# Data Dependence

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I am very pleased to participate in the Annual Outlook Conference here at Middle Tennessee State University. However, perhaps strangely, I'll not say much about the outlook. Others are better qualified than I to discuss that subject. My topic is how the Fed adjusts policy when the economy departs from the central tendency outlook. Of course, forecasters commonly have somewhat different views, but each forecaster's central tendency, or baseline, forecast provides his or her best guess as to how the economy will evolve. However, forecasters also need to be able to say something about probabilities of other outcomes. The probability distribution of possible outcomes is substantially affected by policy responses to deviations from the baseline outlook if and when those deviations occur. And, although I say "if and when," everyone in the forecasting business knows that our knowledge of forecast errors requires that we put much more weight on the "when" than the "if."

The views I express here are mine and do not necessarily reflect official positions of the Federal Reserve System. I thank my colleagues at the Federal Reserve Bank of St. Louis for their comments. Bill Gavin, vice president in the Research Division, provided special assistance.

Let me also note at the outset that this speech is something of a companion to another speech I gave recently, "Understanding the Fed," which was published in the St. Louis Fed's *Review* and is available on our web site.[1]

## SOME BACKGROUND

More than three years ago now, in June 2003, the Federal Open Market Committee (FOMC) set its federal funds rate target at a 40-year low of 1 percent, completing, as it turned out, a series of reductions from a rate of 6½ percent in 2000. The policy statement accompanying the change in the policy target concluded with a concern about an "unwelcome substantial fall in inflation." The decline in the inflation rate was only one of a string of surprises to which the FOMC reacted as it brought its target rate down. The most shocking of the surprises, of course, was the terrorist attack on the United States on September 11, 2001. It would be time consuming, but not difficult, to recount this history, pointing to the data releases and events that led the FOMC to reduce its target rate between early 2001 and June 2003; such an account would provide a clear illustration of what is meant by "data dependence."

[1] William Poole "Understanding the Fed," Federal Reserve Bank of St. Louis *Review*, January/February 2007, *89*(1), pp. 3-13; http://research.stlouisfed.org/publications/review/past/2007/.

William Poole is the president of the Federal Reserve Bank of St. Louis. The author appreciates comments provided by colleagues at the Federal Reserve Bank of St. Louis. William T. Gavin, vice president in the Research Division, provided special assistance. The views expressed are the author's and do not necessarily reflect official positions of the Federal Reserve System.

The roughly two-year period after June 2003 was quite different in the sense that monetary policy does not appear to have been very data dependent. Following its meeting on August 12, 2003, the FOMC issued a statement that said, among other things, that "the Committee believes that policy accommodation can be maintained for a considerable period." The funds rate target remained at 1 percent for a full year. The era of a 1 percent target ended when the FOMC raised the target to 1¼ percent on June 30, 2004, a policy adjustment the FOMC had signaled at its previous meeting in May. By then, as the economy's recovery continued, there was no doubt that the FOMC would have to raise its policy target by a substantial amount to support its long-term inflation objective.

In each of the next 16 consecutive meetings, the FOMC voted to raise the target for the federal funds rate by 25 basis points, finally pausing at 5¼ percent in August of 2006. It appeared to some that policy was on autopilot, as the FOMC raised the target by 25 basis points meeting after meeting, apparently independent of incoming information. That view, I believe, was mistaken. When the FOMC began the series of rate increases, in June 2004, the statement included this sentence: "Nonetheless, the Committee will respond to changes in economic prospects as needed to fulfill its obligation to maintain price stability." Similar language has appeared in every statement since, and the minutes of the meetings have emphasized the same point. What happened over the 18 months after June 2004 was, basically, that incoming data indicated that the economy was so close to the track expected earlier that there was no reason to depart from the "measured pace" of rate increases of 25 basis points at every meeting.

My purpose today is to discuss in a systematic fashion the dependence of policy on new information. I can give you a feel, though not a formula, for why policy decisions are sometimes more data dependent than at other times. When the target rate was at 1 percent, or only modestly above, it was clear that rates had to rise, but a sufficiently large surprise would have led the FOMC to stop, slow, or accelerate the increase. In the event, data surprises were minimal and the FOMC raised the target by 25 basis points 17 times in a row. Increasingly, though, as the FOMC raised the target funds rate, policymakers became more sensitive to the possibility that data surprises could alter the policy course. As it turned out, the decision to stop raising rates was determined, in my mind, less by data surprises than by the economy's slowing more or less as had been expected many months before. The August FOMC meeting turned out to be a good time to pause to take stock of where the economy stood and the likely course of events going forward. Whether the August decision to hold the target funds rate unchanged will turn out to be a pause in the process of raising rates, a longer-lasting stop, or even the peak, will depend on the economy's evolution in coming months.

## THE MODEL

To operate monetary policy effectively and to understand how policy actions affect the economy, the Federal Reserve relies heavily on economic theory developed over the span of many decades. The theoretical framework is complicated in its technical form and implementation but quite straightforward in its bare-bones abstract framework. The real economy evolves along a trend that is buffeted by a variety of economic shocks. Inflation evolves along a trend that is determined by monetary policy and also buffeted by these same economic shocks. Although these shocks drive the business cycle and make the near-term uncertain, expectations about longer-term trends in both real output growth and inflation have become quite stable.

Long-run output growth has almost always been fairly predictable because its trend is determined by the trends in the growth of real factors such as the labor force, the capital stock, and the level of technology in science, industry, and management. These trends evolve slowly; since World War II, real growth has fluctuated around a 3½ percent average and forecasts of future growth tend to be centered on that number or perhaps somewhat lower because labor force growth is slowing as baby boomers retire.

Inflation, on the other hand, has not always been so predictable. Before 1987, there were wide swings in the inflation trend and, unlike the case for real gross domestic product (GDP), long-horizon forecasts of inflation were actually more uncertain than short-horizon forecasts.[2] Today, after a quarter century of effort by the Fed to actively contain inflation, inflation has also become more predictable over all horizons; and forecasts over longer horizons are now much more accurate than those over shorter horizons.[3] Evidence that long-term inflation has become more predictable is important, because it means that the Fed has found a way to anchor the inflation trend.

Thus, our basic model is of an economy in which both real growth and the inflation rate are buffeted by economic shocks in the short run but then tend to return to predictable long-term trends. The fluctuations of both output and inflation around trends have moderated a great deal over the past 25 years, partly and importantly because of better monetary policy. This better policy is due to the Fed concentrating on its objective for long-run price stability through a more systematic reaction to incoming information about the economic shocks.

At one time, many economists believed that there was an inherent tension between stabilizing inflation and stabilizing the real economy. Over the past 25 years, we have learned that a condition for stabilizing the real economy is stabilizing long-run inflation expectations. Thus, one of the most important things to understand about the dependence of monetary policy actions on arriving information is that the Federal Reserve has a deep commitment to achieving a long-run outcome for inflation that is in accord with its price stability objective. Put another way, short-run policy is strongly motivated by long-run considerations.

## MONETARY POLICY

A fundamental component of monetary policy is the decision about the long-run policy objective for inflation. This aspect of policy should not be data dependent. It is possible that an advance in economic knowledge will teach that we should have a different long-run inflation objective. No such advance is on the horizon; but even if it were, it would not be an exception to the rule that the policy objective should be independent of incoming information about the current state of the economy. The policy objective determines the long-run inflation trend in our model and, more importantly, the nominal anchor for the economy.

The reaction of policy to incoming news depends on the state of the economy relative to the trends. The private sector needs to know the Federal Reserve's inflation objective so that it knows how to view fluctuations around the trend. Recently, several individual FOMC members have characterized the long-run inflation goal as a "comfort zone of 1-2 percent inflation" as measured by inflation in the chain price index for personal consumption expenditures. Although the FOMC itself has not adopted a formal, quantitative inflation objective, several members, including me, have said that they believe that greater clarity about the long-run objective would help both the Committee and the markets to make more informed decisions.

It is much easier to agree on a long-run inflation objective than on short-run policy actions consistent with the objective. There is agreement on two conflicting principles. First, it is all too easy to overreact to short-run developments. Agreement on that principle is reflected in the FOMC's emphasis on core inflation—inflation measures excluding volatile food and energy prices—as a guide to short-run policy. Moreover, above-trend inflation may be acceptable under some circumstances, provided we are confident that past policy actions have been sufficient to slow inflation in the future. Nevertheless, there is also agreement on a second principle: It is all too easy to allow wishful thinking on inflation to delay necessary tough policy decisions. The FOMC does its best to make the right choices

[2] See Stephen K. McNees, "How Accurate Are Macroeconomic Forecasts?" Federal Reserve Bank of Boston *New England Economic Review*, July/August 1988, pp. 15-36.

[3] See evidence on forecast errors over 3-, 12-, and 24-month intervals from 1997 through 2006 in William T. Gavin and Kevin L. Kliesen, "Forecasting Inflation and Output: Comparing Data-Rich Models with Simple Rules," Federal Reserve Bank of St. Louis Working Paper 2006-054A, September 2006.

when, as is often the case, "all too easy to overreact" collides with "all too easy to allow wishful thinking on inflation."

In one sense, long-run policy is the accumulation of individual short-run policy decisions. However, if individual decisions reflect only reactions to short-run developments in the economy, then there is no telling where long-run policy will go. The right way for the Fed to think about short-run policy decisions is that they have to be part of, or fit into, a coherent long-term plan. The market's understanding of this plan is central to the determination of long-term interest rates. In general, the rate on any bond depends on expected short rates over the horizon of the bond. Thus, the 10-year Treasury bond rate depends on expectations of short-term interest rates over the 10-year horizon.

Market expectations about future interest rates depend on the interaction of two interrelated sources of influence. One, obviously, concerns Federal Reserve decisions on the intended federal funds rate. Also important are expectations as to the demands for and supplies of funds in the private market. For example, with simultaneous investment and housing booms, credit demands will be high and interest rates will tend to be bid up. In pursuing its policy goals, the FOMC will be adjusting the federal funds rate as needed to keep the inflation rate low and stable. Thus, the market forms expectations about the underlying state of the economy that will bear on Fed decisions.

The Federal Reserve is constantly evaluating the situation in the markets and trying to adjust the intended federal funds rate to produce a satisfactory equilibrium in the economy. When we put the Federal Reserve's and the market's decisions and expectations together, we have a macroeconomic equilibrium.

The interaction between the Federal Reserve and the markets may be confusing at first sight, and indeed was confusing to economists for generations until conceptual breakthroughs in the 1960s and 1970s clarified the issue. Market behavior depends on expectations as to what the Federal Reserve is going to do, and what the Federal Reserve is going to do depends on what the market and the economy are anticipated to do. The full rational expectations macroeconomic equilibrium occurs when the market behaves as the Federal Reserve expects and the Federal Reserve behaves as the market expects. In both cases we assume that the expectations are fully rational, by which we mean that the expectations are fully informed on the basis of all available information. The abstraction of a full rational expectations macroeconomic equilibrium provides a powerful starting point for analysis of a data-dependent policy.

## CAN THE MARKET PREDICT DATA DEPENDENCE?

The "Taylor rule" is a stylized view of the Fed's reaction to incoming information. In 1993, Stanford economist John Taylor proposed a simple formula relating the federal funds rate to (i) a long-run inflation target and (ii) short-run deviations of inflation from that target and short-run deviations of real GDP from a measure of "potential real GDP."[4] Taylor suggested that his simple relationship characterized in broad outline the actual behavior of the federal funds rate in the early years of the Greenspan FOMC. The essence of this relationship is that in the long-run the FOMC seeks to keep the federal funds rate roughly consistent with a level that is believed to produce a target level of inflation. Taylor assumed a target rate of inflation of 2 percent per year measured by the total consumer price index (CPI). In the short run, the relationship implies that the FOMC adjusts the target federal funds rate up as either the observed inflation rate exceeds its target or real GDP exceeds potential real GDP. Conversely, under the Taylor rule, the FOMC reduces the target federal funds rate when inflation falls below its target and/or real GDP falls short of potential real GDP.

The Taylor rule reflects the primacy of a long-run inflation objective while incorporating short-

[4] John B. Taylor, "Discretion versus Policy Rules in Practice," *Carnegie-Rochester Conference Series on Public Policy*, 39, December 1993, pp. 195-214. Taylor compared the values of his formula against the observed history of the funds rate from 1987 through 1992.

run stabilization efforts. The rule provides a formula for computing a baseline, or reference, interest rate that is consistent with policy achieving the Fed's objectives for both output stabilization and price stability. I discussed the Taylor rule in some detail in the speech I mentioned earlier, "Understanding the Fed," and refer you to its published version in this *Review* if you want to dig into the subject more deeply.

Now I'll turn to some comments on future Fed policy, but I want to remind you that I am speaking for myself—other FOMC participants may have different views about how future policy adjustments will depend on arriving information. All economic indicators may have implications for the evolution of the real economy and inflation. I emphasize "may" because we have to filter out as best we can possible data errors and inconsistencies across various indicators.

Before I discuss future Fed policy in any detail, I begin with a warning. New information drives both market adjustments and policy changes, but new information is inherently unpredictable. To gain a sense of the impact of new information on interest rates, I've analyzed data from the eurodollar futures market and discussed the results in some detail in "Understanding the Fed." The bottom line of that analysis is that forecasts embedded in the eurodollar futures market explain 42 percent of the variance of fluctuations in the actual eurodollar yield three months ahead. Thus, unpredictable events even over a three-month horizon are responsible for 58 percent of the variance of the eurodollar yield. Over a six-month horizon, unpredictable events are responsible for more than 70 percent of the variance. Thus, I can discuss various scenarios but have no way of knowing which scenario will come to pass.

Let's start with the outlook for the rest of 2006. Forecasts made by FOMC members and transmitted to Congress in July were 3¼ to 3½ percent growth for real GDP and an increase for the core personal consumption expenditures (PCE) chain price index of 2¼ to 2½ percent. As for 2007, the central tendency of the FOMC members' GDP forecasts is 3 to 3½ percent. This growth outlook should be consistent with keeping the economy close to full employment, based on the Congressional Budget Office forecast of potential GDP growth of 3.24 percent in 2007. As for inflation, the central tendency forecast of FOMC participants for 2007 is 2 to 2¼ percent. Thus, inflation is expected to recede only very slowly from its current level.

There are two cases in which the economic news will pretty clearly predict a change in the Fed's policy stance. If incoming economic indicators show that both output and inflation are rising above these forecasts, then, in the absence of any other information, we can expect that the FOMC will increase its target federal funds rate. On the other hand, if both output and inflation come in weaker than expected, we are unlikely to see further increases in the federal funds target; indeed, if economic weakness is pervasive enough, the FOMC will at some point reduce the target funds rate.

The most interesting—not to mention controversial and difficult—cases are those in which the outlook for inflation and output move in opposite directions. In such cases, the FOMC has to call on all its experience and judgment to reach a decision. It is very difficult for me to be precise about the judgments I am likely to reach based on incoming information because a host of considerations, some of which I cannot foresee, may enter the calculus. But I'll make a stab at how things could play out to illustrate my thought process.

A critically important consideration in my mind concerns the inflation process and the importance of the Fed's commitment to low and stable inflation. It is my conviction that temporizing on actions to control inflation is an invitation to trouble. Accepting higher inflation, or even a continuation of the current rate of inflation, in an effort to sustain current employment levels will only lead to more grief later. Once inflation and inflation expectations rise, the economy will become less stable and reducing inflation from an elevated rate will be more costly than taking the medicine now. Having said that, if inflation pressures are easing, even if only gradually, and there is a genuine prospect that inflation will return to the comfort zone, then I see no reason to accelerate the decline in inflation by maintain-

ing a restrictive policy in the face of declining employment. Policy needs to be as disciplined as necessary to get the job done, but not more so.

The long-run inflation goal and the attitude I've expressed about what risks to take suggest that I will have a bias in the way I interpret incoming information. If data on the real economy come in weaker than expected—if it appears that the economy is falling below the baseline forecast path—then my bias will be in the direction of wanting to be sure that the data paint a consistent picture before I'll advocate a policy easing. But if the picture *is* consistent, and inflation risk *is* receding, then I'll not hesitate to advocate policy easing.

What I hope the FOMC can accomplish is to retain full market confidence that the long-run rate of inflation will remain in the comfort zone. I hope that forecasters assign very low probability to inflation outcomes over the medium term of 3 to 5 years outside the comfort zone no matter what the incoming data look like. Although I am talking about inflation over a horizon well beyond the usual forecast horizon of 1 to 2 years, the long-run inflation outlook has a direct bearing on the forecast. The long bond rate today depends critically on expected inflation over the maturity of the bond. Thus, rates that enter importantly into any economic forecast, such as mortgage and corporate bond rates, depend on the long-run inflation outlook. This outlook has been quite stable in recent years, and that fact is evidence of a major monetary policy success.

With long-run inflation contained, the FOMC has flexibility to respond, vigorously if necessary, to economic weakness should it arise. The FOMC brought the target federal funds rate down aggressively in 2001 in response to incoming information. Aggressive easing kept the recession mild. If the economy comes in below the baseline forecast in coming quarters, the FOMC will have room to act as aggressively as required. I have no idea what scale of easing might be appropriate, for that will depend on the nature of the incoming information. Still, I believe forecasters should assign a relatively low probability to deep recession precisely because of the FOMC's demonstrated willingness to act aggressively as necessary.

I've given you my take on what data dependence means and the attitudes that underlie my likely responses. I've also emphasized that an efficient rational expectations equilibrium requires that the market behave as the policymakers expect and policymakers behave as the market expects. The market's evaluation of the prospects for policy is revealed in the futures markets for federal funds and eurodollar deposits. Current futures prices predict that the federal funds target is expected to begin moving down. Because these market quotes change day by day in response to new information, I do not want to attempt to be particularly precise as to the timing—anything I write as I draft these remarks may be out of date by the time I deliver them or within a few weeks, anyway. What I can safely note is that the market's expectation of future policy easing has been taking hold gradually since late June, say, in response to data on the real economy suggesting that real growth is slowing and inflation data suggesting that the worst may be over on that front.

Although expectations about future policy actions are revealed transparently in the futures market for short-term interest rates, I want to underscore my earlier point about the limited accuracy of those forecasts. Some of the forecast misses have been pretty dramatic. For example, in December 2000, the futures market forecasts were for a decline in the eurodollar yield of 35 basis points over the following three months and a total of 67 basis points over the six-month period. Instead, the FOMC acted aggressively to lower the funds rate target starting in January and continuing through May 2001 by a total of 250 basis points. The FOMC acted aggressively as incoming information pointed to growing weakness in economic activity. Both the FOMC and the markets were surprised by incoming information indicating that the economy was weakening quickly and significantly.

Although I cannot predict unpredictable new information, I've tried to provide a sense of how I might respond to new information as it arrives. I note, however, that it is rare that a single data report is decisive. The economic outlook is determined by numerous pieces of information. Important data such as the inflation and the employment

reports are cross-checked against other information. The FOMC is aware of the possibility of data revisions and short-run anomalies. Sometimes data ought to be discounted because of anomalous behavior.

An example was the increase in tobacco prices in late 1998. Tobacco prices had a transitory impact on measured inflation, both total and core indices, during December 1998 and January 1999, but produced no lasting effect on trend inflation. Similarly, information about real activity sometimes arrives that indicates transitory shocks to aggregate output and employment. An example of such a transitory shock is the strike against General Motors in June and July 1998. Similarly, the September 2005 employment report reflected the impact of Hurricane Katrina, which was expected to be, and turned out to be, temporary from a national perspective.

Transitory and anomalous shocks to the data are ordinarily rather easy to identify. Both Fed and market economists develop estimates of these aberrations in the data shortly after they occur. The principle of looking through aberrations is easy to state but probably impossible to formalize with any precision. We know these shocks when we see them, but could never construct a completely comprehensive list of such shocks ex ante.

Policymakers piece together a picture of the economy from a variety of data, including anecdotal observations. When the various observations fit together to provide a coherent picture, the Fed can adjust the intended rate with some confidence. The market generally understands this process, as it draws similar conclusions from the same data.

So, given policy objectives, and given a view about how policy decisions affect the economy, the central bank can in principle specify a policy rule, or response function, that guides policy adjustments in response to incoming information. To achieve a good result, the general public and market participants need to understand the objectives and the response function so that the private economy can determine its activities with full knowledge of how the central bank will act. Of course, uncertainty is an inherent characteristic of the economic world. What should be predictable are the central bank's responses to the never-ending sequence of surprises that characterize the economic environment.

Market commentary often indicates frustration that the FOMC does not lay out a clearer path for policy, arguing that the FOMC is unpredictable. That view, I believe, is off base. Typically the FOMC cannot be predictable with regard to the path of the target federal funds rate because new information driving policy adjustments is not predictable. All of us would like to be able to predict the future. We in the Fed do the best we can, but the markets should not complain that the FOMC lacks clairvoyance! What the FOMC strives to do is to respond systematically to the new information. There is considerable evidence that the market does successfully predict FOMC responses to the available information at the time of regularly scheduled meetings.[5]

## CONCLUDING COMMENT

To say that policy is data dependent means that policy changes will depend on the incoming news about the state of the economy, both real growth and inflation. That the policy setting is data dependent is a good sign. It means that policy is in a range than can be considered neutral—that is, thought to be consistent with the Fed's longer-run policy objectives. It is important to remember that the long-run inflation objective should not be data dependent. If the objective is well understood, people will know whether the current inflation rate is above or below the desired trend. They will know how to interpret incoming information to gauge what it means for the policy stance. I believe that is just about exactly where we are today.

[5] See, for example, William Poole, "How Predictable Is Fed Policy?" Federal Reserve Bank of St. Louis *Review*, November/December 2005, *87*(6), pp. 659-68; http://research.stlouisfed.org/publications/review/past/2005/.