, models designed for IFT should make an attempt to separate "expectational" from "intrinsic" dynamics.[20] This is so that they can be used to study the implications of different assumptions about how expectations formation may adjust after the adoption of an IFT regime has been adopted. In some cases, the process of developing policy credibility in the IFT regime can occur quite rapidly. For example, Figure 7 shows how long-term inflation expectations became anchored to the 2.5 percent target in the United Kingdom following the implementation of an IFT regime that was based on the creation of an independent central bank with explicit and transparent objectives. In many other countries that have adopted IFT regimes, however, policy credibility and the process that governs inflation expectations has evolved much more slowly over time.



Countries that have adopted IFB targeting have generally embraced the principle that the fundamental role of the monetary authorities is to provide a nominal anchor for the economy. This may cause the monetary authority to believe that its sole purpose is to anchor inflation at the target, leading to quite aggressive

[20] Expectational dynamics are those that are implied by the formation of agents' expectations. Intrinsic dynamics are those that are caused by the presence of adjustment costs (such as fixed-term contracts). See Appendix V.

policy. Indeed, the preceding view of the transmission mechanism includes the well-known stylized fact of "long and variable lags", and this may make the monetary authority even more anxious to react preemptively to inflationary pressures. However, one of the lessons derived from historical experience is that it can be unproductive to ignore stabilization issues by placing too large a weight on manipulating near-term inflation forecasts.[21] That being said, another important lesson from history is that can be even more costly to place too high a weight on extremely uncertain measures of unemployment and output gaps; an understanding of the uncertainties involved in the transmission mechanism brings with it the implication that the monetary authority should also be quite cautious.

[21] That is, there is a trade-off between the *variability* of inflation and the variability of output. Hence the return on more aggressive attempts to anchor inflation is lower and lower, while the consequence is more and more volatile real activity.

APPENDIX IV

A Simple Model of the Output-Unemployment-Inflation Process and a Methodology for Obtaining Timely Model-Consistent measures of the NAIRU and Potential GDP

This appendix has four objectives. First, it provides some general advice about how to provide initial direction to the FPAS and the Model Development Team. Second, it proposes a simple parsimonious open-economy model of the output-unemployment-inflation process. Third, it proposes a hybrid estimation-calibration strategy for choosing the parameters of the model. Fourth, it explains how efficient model-consistent measures of the NAIRU and potential GDP can be constructed and updated as new information arrives.

The role of the Model Development Team and the Forecast Team is to provide a framework that helps the MPC to address policy issues that arise because of uncertainty. This emphasis on the implications of uncertainty for policy suggests a methodology that is geared more towards avoiding large policy errors rather than methodologies that emphasize other criteria such as statistical fit. As mentioned earlier, an approach that is guaranteed not to work in practice would be to blindly follow a strategy that starts with a general unconstrained reduced-form system of linear equations, followed by a testing down procedure to determine which "variables" are statistically significant. Such an approach will create much frustration by all people involved in the process and will not provide much in the way of useful insights for monetary policy.

A preferred approach is to start with an estimation methodology that imposes sufficient structure on the problem so that the Forecast Team and MPC can rule out nonsensical parameter estimates (wrong signs), or bizarre system properties. Indeed, when working with small samples it may be advisable to lean towards pure calibration methods that are designed to produce sensible system properties until sufficient data become available to make estimation strategies feasible. From the perspective of the MPC the approach suggested here involves the following steps.

1. Ask the Model Development Team (MDT) to quickly develop a simple parsimonious model of the economy. This will require them to take a stand on lag structures and the links between the key macroeconomic variables outlined in Figure 6. This will also shift the focus of the discussion away from a backward-looking description of past data towards a more forward-looking discussion that involves making assumptions about fundamental and proximate causation.

2. Ask the MDT to provide their best estimates of specific parameter values, but also ask them to supply plausible ranges for all the parameter values. This includes ranges for the unobservable components such as inflation expectations and the output gap. This will elevate the discussion by explicitly recognizing uncertainty.

3. Ask the MDT to show the implications for the macroeconomic system properties under a comprehensive range of parameter values and other assumptions. This will provide a system-based perspective about how certain linkages (magnitudes of parameter values) contribute to system properties.

4. Encourage the MDT and other staff to study the policy implications of uncertainty and to propose a base-case calibration of the model that will guard against large policy errors.

5. Lock in a base-case model that reflects the collective view of the MPC and the staff, but use differences in views to help quantify uncertainty in the projection.

6. If experience favors a better parameterization (or structure), adjust it as dictated by experience and empirical evidence.

The remainder of this appendix provides a discussion of how the MDT can complete the first two steps.

An Eight Equation Model of the Output-Unemployment-Inflation Process

This appendix includes equation specifications for CPI (or Net CPI) inflation, the output gap, the unemployment gap, the NAIRU and potential GDP.[22] Table 1 presents the equations of the model and Table 2 defines notation; time periods correspond to calendar quarters.

Equation (1) is simply a definition of the output gap. It is defined to be 100 times the difference between GDP and potential. Because both GDP and potential GDP in the equation are measured in logs *ygap* will be approximately equal to conventional measures of the output gap which are measured in percent.

[22] Appendix V discusses the role of the policy rule and a simple generic model that can be used to incorporate simple learning schemes for expectations.

Equation (2) relates the output gap to its own lagged value, the lagged value of a relevant market determined real interest rate measure, and a lagged value of a real exchange rate measure. All variables in this equation are expressed as deviations from their equilibrium values and are expressed as gaps in the equation.[23] The equation also includes a disturbance term that measures all shocks to the output gap that are unrelated to changes in the real exchange rate and market-determined real interest rates. Note, that because the output gap equation is function of market-determined real interest rates, the model can only be closed by specifying links between the policy rate and market-determined real interest rates. In models with some forward-looking agents, it is necessary to specify consistent decision rules for inflation expectations (as well as a monetary policy reaction function) in order to provide logical consistency in the projection scenarios.

Equation (3) is simply a definition of the unemployment gap, measured as the difference between the NAIRU and the unemployment rate. This unemployment gap is therefore measured in percentage points.

Equation (4) is a stochastic process for potential GDP. This specification assumes that there are shocks ($\varepsilon_t^{\overline{gdp}}$) that directly affect the level of potential GDP each quarter. However, in addition, the specification also assumes that there can be large persistent deviations in the trend growth rate of potential GDP (γ_t) from a constant steady-state growth rate (γ^{ss}). The latter assumption is necessary for emerging-market economies that are expected to experience high growth temporarily (but for long periods of time) as their productivity levels catch up toward the levels of productivity in the industrialized economies.[24]

Equation (5) provides a link between the stochastic NAIRU ($\overline{u}$) and the deterministic NAIRU (u^*). The conceptual difference between the two NAIRU concepts is necessary whenever the inflation equation embodies an assumption of convexity—see equation (8) below for an example. In such models the role of monetary policy can be first-order in the sense that monetary policy regimes that result in an avoidance of large boom and bust cycles will produce a permanently

[23] It is also assumed that all variables are seasonally-adjusted, so that lag terms are not needed to proxy for seasonal effects.

[24] Indeed, a more elaborate model would separate GDP into components (such as labor supply and labor productivity) in order to explicitly model catch-up phenomena in productivity levels.

lower sustainable rate of unemployment ($\overline{u}$)—see Box 1 for a description of the implications of convexity in the inflation equation.

Equation (6) is a stochastic process for the deterministic-NAIRU. It assumes that there can be permanent shocks that raise, or lower, the DNAIRU (u^*). Obviously, the DNAIRU cannot follow a pure random walk, but this assumption has been found to provide a useful identification assumption that can be used to obtain timely updates of the NAIRU that is affected by permanent, or highly persistent shocks.

Equation (7) is a dynamic Okun's law equation which posits that unemployment gaps lag output gaps.

Equation (8) is a standard open-economy inflation equation. In this equation, quarterly inflation is assumed to depend on past changes in import price inflation, expectations of inflation over the next year, as well as on the unemployment gap. The functional form that has been chosen assumes that there is convexity in the function and can be derived from conventional models of bargaining. The equation also includes an unemployment gap term written in changes to allow for "speed-limit" effects, which have been found to be empirically relevant in some industrialized economies.[25]

What are reasonable ranges for all the Parameter values in the model?

Estimates of the reasonable ranges for parameter values will be gradually be refined over time. This should be done judgementally after reviewing three types of analysis. This includes: (1) unrestricted estimation; (2) more-restricted estimation; (3) empirical evidence from other sources (estimation of disaggregated models and information from Input-Output Tables would be an example); (4) information from Input-Output Tables; (5) a thorough analysis of system properties; and (6) an evaluation of potential Type I and Type II policy errors. The following provides an initial range of parameter estimates for the equations specified in Table 1.

Initial Range of Parameter Estimates in the YGAP Equation

There are usually significant lags in the monetary transmission mechanism of most economies. This suggests that the sum of the parameters on the real interest

[25] These effects imply that, even though output was below potential, the path of output could still be inflationary if the economy was growing too rapidly.

rate term and the real exchange rate (α_2 and α_3) may be small relative to the weight on lagged dependent variable (α_1). For example, for most economies we would expect that the sum of α_2 and α_3 would likely lie somewhere between 0.10 and 0.40 and that α_1 would likely lie somewhere between 0.75 and 0.95. For very open economies we would expect that α_3 might be larger than α_2 and for fairly closed economies we would expect the opposite. One way of estimating the relative magnitude of these two parameters would to decompose GDP into components—such as domestic demand, exports and imports—and then estimate the real interest rate and real exchange rate effects on these components separately. This preliminary estimation could then be used as a check on estimates obtained from aggregate equations. Without this type of information we would suggest setting a lower bound for α_2 and α_3 in the neighborhood of 0.05 and an upper bound of 0.30.

Initial Range of Parameter Estimates in the UGAP Equation

In economies that have significant hiring and firing costs there are usually significant lags between output gaps and unemployment gaps. This suggests that the parameter on the output-gap term in the unemployment gap equation (ϕ_1) will be small relative to the weight on the lagged dependent variable (ϕ_2). Indeed, for most economies we would expect that ϕ_1 would likely lie somewhere between 0.05 and 0.25 and that ϕ_2 would likely lie somewhere between 0.50 and 0.95.

Initial Range of Parameter Estimates in the Inflation Equation

This is one of the most important equations in the model. The specification proposed in Table 1 reflects a number of considerations. First, it includes a convex functional form that provides a more important role for monetary policy (by creating an incentive to avoid large and costly boom and bust cycles—see Box 1). Second, by including inflation expectations explicitly in the equation, it allows members of the Forecast Team and MPT to consider alternative scenarios based on different assumptions about expectation formation. Third, it also includes a change-in-the-gap term to represent some of the speed-limit effects that are empirically relevant in many countries. Fourth, because the model has been designed for open economies, it includes an imported price inflation term. The exact term that is

included assumes, ceteris paribus, that it takes 4 quarters to feel the complete direct effects of a permanent change in import prices.[26]

The parameter δ_1 measures the effects of imported price inflation on the CPI (or net CPI). This parameter should be approximately the weight of imported goods in the CPI basket, but in theory could be somewhat higher or lower depending on the country. As a first pass, we would suggest setting the range at plus or minus 0.05 around the best point estimate of the imported goods share in the basket. The parameter δ_2 measures the effects of expected future inflation and $(1-\delta_1-\delta_2)$ measures the effect of lagged inflation. Without more specific information about a country we suggest that both of these be constrained to lie between zero and one half.

A Consistent Estimation Methodology

The model parameters in Table 1 can be estimated jointly along with model-consistent estimates of the NAIRU and potential GDP after specifying ranges for certain hyper-parameters. These hyper-parameters determine the degree of variability in both the output and unemployment gaps relative to the degree of variability in potential GDP growth and changes in the NAIRU. This methodology can be shown to be considerably more efficient and robust for doing IFT than estimation approaches that are based on pre-filtering unemployment and GDP data to obtain estimates of the NAIRU and potential GDP.[27]

[26] For countries that have an ongoing trend in their real exchange rates—that are related to catch-up or a lower rate of time preference—the imported price term in the equation should be adjusted to subtract off the trend rate of appreciation in the real exchange rate.

[27] Example of the GAUSS code for doing consistent Constrained-Maximum-Likelihood estimation can be obtained by contacting the authors at MULTIMOD@IMF.ORG.

Box 1: Implications of Convex Phillips Curves

Convexity in the Phillips Curve provides an analytic framework in which stabilisation policies can have first-order effects on the average levels of output and employment (at any given average inflation rate), even though it continues to work within the confines of the long-run natural rate hypothesis. Convexity implies that the tradition of decomposing unemployment into structural and cyclical components requires modification, as does the traditional discussion of the non-accelerating inflation rate of unemployment—the so-called NAIRU. To illustrate, Figure 8 shows a convex (to the origin) short-run Phillips curve, plotted as a relationship between expectations-augmented inflation (vertical axis) and the unemployment rate (horizontal axis), with expectations-augmented inflation corresponding to the difference between actual and (ex ante) expected inflation.[1] The unemployment rate at which expectation-augmented inflation is zero—labelled u^* in Figure 8 and referred to as the DNAIRU or *deterministic* NAIRU—corresponds to the structural rate of unemployment that would prevail in a deterministic world. It is critical to recognise that the DNAIRU is not a feasible stable-inflation equilibrium in a *stochastic* economy with convexity. The average rate of unemployment that would be associated with non-accelerating inflation (and expectations equilibrium) in a stochastic world—labelled $\overline{u}$ in the figure and referred to as the NAIRU—must lie above the DNAIRU. This is because convexity in the short-run Phillips curve means that inflation rises faster when unemployment is below the DNAIRU than it falls when unemployment is commensurately above the DNAIRU. If u were maintained equal to u^* on average, the asymmetry in the response of inflation to symmetric aggregate demand shocks would make it impossible to maintain a constant average inflation rate.

The convex short-run Phillips curve combined with standard models of inflation expectations implies that stabilisation policies that are successful in avoiding boom and bust cycles will reduce the average unemployment rate and raise the average level of output. This can be seen in Figure 8, which has been drawn under the assumption that inflation is symmetrically distributed around the target π^* over the range between $+\pi_1$ and $-\pi_1$; and that expected inflation is always equal to the target. The important point is that success in reducing the variability of inflation and unemployment will also lower the mean value of unemployment. One can see this immediately from Figure 8 by imagining a tighter control on the dispersion of inflation and unemployment. The line LL would move down and to the left and the gap between $\overline{u}$ and u^* would shrink. The key lesson is that stabilisation can matter in the sense that policies that either induce or allow extreme variability in the business cycle will also cause a permanently higher NAIRU.

———————

[1]For the sake of simplicity Figure 8 assumes that expected inflation is always equal to the target rate of inflation π^*.

With convex models of the Phillips curve, the analysis of unemployment behaviour, in addition to identifying the cyclical variation of actual unemployment around its average rate, needs to recognise that the average rate of unemployment exceeds the structural rate of unemployment by an amount that generally reflects both the nature and the magnitude of economic shocks and the effectiveness of stabilisation policies. With convexity in the short-run Phillips, stabilisation policies can have permanent effects on unemployment and output. When combined with more elaborate models of inflation expectations and imperfect policy credibility, the convex Phillips curve paradigm will hopefully provide a much richer macroeconomic framework for assessing the effectiveness of stabilisation policies.

Figure 8. A Convex Short-Run Phillips Curve

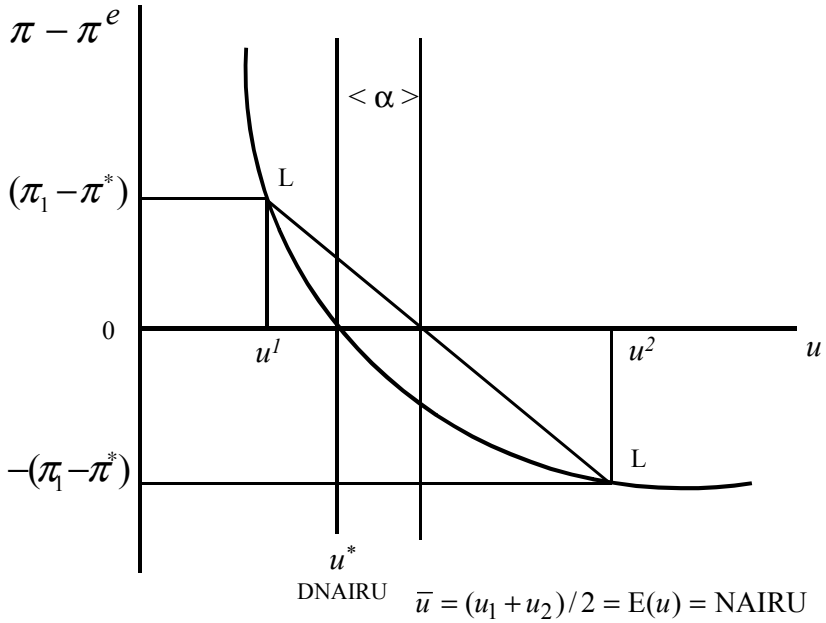


Table 1. Estimation of a Model with Model-Consistent Measures of the NAIRU and Potential GDP

(1) Output Gap Definition:

$ygap_t = 100*(gdp_t - \overline{gdp}_t)$, where *gdp* is measured in logs.

(2) Output Gap Dynamics:

$$ygap_t = \alpha_1\ ygap_{t-1} - \alpha_2\ rrmgap_{t-1} - \alpha_3\ zgap_{t-1} + \varepsilon_t^{ygap}.$$

(3) Unemployment Gap Definition:

$$ugap_t = \bar{u}_t - u_t.$$

(4) Stochastic Process for Potential GDP:

$\overline{gdp}_t = \gamma_t + \overline{gdp}_{t-1} + \varepsilon_t^{\overline{gap}}$, where $\overline{gdp}_t$ is potential GDP measured in logs.

and $\gamma_t = \beta\,\gamma^{ss} + (1-\beta)\,\gamma_{t-1} + \varepsilon_t^{\gamma}$.

(5) Link Between the NAIRU and the Deterministic NAIRU:

$$\bar{u}_t = u_t^* + \omega_t.$$

(6) Stochastic Process for the Deterministic NAIRU:

$$u_t^* = u_{t-1}^* + \varepsilon_t^{u*}.$$

(7) Unemployment Gap Dynamics:

$$ugap_t = \phi_1\ ygap_t + \phi_2\ ugap_{t-1} + \varepsilon_t^{ugap}.$$

(8) Inflation Equation:

$$\pi_t = \delta_1\pi_t^m + \delta_2\ E_t^P\pi 4_{t+4} + (1-\delta_1-\delta_2)\pi_{t-1} + \delta_3\ (u_t^* - u_t)/(u_t - 4) + \delta_4\ \Delta ugap_t + \varepsilon_t^{\pi}$$

.

Table 2. Notation; Time Periods Correspond to Calendar Quarters

Definitions:

$ygap$: Output gap.

gdp : Real GDP in logs.

$\overline{gdp}$: Real potential GDP in logs.

$rrmgap$: Market-determined real interest rate measured as deviations from its equilibrium.

$zgap$: Real exchange rate measured as deviations from its equilibrium.

$ugap$: Unemployment rate gap.

$\bar{u}$: NAIRU, or the sustainable rate of unemployment.

u : Unemployment rate.

π_t : Quarterly change in the log of the CPI (or net CPI).

$\pi 4_t^m$: Year-on-year change in the log of the import price deflator.

$E_t^P \pi 4_{t+4}$: Expected inflation over next four quarters.

Model Parameters:

ω : Wedge between the NAIRU and the Deterministic-NAIRU.

β : Parameter that determines the speed of adjustment of γ to γ^{ss} .

δ_i : Parameters in the inflation equation.

α_i : Parameters in the output gap equation.

ϕ_i : Parameters in the unemployment gap equation.

Table 2. Notation; Time Periods Correspond to Calendar Quarters (continued)

Disturbance Terms and Unobservable Time-Varying Variables:

ε^{π}	:	Shock in inflation equation.
ε_t^{u*}	:	Shock term in the equation for u*.
ε^{ygap}	:	Shock in output gap equation.
ε_t^{γ}	:	Shock term in the equation for underlying potential GDP growth.
$u*$	:	Deterministic NAIRU.
γ	:	Underlying growth rate of potential GDP.
$\varepsilon^{\overline{gdp}}$	:	Level shock term on the equation for potential GDP.
γ^{ss}	:	Estimate of steady-state growth rate of potential GDP.

APPENDIX V

Expectations and the Necessity of Policy Reaction Function

There are two basic reasons why it is important to distinguish explicitly between expectational and intrinsic dynamics in a model designed to support IFT.

1. There must be an explicit role in the core quarterly projection model by which a transparent and unbiased IFT regime can affect the manner in which private agents form their expectations of future inflation.

2. For the projection scenarios to be consistent, each scenario under a given set of assumptions must show how decision makers in the private sector will gradually adjust their expectations to be consistent with how monetary policy is being conducted under the IFT regime.[28]

The generic model that we would suggest for expectations is a simple model that places a weight on the model-consistent solution as well as a weight on any empirically relevant reduced-forms that agents are believed to rely upon. However, it is important that these empirical-based reduced-form forecasting rules contain sufficient restrictions so that they are not inconsistent with rational expectations in the long run, otherwise it will be possible to design policy rules that can fool people in the long run.

In models where the output gap depends on both the past and expected future path of the real policy rate, it is important for the policy rate to be endogenous and set in a forward-looking manner. This is necessary because the correct level of the policy rate today should be computed conditional on a sensible expected future path. Moreover, it is necessary to ensure consistency in the projection scenarios: projection scenarios that are based on constant interest rates will only be consistent if all variables are at their steady-state levels and expected to stay there in the future.

When bond market participants' expectations of the future policy rate differ from what has been assumed in a projection scenario, the role of the Forecast Team will be to model how quickly these expectations will adjust over time as they learn the fundamentals that are being assumed in the scenario. Projection scenarios

[28] For example, Figure 7 shows that the process that governs long-term inflation expectations in the United Kingdom shifted dramatically following the creation of an independent central bank with well-defined inflation objectives.

that are based on the central bank's assumptions about fundamentals will not be internally consistent if they are also based on bond market participant's expectations of the future policy rate. Of course, it is always possible to consider other scenarios that assume fundamentals that are more consistent with expectations held by the public. These should be taken as serious alternatives given that bond market participants have strong economic incentives to get the fundamentals correct.