The Role of Forecasts in Monetary Policy

By Jeffery D. Amato and Thomas Laubach

F orecasts of future economic developments play an important role for the monetary policy decisions of central banks. In the United States, for example, at every meeting of the Federal Open Market Committee (FOMC), the staff of the Board of Governors of the Federal Reserve present forecasts for inflation, output growth, and a range of other variables that give policymakers essential information for monetary policy decisions.

This article argues that forecasts of goal variables can help central banks achieve their goals and make them more accountable to the public. The article provides two explanations for the benefits of forecasts. The first explanation is that monetary policy affects goal variables such as inflation and output only with substantial lags. Policy actions should, therefore, be based on forecasts of goal variables at horizons consistent with policy lags and be taken when these fore-

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casts are inconsistent with policy goals. Under such an approach, the quality of a central bank's forecasts and the effectiveness of its actions to bring forecasts into alignment with targets provide a basis for judging the performance of policymakers and for holding them accountable.

The second, and less intuitive, explanation is that by focusing on a *forecast* of only one variable—inflation—a central bank can potentially achieve multiple goals. This approach can be successful even if there are tradeoffs among the various goal variables. For example, the approach can combine a commitment to long-run price stability with concern for the effects of monetary policy on output.

This approach to monetary policy is consistent with the recent practice in a number of countries of assigning the central bank a single goal of maintaining price stability. The approach also potentially makes it easier to assess the performance of the central bank and thereby hold it accountable. In particular, judging the performance of a central bank that has been assigned the stabilization of a single variable as its sole objective is easier than judging the performance of a central bank with multiple and, possibly, conflicting stabilization goals.

The first section of the article argues that the lagged effects of monetary policy make the use of forecasts necessary. The second section argues that delegating a single goal—such as inflation stabilization—to the central bank facilitates accountability, but at the risk of not achieving other goals. The section then examines how the Eurosystem and the Bank of England, both of which have been assigned a single goal, address the existence of tradeoffs among goals. The third section provides evidence that a monetary policy aimed primarily at stabilizing inflation forecasts—as practiced by the Bank of England, for example—can, in fact, achieve multiple goals.

I. LAGGED EFFECTS OF POLICY AS A RATIONALE FOR FORECASTS

Because monetary policy affects goal variables such as inflation and output with considerable lags, central banks cannot stabilize these variables at very short horizons in the presence of unanticipated shocks. They can, however, take actions today to influence goal variables at the forecast horizon consistent with policy lags. And, these actions can bring forecasts of goal variables into alignment with targets. Thus, while central banks cannot be held accountable for stabilizing all fluctuations in goal variables, they can be held accountable for stabilizing forecasts of goal variables at an appropriate horizon.

The goals of monetary policy

The primary goals of monetary policy are low and stable inflation and sustainable economic growth. The average level of inflation should be low because inflation is harmful to the economy, even if it is constant and perfectly anticipated. Inflation variability should also be low because unanticipated inflation is particularly damaging. For example, when inflation is highly variable—and therefore unpredictable—firms are prone to make errors in their pricing decisions, which are based in part on expected future conditions.

Monetary policy also seeks to achieve sustainable economic growth. At each point in time there is a potential, or efficient, level of output, which is determined by the available factors of production in the economy and the available technologies. This efficient level of output changes over time due to factors such as the development of new technologies, the accumulation of productive capacity, or changes in the labor force.

The actual level of output can differ from its efficient level, but only temporarily. Any attempt by monetary policy to keep output permanently away from its efficient level would destabilize inflation and ultimately prove ineffective. For example, consider a policy that tries to keep output growth at some constant rate (starting at the efficient level of output). If this rate of growth is slower than that of the efficient level of output, inflation would fall at an ever faster rate; if this rate of growth exceeds that of the efficient level of output, inflation would accelerate over time. To stabilize inflation, therefore, monetary policy should aim at keeping output at its efficient level, or at keeping the difference between the actual and efficient levels of output, called the *output gap*, at zero.

Achieving goals in the presence of lagged effects

Most central banks conduct monetary policy by controlling the level of some short-term interest rate. In industrialized countries such as the United States, it takes several quarters for changes in short-term interest rates to have their full effect on inflation and output. In the presence of these lags, a central bank can either base its interest rate decision on an intermediate target—a variable that is readily observable and closely related to its goal variables—or use forecasts.

In the past, many central banks, or their respective governments, have chosen to use an intermediate target for monetary policy. Such

targets were typically the exchange rate of the country's currency vis-à-vis one or a number of other currencies, or the growth rate of some money stock. Intermediate target-based strategies provided a straightforward answer to the question of how to set the interest rate: the central bank set the interest rate at the level necessary to keep the exchange rate from changing or to keep money growth at its target. Because the exchange rate reacted to changes in the central bank's interest rate almost instantly, and the rate of money growth reacted within a few months, neither of these two policies based on intermediate targets depended on forecasts of goal variables.

Underlying these strategies was the assumption that stabilizing the exchange rate, or controlling the rate of money growth, would lead to the desired results for the goal variables of inflation and output growth. Over the past 25 years, however, a number of central banks that used either monetary or exchange rate targets abandoned these intermediate targets because the link between the intermediate targets and the goal variables became increasingly unreliable. The lesson many central banks drew from this unsatisfactory experience was that monetary policy should be aimed directly at goal variables, rather than at some intermediate target.

Because goal variables respond to monetary policy with considerable lags, directing monetary policy at the goal variables themselves requires forecasts. Absent a reliable relationship between any intermediate target and the goal variables, this forecast must take into account a much broader set of variables, of which the exchange rate or money growth are but single elements. Furthermore, forecasts require not only data on a range of variables, but also some kind of model with which to translate the current data into a forecast. Such models are inevitably abstractions of the true structure of the economy, numerous elements of which are not well understood. Hence, the forecasts derived from these models are fraught with uncertainty. While mak-

ing decisions on interest rates using a broad set of information may be less prone to serious misses than intermediate targeting, such a strategy is still far from accident proof.

Besides serving as a guide to setting interest rates, forecasts may also serve as a means for holding the central bank accountable for its actions. In a democratic society, the central bank is accountable to the government, or the public at large, for its conduct of monetary policy. Suppose the central bank is directed to stabilize inflation at some low level and to stabilize output around the efficient level. As mentioned earlier, it may take several quarters for the central bank's interest rate decisions to have their full effect on output and inflation. If an unanticipated event suddenly altered either of these variables, the central bank could do little to immediately offset this impact.

In evaluating the central bank's performance, therefore, it is important to distinguish between those developments in inflation and output the central bank can counter from those it cannot. It would be misleading to focus exclusively on the realized values of output or inflation. Instead, by focusing on forecasts of these variables at the horizon at which policy actions may affect them, the government and the public can hold the central bank accountable for only those developments it can reasonably be expected to have foreseen.

II. A SINGLE GOAL VS. VARIABILITY TRADEOFFS: A CONTRADICTION?

Recognizing the difficulty of holding a central bank accountable for pursuing multiple goals, a number of countries have recently given their central banks a single goal: maintaining price stability. This strategy for improving the central bank's accountability may be problematic, though, due to tradeoffs between stabilizing inflation and stabilizing other variables. This section

discusses these tradeoffs and examines how the Eurosystem and the Bank of England, both of which operate with the single goal of maintaining price stability, address this dilemma.[1]

Tradeoffs among stabilization of goal variables

Why, if the public cares about the effects of monetary policy on variables other than inflation, would a central bank be called on to pursue only price stability? One answer is that with multiple goals it is difficult to assess whether the central bank achieved the best balance among its various goals. If the goals include output gap stabilization, the situation is complicated further by the unobservability of the efficient level of output. By contrast, a mandate formulated only in terms of inflation makes it easier to evaluate the central bank's performance because inflation is readily measurable.

This approach to improving accountability would be less problematic if all other goal variables that may be affected by monetary policy, notably the output gap, were stabilized as well. However, there may be situations in which there is a tradeoff between stabilizing inflation and stabilizing the output gap. When this occurs, a mandate for maintaining price stability might lead to undesirably high output gap variability.

Handling variability tradeoffs:
The Eurosystem and the Bank of England

The Eurosystem and the Bank of England both conduct monetary policy under mandates that assign, in different ways, primacy to the goal of maintaining price stability. However, both central banks are mindful of the consequences that their monetary policy actions have for economic activity, and not merely for inflation. To take account of output stabilization, the Eurosystem emphasizes maintaining price stability over the "medium term," while the Bank of England focuses on stabilizing inflation forecasts.

The Eurosystem. The Eurosystem consists of the European Central Bank (ECB) and the national central banks of the 11 countries that have adopted the euro as their currency. The Governing Council, which consists of the six members of the ECB's Executive Board and the 11 governors of the national central banks, is responsible for the conduct of monetary policy in the area of those 11 countries, the "euro area." Article 105 of the Treaty establishing the European Community describes the primary objective of the Eurosystem as maintaining price stability and states that, "without prejudice to the objective of price stability," its policy shall support the general economic policies in the euro area.

In the pursuit of this objective, the Governing Council is free to choose its operational strategy. On October 13, 1998, the Governing Council announced the main elements of its "stability-oriented monetary policy strategy." This strategy consists of a numerical definition of the objective of price stability and two pillars used to achieve this objective: a reference value for the growth of a specific monetary aggregate and a "broadly based assessment for the outlook for price developments" (ECB 1998).

In explaining its definition of price stability, the Governing Council makes clear that price stability "is to be maintained over the medium term," which is explained as reflecting "the need for monetary policy to have a forward-looking, medium-term orientation" (ECB 1999). In part, the focus on the medium term arises because of the lagged effects of policy. "The Eurosystem cannot be held responsible for . . . short-term shocks to the price level, over which it has little control. Rather, assessing the performance of the Eurosystem's single monetary policy over the medium term ensures genuine and meaningful accountability" (ECB 1999).

A second reason for focusing on maintaining price stability over the medium term is "to per-

mit a gradualist and measured response" to disturbances affecting the economy. The advantage of such a response is that it avoids introducing "unnecessary and possibly self-sustaining uncertainty into short-term interest rates or the real economy," while still maintaining price stability. In essence, by evaluating over a sufficiently long horizon whether price stability is achieved, the Eurosystem tolerates short-lived deviations from the numerical definition of price stability, if necessary, to avoid excessive output fluctuations.

The Bank of England. Since October 1992, monetary policy in the United Kingdom has been conducted using an inflation target. Under the current arrangement, the Bank of England, specifically its nine-member Monetary Policy Committee (MPC), has operational responsibility for setting short-term interest rates to achieve an inflation target determined by the UK government.

As with the Eurosystem, the need for forecasts is in part determined by the lags with which monetary policy affects inflation. "The most appropriate guide to monetary policy is the best obtainable forecast of the probability distribution for inflation, over a time horizon defined by how long it takes for a change in monetary policy to affect inflation" (Bowen). The Bank of England further stresses the importance of its inflation forecast for its accountability to the government and the public. Since February 1993, the bank has published a quarterly *Inflation Report*, in which it provides both detailed analysis of recent developments related to inflation and its own assessment for future inflation. A key element of each *Inflation Report* is a chart showing the bank's inflation forecast over the following eight quarters. The Bank of England Act of 1998 "does not require the MPC to publish a forecast of inflation, but we believe that it is right to continue the practice. . . . The public is free to comment on and criticize the projections. It can assess the views that informed the MPC's decisions" (Budd).

Inflation forecasts also play a central role in handling variability tradeoffs. The Bank of England stresses the consequences of setting interest rates such that its own forecast of inflation eight quarters ahead is at its target value. Although monetary policy affects inflation at a horizon shorter than two years, an important argument against controlling inflation at too short a horizon is that "the lagged effects of monetary policy can lead . . . to large-scale, 'excessive' variations in output. . . . [T]he MPC should choose an appropriate horizon at which to aim to return to the inflation target set by the Chancellor. By doing so, they should be able to minimize the variance of both output and inflation" (Goodhart).

III. RESOLVING VARIABILITY TRADEOFFS BY TARGETING INFLATION FORECASTS

How can goals for output and inflation both be achieved with a mandate for controlling only inflation? This section shows how monetary policy can take account of other goals by pursuing inflation stabilization at an appropriate time horizon. By setting interest rates such that the bank's forecast for inflation at some future time is kept at the desired level, rather than by focusing on current inflation, the central bank can balance its mandate of maintaining price stability with the public's interest of avoiding undesirable fluctuations in output.[2]

The choice of time horizons for inflation forecasts is important because it influences the behavior of other goal variables. A central bank may move interest rates strongly to control inflation at a short horizon, or move rates more gradually to control inflation at a longer horizon. The effects of an interest rate change over the first one or two months are probably small, suggesting big interest rate changes are needed to stabilize inflation at short forecast horizons. For example, in a relatively open economy, a strong change in interest rates may have an

immediate influence on the exchange rate, which may affect inflation within a few months through a change in the prices of imported goods. By contrast, moving the interest rate gradually to control inflation over a longer horizon accepts a greater amount of inflation variability in the short run but should lead to less undesirable fluctuations in economic activity.

This section uses a small simulation model to evaluate the effects of policy over various time horizons. The results show that a policy of stabilizing inflation is best pursued by focusing on forecasts of inflation at a five-quarter horizon.

A framework for analyzing the effects of alternative policies

The framework, or model, used for evaluating alternative interest rate policies consists of four relations, each representing the behavior of agents in the economy. The four relations explain the movement in output, price inflation, wage inflation, and the short-term interest rate over time.[3] The first relation is based on the assumption that demand for output today depends negatively on future expected real interest rates. In other words, household decisions about how much to consume today and how much to save depend on expectations of future *real* interest rates (expected nominal interest rates less expected inflation). In particular, an upward revision in household expectations of future real interest rates causes households to postpone a certain amount of planned spending on consumption or investment.

The next two relations are based on the assumption that not all firms and households adjust their prices and wages each quarter. However, firms and households supply whatever quantity of their product or labor, respectively, that is demanded at the current price or wage. Prices and wages are assumed to remain unchanged on average for three quarters.[4]

Whenever a firm adjusts the price for its prod-

uct, it sets the price proportional to the cost of production that is anticipated over the lifetime of the price, based on expected future demand. The firm's expectations of future demand are in turn affected by its expectations of competitors' prices over the lifetime of the price, because the demand for its product depends on its price *relative* to those of its competitors. Similarly, households enter into wage agreements, which, over the lifetime of the contract, make households indifferent between working a little more, and earning some more income, or to working a little less, and earning less. Households are concerned about their wages relative to those of other households for the same reason that firms care about their relative price. This behavior on the part of both households and firms leads to relationships between current inflation and expected future costs, and between current nominal wage increases and expected future demand for labor services.

The fourth relation describes the way in which the central bank adjusts its short-term interest rate. Specifically, the central bank changes the interest rate in response to developments in output, wage inflation, and price inflation. Even if the central bank is concerned only with stabilizing price inflation, it may nonetheless react to developments in output and wage inflation because those developments help the central bank predict future price inflation. The central bank's interest rate today also depends on its own past values insofar as the central bank chooses to react to developments in the economy in a gradual manner.

This model—with parameters estimated from U.S. data characterizing household behavior, technology, the process of price and wage adjustment, and past monetary policy—closely replicates the effects of monetary policy described earlier. The responses of output and inflation to an increase in the central bank's interest rate, while strongest during the first year following the rate increase, are long and drawn out. Like-

wise, the real wage falls for four quarters following the rate increase and then reverts slowly back to its original level. That the model replicates these features of U.S. data suggests that it captures important determinants of output, price and wage inflation, and the interest rate.

Policy goals and tradeoffs within the framework

Not only does the model replicate key features of U.S. data, it also implies specific goals for monetary policy that are similar to those of many central banks. The goals are not all mutually compatible, though, giving rise to tradeoffs among the goals.

Policy goals. Because of the assumption that individual households and firms maximize their welfare and profits, the model can be used to determine how monetary policy affects household welfare. Simulations of the model can then be used to evaluate alternative policies, with policies that lead to the highest welfare considered the best.

The factors that affect household welfare in this framework correspond closely to the goals of monetary policy discussed earlier. Specifically, both the level and variability of price inflation can be harmful, as is the variability of the output gap. In addition, the level and the variability of wage inflation can also be harmful. While stabilizing wage inflation is not often mentioned as a goal of policy, the model provides a clear rationale for this goal. As already discussed, the demand that firms and households face for their products and labor services depends, respectively, on their price and wage relative to the prices and wages charged by other firms and households. Because firms and households cannot adjust their individual prices and wages every period, high and variable rates of price and wage inflation reduce welfare by causing unintended fluctuations in relative prices and wages. This condition forces firms and households to

supply more, or less, of their products and labor than intended.

The relative weights among the various goals of monetary policy depend on the parameters characterizing household preferences, technology, and the price and wage adjustment process. For the parameter estimates used here, household welfare is reduced almost as strongly by wage inflation variability as by price inflation variability, and as strongly by the average level of wage inflation as by the average level of price inflation. The relative weight on output gap variability, by contrast, is much smaller, reflecting the fact that in the model households and firms are more strongly affected by unintended fluctuations of their wages and prices compared with those of their competitors than by the economy-wide level of income.

Tradeoffs among policy goals. If the efficient level of output and the level of output at which price inflation remains unchanged were identical, there would be no tradeoff among policy goals. The central bank could stabilize both price inflation and the output gap completely simply by setting its interest rate so that at any point in time the level of output demanded and the efficient level of output were equal. Alternatively, the central bank should stabilize price inflation completely, since by assumption the level of output that would result under such a policy would be the efficient level.

Such a simple prescription might not deliver good results in practice, however, for several reasons. The efficient level of output may be highly variable. For example, technological developments may sharply alter the efficient level of output. Given that the central bank's short-term interest rate affects the demand for goods and services only with substantial lags, sharp swings in the interest rate would be required to match, even approximately, aggregate demand with the efficient level of output.

Such a policy would be problematic because the central bank's interest rate cannot fall below zero. To implement a policy that requires highly variable short-term interest rates, the average level of short-term interest rates over time would have to be high. And, high average short-term interest rates would imply high average inflation. This is because any nominal interest rate is the sum of the real interest rate and expected inflation, and the real interest rate in the long run is determined by technological factors outside the central bank's control. Hence, a policy of jointly stabilizing inflation and the output gap is inconsistent with the goal of keeping the average level of inflation low.

Another tradeoff comes from the fact that the efficient level of output may not always coincide with the level of output at which inflation remains unchanged. This situation may arise when some prices or wages adjust gradually in response to changes in demand for products and labor services, respectively.

For example, consider a technological innovation that increases the productivity of labor. This innovation causes firms to demand more labor services, which leads households to demand a higher real wage. However, not all households can instantly adjust their wage. Those workers have to supply whatever hours are demanded at their current wage. Other workers, who have the opportunity to renegotiate their wage, moderate their wage demands because they compete in the labor market with workers whose wages do not adjust.

Under a monetary policy that holds the price level constant, the resulting partial adjustment of nominal wages implies a partial adjustment of real wages. Workers, in general, supply more labor than would be supplied if real wages were free to adjust fully. As a result, output is pushed above its efficient level. In contrast, under a monetary policy that lowered the price level after a technological innovation, real wages

would rise more and the deviation of output from its efficient level would be less.

In summary, situations may arise in which a deviation from price stability works in the direction of stabilizing output at its efficient level. Price stability still remains a goal of policy, but in such a situation a tradeoff exists between price stability on the one hand and output gap stabilization on the other.
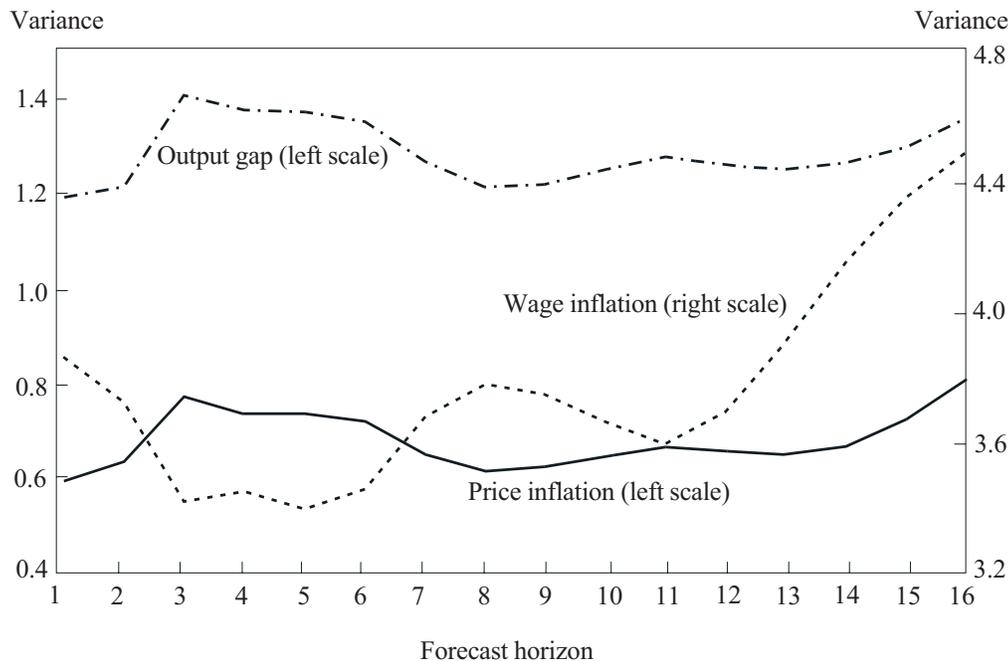
Monetary policy based on inflation forecasts

In the presence of tradeoffs among goals, monetary policy should seek to stabilize the various goal variables based on the public's assessment of their relative importance. In this article's model, for example, household welfare is more strongly reduced by instability in prices and wages than by fluctuations in the output gap. Therefore, the model suggests that it is in the public's interest for monetary policy to focus more on stabilizing wage and price inflation than on stabilizing the output gap. The question is: Can a central bank focus solely on inflation forecasts and still achieve multiple goals? If so, which forecast horizon delivers the best results?

To be precise, the simulations consider a central bank that minimizes the deviation of its forecast of inflation from the desired level some k quarters ahead. For reasons already discussed, the central bank also minimizes interest rate variability. However, the central bank deliberately does not attempt to minimize fluctuations in any other variables, such as the output gap or wage inflation.

For any such objective with a given horizon k, the central bank chooses an interest rate policy that stabilizes inflation as much as it can, ignoring fluctuations expected to occur up to k quarters ahead. The simulations evaluate the policy for each horizon from a public welfare perspec-

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Forecast horizon

tive, taking into account the public's preferences not only about inflation performance but about other goals as well. Trying to stabilize inflation at too short a horizon—for example, trying to keep inflation at its desired level from quarter to quarter—might create substantial and undesirable fluctuations in other goal variables. In contrast, focusing on a horizon that is too far ahead might lead to large and prolonged deviations from the desired level of inflation.
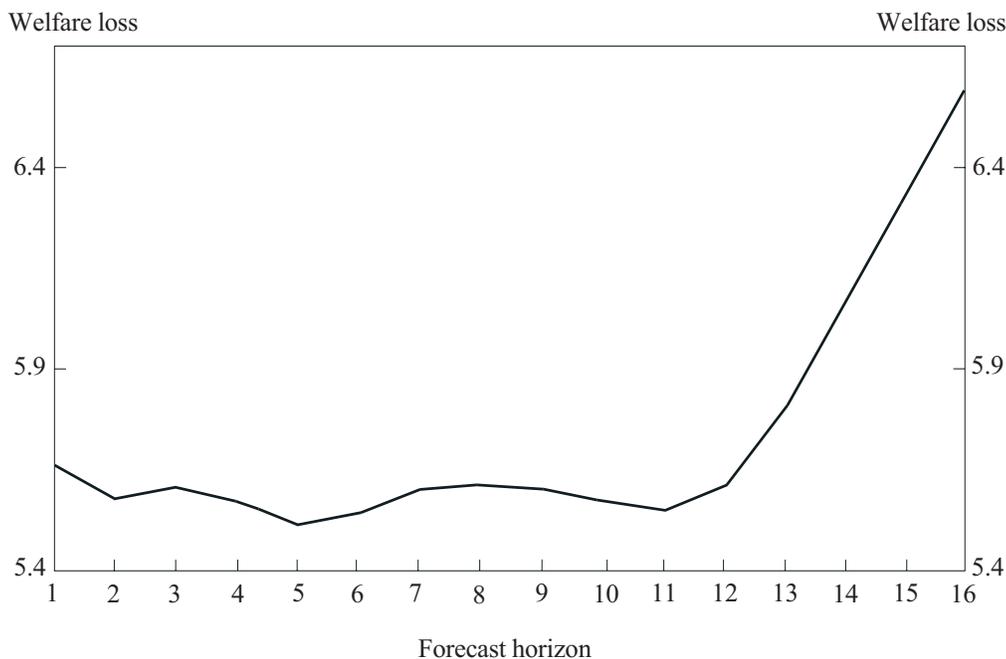
Evidence from simulations

Chart 1 shows the variance of goal variables estimated for simulations of the model. The simulations are based on a monetary policy that stabilizes expected inflation at forecast horizons ranging from one to 16 quarters ahead. In the chart, the variance of price inflation, wage inflation, and the output gap are each multiplied by

the weight with which it enters the public's welfare loss. The weight on price inflation variability is normalized to 1.

As shown in the chart, the overall variability of inflation increases initially as the forecast horizon increases. Beyond three quarters, however, inflation variability falls almost to the same level as when the central bank attempts to stabilize all fluctuations in inflation. Only after eight quarters does inflation variability increase again. Output gap variability shows an almost identical pattern. In particular, variations in the output gap are minimized at forecast horizons of one and eight quarters. Thus, looking only at output and inflation, a forecast horizon of either one or eight quarters would appear optimal.

The pattern of wage inflation variability across horizons looks markedly different. In

Chart 2
WELFARE LOSS

particular, by ignoring fluctuations in price inflation expected over the first two quarters, monetary policy can achieve a substantial reduction in the variability of wage inflation, even though wage inflation does not directly enter the central bank's objective at all. This is an example of the tradeoffs among policy goals discussed earlier: the increase in price inflation and output gap variability is balanced by a reduction in the variability of wage inflation. The variability of wage inflation is minimized at a horizon of five quarters and increases thereafter.

Chart 2 shows the results from combining the various components of the welfare loss using the weights in the public's welfare derived from the parameters of the model.[5] The welfare loss is minimized at a horizon of five quarters. It increases over the following three quarters and then falls again until, at 11 quarters, it is only slightly higher than at five quarters. The increase over quarters six to eight is due to the rise in wage inflation variability. From nine to 11 quarters, wage variability falls while price inflation and output gap variability remain relatively low. Overall, the welfare loss shows little change between one and 11 quarters. Beyond 11 quarters, wage inflation variability rises steeply, and beyond 13 quarters price inflation and output gap variability rise. Welfare losses therefore increase steadily beyond 11 quarters.

Other studies assessing the desirable forecast horizon that use different models and different methods arrive nevertheless at similar results. For example, Batini and Haldane consider the issue of the best forecast horizon for the United Kingdom. Their work shows that the best results

are obtained when the central bank focuses on inflation forecasts five to eight quarters into the future.[6]

IV. SUMMARY

This article shows that the use of forecasts in monetary policy can help central banks achieve multiple goals and at the same time enhance the central bank's accountability to the public. The article first presents the argument for using forecasts based on the fact that the variables that central banks seek to affect react only with substantial delay to changes in the interest rates that central banks control. It then considers the role that forecasts play in the conduct of monetary policy by central banks whose single goal is to maintain price stability, such as the Eurosystem and the Bank of England. It shows that, if the central bank's mandate is defined in terms of inflation stabilization only, it may be in the public's best interest that the central bank stabilize forecasts for inflation at some horizon, instead of stabilizing current inflation. Evidence from a small simulation model suggests that a horizon of five quarters leads to particularly desirable results.

ENDNOTES

[1] Many of the countries that have given their central bank the single goal of price stability have done so in the context of adopting an inflation target. The experiences of these countries, among them New Zealand, Canada, and Sweden as well as the United Kingdom, with the strategy of inflation targeting are examined in Bernanke and others. Kahn and Parrish survey the operational implementation of inflation targets in a number of countries. The case of the Bank of England is studied in this article as an example of an inflation-targeting country. However, the use of forecasts in monetary policy is not limited to inflation-targeting countries, as illustrated by the role that forecasts play for the Eurosystem.

[2] A number of studies examine "inflation forecast targeting" as a strategy for monetary policy, notably the work of Svensson. In contrast to Svensson, however, the present study aims to explain why a central bank might focus on inflation forecasts at a horizon longer than the shortest horizon at which the central bank is able to control inflation.

[3] The model is developed in more detail in Amato and Laubach, who also present further details about the simulations.

[4] While some employees' wages are adjusted more frequently, many employees are covered by wage contracts that are adjusted annually.

[5] In addition to the three components displayed in the top panel, the welfare loss includes the contribution from average inflation incurred by interest rate variability and the zero lower bound on nominal interest rates. Because this component is quantitatively small, it is not displayed in the top panel.

[6] The results of Batini and Haldane refer to the optimal forecast horizon when the central bank uses an interest rate rule in which the current interest rate responds to deviations of the inflation forecast from the inflation target at some horizon.

REFERENCES

Amato, Jeffery D., and Thomas Laubach. 1999. "Forecast-Based Monetary Policy," Federal Reserve Bank of Kansas City, working paper no. 99-10, October.

Batini, Nicoletta, and Andrew G. Haldane. 1999. "Forward-Looking Rules for Monetary Policy," in John B. Taylor, ed., *Monetary Policy Rules*. Chicago: Chicago University Press.

Bernanke, Ben S., Thomas Laubach, Frederic S. Mishkin, and Adam S. Posen. 1999. *Inflation Targeting: Lessons from the International Experience.* Princeton: Princeton University Press.

Bowen, Alex. 1995. "British Experience with Inflation Targetry," in Leonardo Leiderman and Lars E.O. Svensson, eds., *Inflation Targets*. London: CEPR.

Budd, Alan. 1998. "Economic Policy, with and without Fore-casts," Bank of England, *Quarterly Bulletin*, November.

European Central Bank. 1998. "A Stability-Oriented Monetary Policy Strategy for the ESCB," October 13, available on the internet at http://www.ecb.int/press/pr981013_1.htm.

European Central Bank. 1999. "The Stability-Oriented Monetary Policy Strategy of the Eurosystem," ECB *Monthly Bulletin*, January.

Goodhart, Charles A.E. 1999. "Central Bankers and Uncertainty," Bank of England, *Quarterly Bulletin*, February.

Kahn, George A., and Klara S. Parrish. 1998. "Conducting Monetary Policy with Inflation Targets," Federal Reserve Bank of Kansas City, *Economic Review*, Third Quarter.

Svensson, Lars E.O. 1997. "Inflation Forecast Targeting: Implementing and Monitoring Inflation Targets," *European Economic Review,* 41.