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Chairman's Remarks

Alan Greenspan

TRANSPARENCY IN MONETARY POLICY

It is my pleasure to address this distinguished group that President Poole and his colleagues have assembled to consider the timely issue of transparency in monetary policy. We at the Federal Reserve are given two mandates that are not often spelled out explicitly. First, to implement an effective monetary policy to meet our legislated objectives. But, second, to do so in a most open and transparent manner in recognition that we, as unelected officials, are accountable both to the Congress from which we derive our monetary policy mission and, beyond, to the American people.

These twin goals do not always work in concert. In the extreme, we could achieve full transparency if our deliberations and actions occurred only in public fora. In principle, there is no reason this could not be done. And I do not doubt that there exists a select group of professionals who could deliberate in such open fora as effectively as behind doors. Milton Friedman—whose effect on monetary policy, especially here at the Federal Reserve Bank of St. Louis, is legendary—is one with such sharply refined skills. I might be able to name a few more, but I doubt that I would get much beyond counting the fingers on one hand.

Human nature being what it is, the vast majority of us are disinclined to offer half-thought-through, but potentially useful, policy notions only to have them embarrassingly dissected in front of a national television audience. When undertaken in such a medium, deliberations tend toward the less provocative and less useful. I do not say that such a system cannot function, but I do say that in my three decades in and out of government, I have never seen it function well. The undeniable, though regrettable, fact is that the most effective policymaking is done outside the immediate glare of the press. But that notion and others have been used too often in the past to justify a level of secrecy that turned out to be an unnecessary constraint on our obligation to be transparent in conducting the public's business.

We need to remember that in decades past it was believed that monetary policy was most effective when it was least transparent. The argument back in the 1950s, as I remember it, was that market uncertainty created significant differences of opinion in the direction of the prices of short-term debt instruments. The result was a "thick market" of bids and asks that increased the degree of liquidity. More recently, in the 1980s, policymakers, myself included, were concerned that being too explicit about short-run targets would make such targets more difficult to change, impeding necessary adjustments to evolving market and economic conditions. Not too many years ago, the world learned of decisions of the Federal Open Market Committee through minor variations in the minutia of daily open market operations—that is, effectively through faint signals that only informed market professionals knew how to read with accuracy. True, over time, those signals became increasingly clear, so that in the end, market participants never missed a policy decision or read into our open market operations a policy action when there was none.

As markets, experience, and the magnitude of outstanding financial instruments changed, the dead-weight loss created by such uncertainty—read: "risk"—became increasingly evident, as did the value of transparency. Simply put, financial markets work more efficiently when their participants do not have to waste effort inferring the stance of monetary policy from diffuse signals generated in the day-to-day implementation of policy. And being clear about that stance has not constrained our ability to adjust the stance of monetary policy in either direction.

Our current disclosure policy, one hopes, obviates such complexities. In recent years, we have achieved a far better balance, in my judgment, between transparency and effective monetary policy implementation than we thought appropriate in the past. Accordingly, as you know, we moved to the immediate disclosure of our policy actions and, over time, to explaining our decision and our sense of future risks directly after each meeting. In addition, we now publish full transcripts of our meetings after five years. Through these disclosures, together with congressional testimony, speeches by Board Governors and Reserve Bank Presidents, and the publication of the System's sizable research output, we endeavor to keep the public well informed. We

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Alan Greenspan is the Chairman of the Board of Governors of the Federal Reserve System. His remarks were presented via video-conference.

have gotten to our present degree of transparency through an incremental process, and our disclosure policy will continue to evolve. At each step, we need to review whether in our judgment this new degree of openness optimizes the Federal Reserve's ability to implement effective monetary policy in the context of maximum feasible disclosure.

It is inherent in the complex and changeable nature of our economy that no one can forecast near-term outcomes with precision. However, it is also inherent in our economy that in the long run, the central bank has influence over only nominal magnitudes. As a result, the Federal Reserve can be quite explicit about its ultimate objectives—price stability and the maximum sustainable growth in output that is fostered when prices are stable. By price stability, however, I do not refer to a single number as measured by a particular price index. In fact, it has become increasingly difficult to pin down the notion of what constitutes a stable general price level.

When industrial product was the centerpiece of the economy during the first two-thirds of the twentieth century, our overall price indexes served us well. Pricing a pound of electrolytic copper presented few definitional problems. The price of a ton of cold rolled steel sheet, or a linear yard of cotton broad-woven fabrics, could be reasonably compared over a period of years. But in our new century, the simple notion of price has turned decidedly ambiguous. What is the price of a unit of software or a legal opinion? How does one evaluate change in the price of a cataract operation over a ten-year period when the nature of the procedure and its impact on the patient has changed so radically? Indeed, how will we measure inflation, and the associated financial and real implications, in the twenty-first century when our data—using current techniques—could become increasingly less adequate for tracing price trends over time?

So long as individuals make contractual arrangements for future payments valued in dollars however, there must be a presumption on the part of those involved in the transaction about the future purchasing power of money. No matter how complex individual products become, there will always be some general sense of the purchasing power of money both across time and across goods and services. Hence, we must assume that embodied in all products is some unit of output, and hence of price, that is recognizable to producers and consumers and upon which they will base their decisions. Doubtless, we will develop new techniques of price measurement to unearth those units as the years go on. It is crucial that we do, for inflation can destabilize an economy even if faulty price indexes fail to reveal it.

For all these conceptual uncertainties and measurement problems, a specific numerical inflation target would represent an unhelpful and false precision. Rather, price stability is best thought of as an environment in which inflation is so low and stable over time that it does not materially enter into the decisions of households and firms. Nonetheless, I cannot help but conclude that the progress that the Federal Reserve has achieved over the years in moving toward this old definition of price stability has contributed to the improvement in our nation's longer-term growth prospects that became evident in the latter part of the 1990s. So, for the time being, our conventional measures of the overall price level will remain useful.

President Poole has picked an appropriate topic for this group to consider. The historical record indicates that the increased transparency of the Federal Reserve has helped improve the functioning of markets and enhanced our credibility. But, to repeat, openness is more than just useful in shaping better economic performance. Openness is an obligation of a central bank in a free and democratic society. U.S. elected leaders chose to vest the responsibility for setting monetary policy in an independent entity, the Federal Reserve. Transparency of our activities is the means by which we make ourselves accountable to our fellow citizens to aid them in judging whether we are worthy of that task.

Are Contemporary Central Banks Transparent About Economic Models and Objectives and What Difference Does It Make?

Alex Cukierman

I. INTRODUCTION

Authority over monetary policy has increasingly been delegated to central banks with substantially higher levels of independence than in the past. This worldwide trend has propelled the twin issues of accountability and transparency to the forefront of the debate on monetary institutions. The current debate is particularly intense on the European side of the Atlantic where the formation of a European Central Bank (ECB) facing 12 different fiscal authorities and different types of labor markets has transformed those previously mainly academic questions into practical policy issues.

There is nowadays a good deal of consensus about the objectives and desirable organization of monetary policymaking institutions. In particular, there is widespread consensus that the main objective of monetary policy should be price stability, that the central bank (CB) should have the freedom to set the interest rate without political interference, and that the objectives and the procedures followed by the CB should be reasonably transparent. The insistence on transparency is motivated by the desire to ultimately make the CB accountable to the general public either directly or through the intermediation of elected officials. But once those general principles are translated into operational guidelines, some differences appear. The consensus about transparency is most fragile to the introduction of practical guidelines, as illustrated by a recent interchange between Buiter (1999) and Issing (1999). Buiter's position largely reflects what I have called elsewhere the (new) Bank of England (BE) approach, and Issing's position reflects the approach of the ECB, which has been largely shaped by the philosophy of the Bundesbank (BB) during the last several decades.[1]

Both approaches agree on the principle that a CB should be transparent and accountable but differ on the means to achieve those goals. The most vocal disagreements have been about the early publication of CB forecasts and the voting record of individual monetary policy council members. The BE approach is in favor of early release of this information, while the BB approach is against it. Those differences partly reflect the BB view that there should be "collective responsibility" at the CB, while the BE approach puts relatively more emphasis on the accountability of individual council members. They also reflect the fact that since the second half of the 1990s countries such as the United Kingdom and Sweden have put in place an explicit mechanism of inflation targeting in conjunction with a numerically specified inflation target that is decided upon by government.[2] In such systems the early publication of CB forecasts is believed to be an essential element of accountability because it enables the principal (government) to judge whether ex post deviations from the target were due to poor performance by the agent (the CB) or to unanticipated economic shocks. The colorful debate about the publication of forecasts and CB votes overshadowed two possibly more fundamental areas in which most (perhaps even all) existing central banks are rather opaque. One concerns the economic model, or models, used in making policy decisions, and the other concerns the operational objectives of the CB.

This paper focuses on those issues. It has two main parts. The first evaluates the degree of transparency about the economic models used by con-

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[1] A fuller discussion of the differences between those two approaches regarding the practical implementation of transparency and other issues appears in the concluding section of Cukierman (2001). See also de Haan and Eijffinger (2000) for an appraisal of the Buiter-Issing interchange.

[2] Some other countries with explicit inflation targeting systems are New Zealand, Canada, Finland, Australia, and Spain. In almost all cases the final formal authority to set the target resides with government. By contrast, in the case of the BB and the ECB, the target is chosen by the CB.

temporary central banks and about their objective functions. It argues that, in spite of the recently acknowledged importance of transparency (particularly in some inflation-targeting countries), there is substantial haziness about the economic models used by CBs to generate forecasts as well as about their objective function. Some of this haziness is due to the absence of clear knowledge about the "true" model of the economy and some is due to the attempt of policymakers to hedge their positions in the face of model and of political uncertainties.

The second part of the paper examines whether haziness about objectives matters for credibility when monetary policymakers are more sensitive to negative than to positive output gaps. The initial motivation for this exercise is the following statement from Blinder (1998, pp. 19-20), made shortly after his resignation from the office of Vice Chairman of the Fed: "In most situations the CB will take far more political heat when it tightens preemptively to avoid higher inflation than when it eases preemptively to avoid higher unemployment."

A fuller description of the second part of the paper is provided after the following recent literature review.

Since the early 1980s the dominant academic paradigm for conceptualizing the positive and sustained inflation rates experienced by most countries during the twentieth century has been the Kydland-Prescott (1977) and Barro-Gordon (1983) framework (henceforth KPBG). This view includes an inflation bias that is due to the fact that, owing to tax and/or other labor market imperfections, the natural level of employment is lower than the level targeted by policymakers. This induces policymakers to try to stimulate employment by means of inflationary surprises. Because the public anticipates such behavior, it adjusts nominal wages (and other) contracts accordingly, which leads to an equilibrium in which inflation has a positive bias but output remains at the natural level.

Recently two central bankers with strong academic backgrounds have expressed the view that decisionmakers in their respective CBs are not trying to maintain employment above its natural level and conclude, therefore, that the KPBG bias story is not applicable to their respective CBs.[3] In particular, Blinder (1998, p. 43) argues that policymakers at the Fed do not try to systematically maintain employment above the natural level. As a matter of fact, when in office, he personally felt duty bound to conduct monetary policy so as to hit the natural rate. In a similar vein, while recently summarizing the U.K. experience with inflation targeting, John Vickers (1998, p. 369) expressed the following view: "There is a large literature on inflation bias but it simply is not applicable to the MPC. We have no desire to spring inflation surprises to try to bump output above its natural rate (wherever that may be)."

Coming from a former Fed's vice chairman and from an executive director and chief economist at the BE, such introspective statements certainly deserve serious consideration, not the least because acceptance of this view carries with it the important implication that the credibility problem of monetary policy is a thing of the past.[4]

In parallel, recent inflation targeters such as the (reborn with instrument independence since 1997) BE acknowledge that, although their primary objective is price stability, they are also averse to excessive short-run fluctuations of actual output around potential or natural output. Hence, they attempt to achieve the inflation target on average rather than in each period. In Mervyn King's words, they are not "inflation nutters" (e.g., see King, 1997). For example, if an adverse supply shock pushes inflation above target for some time, they do not seek to put inflation back on target immediately because of the associated excessive fluctuations this would create in the output gap.

Svensson (1997) refers, somewhat more neutrally, to such a bank as a "flexible inflation targeter" and to King's "inflation nutter" as a "strict inflation targeter." Recent inflation targeters such as the United Kingdom, New Zealand, Canada, and Sweden have been rather transparent about the fact that they are flexible rather than strict inflation targeters. In terms of the familiar quadratic loss function used by KPBG and much of the ensuing literature, this means that, although they do not try to maintain output above its natural level, their loss function assigns a positive weight *also* to deviations of output from its potential level. I shall refer to the relative weight assigned to deviations of output from target in comparison with deviations of inflation from

[3] McCallum (1995, 1997) expresses a similar view.

[4] The views expressed by Blinder and Vickers are not inconsistent with the existence of a KPBG inflationary bias prior to the 1990s, provided that policymakers, at the time, believed in a stable tradeoff between inflation and economic activity. As the idea of no tradeoff percolated through policymaking circles during the 1990s, policymakers, realizing the futility of attempting to maintain output above its natural level, settled for the natural rate. Sargent (1999) models this process using least-squares learning about the slope of the long-run Phillips curve.

target as the "flexibility parameter" and denote it by A.

In any precise characterization of optimal policy in such a context, A is obviously an important determinant of the speed with which policy seeks to put inflation back on target following adverse shock realizations. The larger is A, the larger is the "flexibility" allowed in returning to the inflation target following a shock. Hence, along the optimal policy plan of a flexible inflation targeter, the parameter A determines the period-by-period deviations of inflation from its target. In spite of its obvious importance and of their insistence on transparency, recent inflation targeters have been rather hazy about the magnitude of the flexibility parameter. This is recognized by Vickers (1998, p. 370) who candidly writes, "The MPC remit is silent on this parameter of the loss function, but optimal policy is arguably not too sensitive to its value within a reasonable range."[5]

While most explicit inflation targeters openly admit that they are of the "flexible" variety, that was not usually the case with the BB when it was in charge of German monetary policy, nor is it currently the case with it successor—the ECB. In view of the strong and unequivocal priority given to price stability in the charter of those banks, their officials probably prefer to view and to project to the public an image of the bank as a strict, rather than a flexible, inflation targeter. But evidence presented in Clarida and Gertler (1997) is consistent with the view that the actual policy of the BB did not significantly differ from that of a flexible inflation targeter. Thus, there seems to be substantial haziness about the parameter A among both explicit and implicit inflation targeters.

The second part of the paper takes the statements of Vickers (1998) and of Blinder (1998) (that the output target of BE and Fed policymakers is the natural level) at face value and examines the consequences of flexible inflation targeting and of haziness about the parameter A for credibility in the presence of asymmetric objectives. Besides the statement by Blinder hinting at an asymmetry in the objectives of the U.S. political establishment, this exercise is motivated by the following considerations.

Cukierman (2000a) shows that, with a Lucas-type transmission mechanism, uncertainty about the future state of the economy and asymmetries in the output gap segment of the CB loss function, there will be an inflation bias even if the CB targets the normal level of output. This framework implies that there should be a positive association between the variability of economic activity over the cycle and the magnitude of the inflation bias. Preliminary cross-sectional evidence in Gerlach (2000) supports this implication.[6] Last but not least, the quadratic objective function originally postulated by KPBG carries the rather unintuitive implication that, *given inflation*, an upward deviation of employment from its desired level is as costly as a downward deviation of the same size. It is hard to see why policymakers, or social planners for that matter, would object, given inflation, to a positive output gap. As a matter of fact, it's quite likely that, in the range of positive output gaps, the quadratic function was postulated mainly for analytical convenience rather than for its descriptive realism.[7]

Because there is substantial uncertainty about the correct model of the economy, the consequences of asymmetric objectives are examined also for an economy with a New Keynesian transmission mechanism of the type recently reviewed by Clarida, Gali, and Gertler (1999). In this case there is an inflation bias that has two distinct origins. One of those arises, as in the case of an expectations-augmented Phillips curve, due to the interaction of asymmetries in the output gap segment of the loss function with uncertainty about the future state of the economy. Thus, flexible inflation targeting in conjunction with asymmetric output gap objectives leads to credibility problems even when policymakers target the average natural level. Furthermore, contrary to conventional wisdom (with an expectations-augmented Phillips curve), this bias is an increasing function of the extent to which the CB is "flexible" in targeting inflation as measured by the parameter A. Because this is precisely the parameter about which contemporary CBs tend to be hazy, it follows that there is also uncertainty about the size of the bias.

The additional inflationary tendency that arises in the New Keynesian framework is related to the fact that, because prices are sticky, policymakers

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[5] The qualifier refers to work by Bean (2000) and Batini and Haldane (1999), who claim that for recent structural parameters of the United Kingdom the optimal policy of a flexible inflation targeter is insensitive to the precise value of A.

[6] In addition, Ruge-Murcia (2001) provides individual time-series evidence for several countries. His evidence supports the existence of asymmetries in CB losses from deviations of unemployment from its natural level for France and the United States but not for the United Kingdom and Japan.

[7] The quadratic function does not admit the possibility that policymakers might have precautionary demands for expansions and for price stability. A formulation of policymakers' objective functions that allows for both possibilities appears in Cukierman and Muscatelli (2002).

face a long-run tradeoff within some range between average inflation and the average output gap. Policymakers with asymmetric losses from positive and negative output gaps choose a point along this tradeoff that is characterized by both positive average inflation and a positive average output gap.[8]

Section II documents existing haziness about the economic models used by decisionmakers in CBs and about the level of output that they target. It is argued that, while a large part of this haziness is due to lack of clear consensus about the transmission mechanism within the economic profession itself, this state of affairs leaves quite a bit of discretion to CBs and opens the door for strategic use of information. Section III examines the extent to which contemporary CBs are transparent about their objectives and concludes that here, too, there is quite a bit of haziness, particularly among the new "flexible inflation targeters." It then reviews recent theoretical arguments and empirical work that support the hypothesis that at least some CBs have different attitudes about positive and negative output gaps.

Section IV shows, for a Lucas-type transmission mechanism, that, in the presence of such asymmetries and uncertainty about the upcoming state of the economy, policymakers "hedge" their position on the side of expansion to reduce the likelihood of surprise recessions. This behavior is shown to induce an inflationary bias even when the policymakers' output target is potential output. Section V first shows that a similar mechanism operates also in sticky price, New Keynesian models of the economy. But, because policymakers can control the real rate of interest in such frameworks, asymmetric preferences lead to an additional inflationary tendency that is associated with average positive real effects on the output gap.

II. HAZINESS ABOUT THE ECONOMIC MODEL USED FOR MAKING POLICY DECISIONS

Practically all CBs are rather noncommittal about the economic model or models they use in making policy decisions. Admittedly, many of the major CBs have at least one big econometric model of the economy in store. But the forecasts generated by such models are only one of many inputs used in formulating policy. Decisionmakers at major CBs have access to a multitude of alternative "models" and information. The aggregation of this information by each board member and the further aggregation of the position of each board member into a collective decision is a rather complex process; a full description of this would require very detailed tracking of the thought process of each board member as well as of the interaction among the board members. Vickers (1998, p. 370) candidly admits that there are serious limits to how much of this process can be put in the public domain[9]: "While transparency—inflation reports, MPC minutes, Treasury Committee hearings and so on—increases what is in the public domain (desirably in my view), there is surely information relevant for policy-making that is simply incapable of being put in the public domain."

A substantial part of this ambiguity is caused in the first place by the absence of consensus within the economic profession about the correct model of the economy. In the absence of consensus, a "reasonable" central banker is likely to hedge his position by intuitively assigning nonnegative weights to alternative conceptions of the economy. This complicates the decisionmaking process of central bankers, makes them vulnerable to ex post criticism, but also leaves them substantially more discretion than they would have otherwise. As a matter of fact, current economic literature entertains several conceptually different views of the transmission process of monetary policy even before taking into account differing views about length of lags, parameter magnitudes, and functional form within a given broad conception of the transmission mechanism.

This section illustrates some of this conceptual variety by briefly reviewing and contrasting three well-known alternative conceptions of the transmission process of monetary policy used in the current economic literature. One is a monetarist Lucas-type expectations-augmented Phillips curve and the other two are neo-Keynesian in spirit in that both rely on staggered nominal price setting in conjunction with costs of price adjustment. In both variants the CB is able to influence the real rate by means of the nominal rate of interest because the price level is temporarily sticky. In the first version, current prices are fully backward looking in that current pricing decisions depend only on predetermined past prices. In the second version, they are fully

[8] I refer to this second mechanism as a "tendency" rather than a "bias" because it is associated with some gain in the average value of output.

[9] Even if all those details could be put in the public domain, it is unlikely that, because of cognitive limitations, the bulk of the (largely nonprofessional) public would absorb and digest them accurately. A fuller discussion of those and related issues appears in Winkler (2000).

forward looking in that current pricing decisions depend on expected future inflation rather than on past pricing decisions.[10]

A Monetarist Lucas-Type Transmission Mechanism (Model 1)

This transmission mechanism is the one most frequently used in models of endogenous monetary policy. The main idea is that monetary policy has real effects only to the extent that it creates unexpected inflation. In particular, the deviation of output from its natural level is an increasing function of unexpected inflation. Formally,

$$(1) \qquad y_t \equiv Y_t - Y_{nt} = \alpha(\pi_t - E_t\pi_t),\ \alpha > 0,$$

where Y and Y_n are actual and natural output, π is the rate of inflation, $E\pi$ is the (rational) expectation of that rate of inflation when output decisions are made, and t is a time index. The instrument of monetary policy is not modeled explicitly, but it is assumed, at least implicitly, that the monetary authority can set its instrument (the money supply or the interest rate) so as to bring about the inflation rate that it desires. Hence, from a formal point of view the "instrument" of the monetary authority here is the rate of inflation.[11] Equation (1) is also known as an expectations-augmented Phillips curve. In its starkest monetarist interpretation, prices and wages are fully flexible and monetary policy has real effects only when inflation is not currently fully perceived. In the presence of nominal wage contracts, which are preset one period in advance on the basis of expected future inflation, there are real effects when there are deviations between the rate of inflation that had been expected at contracting time and the subsequent realization of inflation. In this variant, $E_t\pi_t$ is replaced by $E_{t-1}\pi_t$.[12]

A Neo-Keynesian Transmission Mechanism with Backward-Looking Pricing (Model 2)

In this framework, the current output gap, normally defined as the deviation of actual from potential output, depends on the lagged real interest rate and on its own lagged value. Current inflation is positively related to the lagged value of the output gap and to its own lagged value. A compact formulation of the model, due to Svensson (1997), is

$$(2) \qquad x_{t+1} \equiv Y_{t+1} - Y_{pt+1} = -\varphi\left(i_t - E_t\pi_{t+1}\right) + \phi x_t + g_t,$$

$$(3) \qquad \pi_{t+1} = \pi_t + \lambda x_t + u_{t+1},$$

where Y_{pt} is potential output; x_t is the output gap; π_{t+1} is the rate of inflation between period t and period $t+1$; $E_t\pi_{t+1}$ is the (rational) public's forecast of this inflation given the information available to it in period t; i_t is the nominal rate of interest on one-period loans contracted in period t; u_{t+1} is a cost shock; g_t is a nonmonetary shock to aggregate demand; and φ, ϕ, and λ are nonnegative parameters. Note that although there is some analogy between x_t and y_t from the first model, they are not identical since natural and potential output are not necessarily identical concepts. The difference between them is discussed later in this section.

In this framework, the monetary policy instrument is the nominal rate of interest. Because of price stickiness, the CB can affect the real rate (and through it the output gap and future inflation) by its choice of the nominal rate. Svensson (1997) notes that, in spite of its simplicity, this model captures some of the essential features of more elaborate econometric models used by some CBs. The model reflects the declared belief of some CBs, such as the BE, that current interest rate policy affects the output gap with a lag of one period and the rate of inflation only with a lag of two periods. The model is fully backward looking in that current pricing behavior depends only on lagged variables.

A New Keynesian Transmission Mechanism with Forward-Looking Pricing (Model 3)

The main difference between this framework and the previous one is that current price setting and the current output gap depend on expectations of future inflation and on the expected future output gap, respectively, rather than on the lagged values of those variables. Thus, the model is fully forward looking. The main idea is that a change in expectations of future variables alters current pricing behavior. This modification has its origin in more explicit microeconomic foundations with monopolistic competition and costs of price adjustment. A stylized

[10] An additional transmission channel that is not captured by either of those models is the credit channel.

[11] In some versions of this model, policymakers have only imperfect control of inflation. In such a case the planned rate of inflation becomes the instrument of monetary policy.

[12] A fuller discussion appears in Cukierman (1992, Chap. 3).

aggregate version of such a model has recently been summarized compactly by Clarida, Gali, and Gertler (1999) and is reproduced as follows:

$$x_t = -\varphi\left(i_t - E_t\pi_{t+1}\right) + E_t x_{t+1} + g_t, \quad (4)$$

$$\pi_t = \lambda x_t + \beta E_t \pi_{t+1} + u_t. \quad (5)$$

Here φ, λ, and β are positive coefficients. All the variables have the same meaning as in the previous model. The expected future output gap appears in the output gap equation to reflect the notion that, because individuals smooth consumption, expectations of higher consumption next period (associated with higher expected output) leads them to demand more current consumption, which raises current output.

As in stylized models of sticky staggered prices pioneered by Calvo (1983), current inflation depends on future expected inflation. In this type of model, only a fraction of firms has the opportunity to adjust its price each period and, because of costs of price adjustment, each firm adjusts its price at discrete intervals. Hence, when it is given the chance to adjust its price, the firm adjusts it by more the higher is expected future inflation. This interpretation implies that β is a discount factor.

Comparison Between the Conceptions Underlying the Different Models

The three models above are grounded in different conceptions regarding the channels through which monetary policy affects output and inflation. In the Lucas-type model, monetary policy affects output only if it is unanticipated, either currently or when relevant nominal contracts have been concluded. Inflation in those types of models is usually thought of as being directly related to the choice of money supply via the quantity theory of money. By contrast, in the last two models, because output is demand determined, a change in the rate of interest by affecting demand also affects output independently of whether inflation is anticipated or not. Furthermore, the effect of policy on inflation in those models is through the effect that policy has on the output gap.

The main conceptual difference between the second and third models is this: In the second model, the current policy cannot affect current inflation or the current output gap; in the third model, current policy can affect the current values of both variables by changing current expectations of future variables. Woodford (1999) utilizes this feature of the third model to show that, under an appropriate form of commitment to interest rate inertia, changes in current policy, by changing expectations, have an immediate effect on inflation and the output gap. This is a far cry from the BE view (illustrated by the second model) in which policy in year t can affect inflation only from year $t+2$ onward.

Haziness About the Meaning of Potential or Normal Output

At the broad conceptual level, potential output is meant to capture long-term supply determinants of output. But there are several related concepts such as the natural level of output and the NAIRU (non-accelerating inflation rate of unemployment). At the empirical level, those concepts are often implemented by means of some statistical smoothing procedure such as the Hodrick-Prescott (1997) filter.

Are those concepts identical? I believe the answer is not necessarily. In the work of Friedman (1968) and subsequent U.S.-based neo-monetarists like Lucas (1972, 1973), the conception of the natural level of employment is the level of employment that is generated by the *real* general equilibrium of the system in the absence of inflationary surprises. Its counterpart in the United Kingdom is the NAIRU. Layard, Nickell, and Jackman (1991, pp. 14-15) characterize this rate as the rate of unemployment below which inflation is accelerating and above which it is decelerating.

Although related, the concepts developed by Lucas and Layard, Nickell, and Jackman are not necessarily identical. More importantly, both concepts generally differ from potential output because, due to the existence of real business cycles, the gap between actual and potential output may be nonzero even when inflation is fully expected and the rate of inflation is stable. As a consequence, the output gap, x_t, from neo-Keynesian frameworks is not identical to the monetarist deviation, y_t, of actual from natural output. Nor is there a clear relation between the output gap and the deviation of actual output from the NAIRU.

Woodford (2002) proposes to conceptualize potential output as the equilibrium level of output under full price flexibility and to view the output gap as arising from the existence of sticky prices. Although useful and elegant, this conception of the output gap does not provide guidance about how

to measure the level of output under full price flexibility. It would appear that the relation between this concept and the smoothing procedures used to measure potential output in practice (such as the Hodrick-Prescott filter, 1997) is rather tenuous.

Implications for Model Transparency and for Accountability

The brief survey of alternative current models of the transmission process presented above illustrates the objective difficulties faced by the contemporary honest central banker. When faced with those and other different conceptions of how the economy works, what will he do? It is likely that he is going to intuitively assign some nonnegative weight to each of the models and to many other bits of information and ideas not surveyed here.[13]

What should he do when asked to be transparent about the economic model he is using to generate forecasts? This is not just an academic but also a practical question. As a matter of fact, when recently confronted with such a demand, the president of the ECB (Duisenberg) responded by promising to publish, in due time, the forecasts generated by the econometric model of the ECB. Although such an action is desirable, it is unlikely to come close to the actual aggregation of information and of models that decisionmakers at the ECB, the BE, or the Fed go through when making monetary policy decisions.

To a large extent, the inability of central bankers to be fully transparent about the economic model or models they are using is tied to the proliferation of alternative views of the transmission mechanism within the economic profession. Because central bankers are consumers and not providers of economic models, they obviously cannot be faulted for this state of affairs.[14] But the absence of consensus about the "correct" model of the economy endows them with considerable discretion, which they can also use to hedge their positions in the face of model uncertainty and of political pressures. It also opens the door for the strategic use of information.[15]

Most contemporary CBs are pretty transparent about their inflation target, both in terms of the index used and the numerical target value. There is substantially less transparency about output targets. Even in countries that insist on high levels of transparency like the United Kingdom, there is quite a bit of murkiness about the output or employment target that the CB is supposed to attain.

Again, a nonnegligible part of this haziness about the output target is due to (and made possible by) the different concepts of "normal" output surveyed above. Those different conceptions allow substantial leeway for the measurement of potential or natural output, leaving room for the reintroduction of discretionary monetary policy through the back door. This is obviously the case whether or not the output target of contemporary CBs is at the natural or the potential level of output or above them.[16]

In the long run, transparency and accountability will be enhanced when better and more accurate models of the ways monetary policy affects the economy become available. The wider implication of this conclusion is that, until this happens, accountability by means of transparency about the economic models used by decisionmakers at the CB will be limited. What should be done in the mean time? There is no easy answer to this question. My own view is that, given the current state of economic knowledge, the discharge of accountability should be achieved to a large extent by two things: appointing as decisionmakers at the CB individuals with high levels of integrity and professional standards and making sure these decisionmakers have little or no association with particular interest groups.

III. ARE NEW CENTRAL BANKS TRANSPARENT ABOUT THEIR OBJECTIVES?

In comparison with past decades, there is nowadays substantially more transparency about the main objective of monetary policy. In most contem-

[13] Jensen (2001) presents a compact hybrid neo-Keynesian model that combines forward- with backward-looking elements. Using a more elaborate hybrid model of the same type for the United States, Rudebusch (2001) estimates the weight on forward-looking elements to be around one-third and the weight on backward-looking elements to be around two-thirds.

[14] One way to bridge the gap between this proliferation of models and practical policymaking is to look for a policy rule that is uniformly best for many models. A recent attempt for two variants of micro-founded structural models appears in McCallum and Nelson (1999). Hansen and Sargent (2000) develop a systematic analysis for decision-making when policymakers cannot distinguish between economic models within a given class.

[15] Reflecting on his term in office as Chairman of the Board of the Fed, Burns once said that when Keynesians on one side and monetarists on the other assailed him with diametrically opposite criticisms, he found it safe to duck in the middle.

[16] Staiger, Stock, and Watson (1997) show, for the United States, that there is substantial uncertainty about the location of the natural rate. Faust and Svensson (2001) show that more ex post transparency about the output target of policymakers raises social welfare.

porary CBs, the main *legally mandated* objective of monetary policy is price stability and all other objectives are either nonexistent (as is nearly the case in the charter of the ECB) or relegated to being (at least legally) a distant second priority (as is the case with the growth and employment objectives in the charter of the BE). This is a far cry from the 1980s and previous decades during which most CB charters featured several conflicting objectives with no clear specification of the subjective tradeoffs among them. Nowadays all explicit inflation targeters even specify a precise numerical value in terms of a well-defined index for the target rate of inflation, and even the ECB, which is not an explicit inflation targeter, has specified a numerical inflation target for the euro area.

In spite of those advances, there still are non-negligible dark spots about the output gap segment of the loss function of modern CBs. For *truly strict* inflation targeters, or inflation nutters, this murkiness is unimportant. Because the output gap is not part of their objectives, transparency about the output gap segment of their loss function is irrelevant. But practically all explicit inflation targeters openly acknowledge that they also care about the output gap, i.e., they are flexible rather than strict inflation targeters. For such banks the features of the output gap segment of the loss function and its importance relative to achieving the inflation target in each period become relevant. To illustrate, consider the following specification of the one-period CB loss function:

$$L_t = Af(x_t) + \pi_t^2. \quad (6)$$

When $A = 0$, the CB is a strict inflation targeter, so murkiness about $f(x_t)$ does not matter. But when A is positive, the CB is a flexible inflation targeter so that murkiness about the precise form of the function $f(x_t)$ and the magnitude of the parameter A become important. Following Svensson (1997) I will refer to A as the "flexibility parameter."[17] There is little doubt that all CBs are quite opaque about the parameter A. This is admitted quite candidly in a recent review of the U.K. experience with inflation targeting by Vickers who notes that the MPC's remit is silent on the parameter A (the full quote and source appear in the latter part of the introduction).

Ironically, the lack of transparency about $f(x_t)$ seems to matter the most in countries like the United Kingdom, which strongly insist on formal transparency, and the least in countries like Germany, which, judging by the BB charter, should be classified as a strict inflation targeter. But the matter is not that simple. Recent empirical work by Clarida and Gertler (1997) supports the view that the Bundesbank actually conducted policy in a way that is indistinguishable from that of a flexible inflation targeter. As a matter of fact, the currently emerging consensus seems to be that, whether they admit it or not, all CBs are behaving in a manner that is consistent with flexible inflation targeting. The main difference, on this view, is only whether the bank and its charter admit the "flexible" part openly or not. In terms of the loss function in equation (6), this means that there generally is a lack of transparency with respect to the coefficient A.

How about $f(x_t)$? Available public information on this term is rather scant for two reasons. First, neither the CB nor the political authorities have taken the trouble to indicate what it is. Vickers (1998, p. 370) ventures several remarks on the shape of the BE's loss function since 1997 and concludes that, at least as far as inflation is concerned, losses are symmetric; but he remains silent on what the shape of $f(x_t)$ might be. Secondly, as discussed at some length in the previous section, there are numerous ambiguities in the definition of potential, normal, natural, and NAIRU output. Obviously the output gap that enters into the loss function inherits those ambiguities. In summary, existing CBs are generally quite opaque about their output objective, the shape of the function $f(.)$, and the flexibility of the parameter A.

The Case for Asymmetries in CB Losses from the Output Gap

In the absence of solid information about $f(.)$, the academic literature has assumed that $f(.)$ is a quadratic function implying that losses from negative and from positive output gaps are the same as long as the absolute value of the gap is the same.[18] But it is hard to see why CBs, social planners, or political authorities would consider, *given inflation*, a positive output gap of a given magnitude to be equivalent to a negative output gap of the same magnitude. A negative output gap means that

[17] Note that A is the inverse of Rogoff's parameter of CB conservativeness. The terminology in the text is chosen to highlight the fact that, within the context of the present discussion, it determines the degree of flexibility in allowing temporary deviations from the inflation target.

[18] From here on, I abstract for simplicity from the ambiguities in the definition of the output gap and assume that the output target of monetary authorities is equal to a well-defined and publicly known measure of "potential or natural output."

employment is below the normal level, whereas a positive output gap means employment is above the normal level. While casual observation suggests that policymakers dislike employment below the normal level, it does not support the notion that, given inflation, they also dislike employment above the normal level.[19]

Recently this casual empiricism got backing from Blinder after his resignation from the office of Vice Chairman of the Fed. Blinder expressed the view that the Fed takes far more political heat when it tightens preemptively to avoid inflation than when it eases preemptively to avoid unemployment (the precise quote and reference appear in the introduction). To the extent that the CB is not totally indifferent to the priorities of the political establishment, this asymmetry is likely to partially affect the Fed's policy choices. Preliminary empirical work by Gerlach (2000) and by Dolado, Maria-Dolores, and Naveira (2000) supports this hypothesis for the Fed.[20]

Recent theoretical work by Cukierman (2000a) shows that, with (i) a Lucas-type transmission mechanism, (ii) uncertainty about the future state of the economy, and (iii) asymmetries in the output gap segment of the CB loss function, there will be an inflation bias even if the CB targets the normal level of output. This framework implies that there should be a positive association between the variability of employment over the cycle and the magnitude of the inflation bias. Preliminary cross-sectional evidence in Gerlach (2000) supports this implication. Using a formulation that nests both symmetric and asymmetric losses from deviations of unemployment from its natural level, Ruge-Murcia (2001) performs a test of the asymmetry hypothesis over time within several countries and finds support for this hypothesis in France and the United States.

In summary, in spite of the silence of policymakers about the shape of $f(.)$, there seem to be sufficient early indications to warrant a more serious investigation of the consequences of an asymmetric $f(.)$. The remainder of the paper investigates the consequences of this asymmetry for the credibility of monetary policy and related issues.

IV. IS THE CREDIBILITY PROBLEM GONE WHEN THE CENTRAL BANK TARGETS THE NORMAL LEVEL OF OUTPUT?

The discussion in this section and the next one is built on two presumptions. The first is that contemporary CBs do not attempt to maintain output above its normal or natural level, and thus there is no credibility problem because of the classical KPBG reasons. In accepting these presumptions, this section takes at face value the statements by Blinder and Vickers and also addresses McCallum's (1995, 1997) criticism of the KPBG conception of the reasons for inflation. It will be recalled that those statements and McCallum's arguments imply that the output target of central bankers is identical to the normal or potential level of output. The second presumption is that the CB loss function is more sensitive to negative than to positive output gaps. The main results of the section are as follows:

1. The presence of asymmetries in losses from the output gap in conjunction with uncertainty on the part of the CB about the state of the economy induces an inflation bias even when the CB targets potential or natural output.
2. There is no bias when the CB is a strict inflation stabilizer ($A = 0$).

Those results hold both for a Lucas-type, expectations-augmented Phillips curve and for many other models including, in particular, a New Keynesian, sticky/staggered prices transmission mechanism of the type reviewed in Clarida, Gali, and Gertler (1999). But in the second case there is an additional inflationary tendency that arises even when decisionmakers at the CB are fully informed about the relevant shocks at the time policy choices are made. This section demonstrates the existence of a bias within the framework of a Lucas-type expectations-augmented Phillips curve (model 1). The next section shows that, in addition to this bias, there is in New Keynesian economies (model 3) an additional average inflationary tendency. A third result holds true for both a Lucas-type and a New Keynesian transmission mechanism:

[19] Given inflation, some politicians probably even *like* positive output gaps on the view that the higher output is, the better it is. As a matter of fact, it is quite likely that the quadratic function on the output gap, so often used in the academic literature, was chosen mainly for analytical convenience rather than for descriptive realism. In the usual KPBG setup this assumption does not make a difference as long as policymakers do not face uncertainty or are risk neutral because the equilibrium is in the range of negative output gaps in which the quadratic is reasonable. A formulation of the KPBG framework under certainty in which the quadratic is limited to the range of negative output gaps without making any difference for their basic result appears in Cukierman (1992, Chap. 3, equation (3.1)). But once it is recognized that policymakers face uncertainty, the characteristics of their objective function in the *entire range* of output gaps become important.

[20] However, Dolado, Maria-Dolores, and Naveira (2000) do not find evidence of asymmetry in losses from the output gap for the BB, the Banque de France, or the Banco de Espana.

Figure 1

The Sequence of Events

1. $E_{t-1}\pi_t$ is formed → 2. policy, m_t, chosen → 3. ε_t realizes.

3. Other things the same, the bias is larger the larger the (inflation targeting) flexibility parameter A is.

An Asymmetry-Cum-Uncertainty Inflation Bias with a Lucas-Type Transmission Mechanism

The results in this subsection draw on Cukierman (2000a). Here I briefly present the basic framework, the main result, and the intuition underlying it and move on to discuss its wider implications. (See that article for further details and some of the derivations.) The asymmetry in CB losses regarding the output gap is modeled by postulating that period t's loss function is given by

$$L_t\begin{cases}\frac{1}{2}\left(Ax_t^2+\pi_t^2\right) \text{ when } x_t<0\\ \frac{1}{2}\pi_t^2 \text{ when } x_t\geq 0\end{cases}, \tag{7}$$

where $x_t \equiv Y_t - Y_{pt}$ is the output gap. This specification of the loss function states that the employment target of policymakers is potential output and that as long as the output gap is negative the standard quadratic loss function is in effect. But when the output gap is positive or zero, policymakers do not incur any losses or gains. The kink at the zero output gap introduces an effect that is analogous to the condition that leads to a precautionary saving motive in the theory of savings and consumption under uncertainty. A basic result from this literature is that there is a precautionary saving motive if and only if marginal utility is convex, i.e., the third derivative is positive (Kimball, 1990).[21] I shall return to the consequences of this analogy later.

The natural level of output is given by

$$Y_{nt} = Y_{pt} + \varepsilon_t, \tag{8}$$

where $\varepsilon_t = Y_{nt} - Y_{pt}$ is the output gap in the absence of inflationary surprises. Actual output is given by the expectations-augmented Phillips curve in equation (1). For simplicity, ε_t is specified as a zero-mean stochastic shock to the natural level of output with distribution function $G(\varepsilon)$. Inflation is determined both by the choice of monetary policy and by the realization of the shock, ε_t, and is given by the following equation:

$$\pi_t = m_t - \gamma\varepsilon_t, \tag{9}$$

where m_t is the rate of inflation planned by the CB and γ is a positive parameter that determines the effect of shocks to employment on inflation. For concreteness I think of ε_t as a supply shock so its effect on inflation is negative. But the basic result of this subsection goes through also when ε_t is a demand shock so that γ is negative or when ε_t is a combination of supply and demand shocks. Equation (9) states that, given planned inflation, actual inflation is lower the larger the supply shock to the economy is. Provided there is no instrument uncertainty, this formulation is consistent both with situations in which the policy instrument is the interest rate as well as with situations in which it is some nominal shock.

I focus on a one-shot game with three stages. The sequence of events and the structure of information is as follows. First, expectations, $E_{t-1}\pi_t$, are formed and embedded into nominal contracts. In the second stage, the CB picks the value of its instrument, m_t. Finally, the stochastic real shock to employment, ε_t, realizes and determines, along with monetary policy, both employment and inflation. This sequence of events is illustrated in Figure 1. A crucial element is that, when it chooses the setting of its instrument, the CB is uncertain about the magnitude of the real shock to output. This is a fortiori true for the public when they form their expectation.

The shock, ε_t, affects employment directly as well as indirectly by creating, given monetary policy, unanticipated inflation in a direction that is opposite to the sign of the shock. From equations (1), (8), and (9) the combined marginal impact of the shock on employment is

$$q \equiv 1 - \alpha\gamma. \tag{10}$$

I assume that the direct effect of the shock on

[21] The kink at zero in equation (7) implies that the marginal *benefit* from higher economic activity is globally convex.

employment dominates its indirect effect by means of unexpected inflation so that q is positive. Substituting equations (1), (8), and (9) into the loss function in equation (7), the expected value of the CB loss function is

(11)
$$\frac{A}{2}\int_{-\infty}^{b(\pi^e-m)}\left[q\varepsilon+\alpha\left(m-\pi^e\right)\right]^2 dG(\varepsilon)+\frac{1}{2}E_{t-1}(m-\gamma\varepsilon)^2,$$

where $b\equiv(\alpha/q)$, $\pi^e\equiv E_{t-1}\pi_t$, and the time index has been suppressed for simplicity. Minimization of equation (11) with respect to m yields the following reaction function for the monetary authority:

(12)
$$m=\frac{1}{1+\alpha^2 AG\left[b\left(\pi^e-m\right)\right]}\left[\alpha^2 AG\left[b\left(\pi^e-m\right)\right]\pi^e-\alpha Aq\int_{-\infty}^{b(\pi^e-m)}\varepsilon dG(\varepsilon)\right].$$

I turn next to expectation formation which occurs at the first stage of the game. Although individuals do not know the realization of ε at this stage, they do know its stochastic structure as well as the structure of the economy and of CB objectives. Taking the expected value of inflation in equation (9) conditioned on this information as the operational proxy for the public's rational expectation of inflation, we obtain

(13)
$$\pi^e=m=-\alpha Aq\int_{-\infty}^{b(\pi^e-m)}\varepsilon dG(\varepsilon).$$

In equilibrium, both equations (12) and (13) must be satisfied. It follows that $\pi^e-m=0$ so that equation (13) becomes

(14)
$$E_{t-1}\pi_t\equiv\pi^e=m=-\alpha Aq\int_{-\infty}^{0}\varepsilon dG(\varepsilon)=-\alpha AqG(0)E\left[\varepsilon\,\middle|\,\varepsilon<0\right].$$

$G(0)$ is the probability of a recession. More precisely it is the probability that the realization of the employment shock, ε, is lower than the mean of this shock, which is zero. $E[\varepsilon\,|\,\varepsilon<0]$ is the expected value of ε conditioned on the economy being in a recession (ε negative). Because the probability of a recession is positive and the expected value of ε conditioned on the economy being in a recession is negative, both planned and expected inflation are positive. Furthermore, in spite of its attempt to reduce the size of recessions, the CB has no influence on output, which remains at its natural level. Had the CB been committed to a zero rate of monetary expansion, output would still be at its natural level. Hence there is an "inflationary bias" on average.

Intuitively, this bias arises because the CB is more sensitive to policy errors in which monetary policy is too tight than to policy errors in which it is too expansionary, in conjunction with the fact that it does not have perfect information about the state of the economy. The upshot is that an inflationary bias arises even when the CB targets potential output. This bias arises whenever the CB is more averse to negative than to positive output gaps, in conjunction with the fact that it is uncertain about the state of the economy. The second condition is obviously highly realistic, and the first one appears to be satisfied for at least some CBs.

Although, as in KPBG, the bias arises because of the CB concern (at least in some states of nature) about the output gap, the new bias identified here does not rely on dynamic inconsistency. To see this, note that this bias is present also if the choice of policy in Figure 1 precedes the formation of expectations, as long as both the formation of expectations and the choice of policy precede the resolution of uncertainty about the shock, ε_t. The origin of the bias resides, instead, in the precautionary behavior of the CB with respect to recessions in a world of uncertainty, in conjunction with the public's awareness of this asymmetry in CB objectives.[22]

Discussion

The expression for the inflation bias in equation (14) implies that, other things the same, the bias is larger the larger is the variability of natural output. Gerlach (2000) presents preliminary cross-sectional evidence suggesting that there is a positive association between the average level of inflation in a country and the variance of its rate of growth. In related work Ruge-Murcia (2001) finds a positive (over time) relation between inflation and the conditional variance of unemployment in the United States and France. Given his model, this finding supports the view that policymakers in those countries are more averse to negative than to positive output gaps. Cukierman and Muscatelli (2002) find evidence of nonlinearity in interest rate reaction functions for the United States, the United Kingdom, and Japan. The pattern of these nonlinearities supports the existence of a precautionary demand for expansions in the post-1985 period in the United States.

[22] Obviously, it is not easy to verify ex post whether the CB is conducting policy so as to build in a precautionary demand for expansions. As a consequence, it is not straightforward to verify a precommittment to conduct policy in a symmetric manner.

As demonstrated earlier, this type of precautionary demand leads to an inflation bias.

Equation (14) also implies that the bias is an increasing function of the flexibility parameter, A. Hence CBs of countries that are more flexible inflation targeters have a more serious credibility problem. Because we saw earlier that transparency concerning the flexibility parameter is generally rather poor, the magnitude of this bias is generally opaque too. But, holding other things the same, it is likely to be higher in countries such as the United Kingdom than in the euro area. This is true if only because the 1997 charter of the BE explicitly mentions growth and employment as objectives for the CB, whereas that of the ECB does not.

Those rather pessimistic conclusions appear to conflict, at first sight, with the remarkable era of price stability that Western democracies have recently experienced. The "new inflation bias story" presented here is consistent with this observation because it implies that, when the probability of recession is low and/or its expected depth mild, the bias will be negligible for most values of the flexibility parameter, A. But this observation should also be taken as a warning against overoptimism in the long run. In particular, if and when the likelihood of a serious recession increases, the countries of more flexible inflation targeters are likely to experience larger inflationary accelerations.

Let me conclude this discussion with a theoretical remark regarding the analogy between the behavior of policymakers in the "new inflation bias story" presented above and the theory of precautionary savings. The kink at a zero output gap in the loss function in equation (7) implies that the marginal *benefit* from higher economic activity is globally convex. As shown by Kimball (1990) there is a precautionary saving motive if and only if the marginal utility from consumption is convex. Similarly, asymmetric preferences with respect to the output gap induce a precautionary demand for expansions on the part of central bankers. This precautionary demand induces them to conduct a somewhat looser policy in comparison with the benchmark case of symmetric losses from the output gap.[23]

But there is also a crucial difference between the two cases. While the individual consumer "buys" more desired future security by foregoing some current consumption, the central banker does not buy any improvement in economic activity because individuals in the economy undo this potential improvement by setting their nominal contracts in a way that anticipates this tendency of the central banker.

V. THE EFFECTS OF ASYMMETRIC LOSSES FROM THE OUTPUT GAP IN NEW KEYNESIAN FRAMEWORKS

This section investigates the consequences of an asymmetric objective function, as specified in equation (7), when the economic structure is characterized by a New Keynesian transmission mechanism with forward-looking pricing of the type given by equations (4) and (5). This section discusses two related but distinct issues. First, it shows that the presence of asymmetries in conjunction with uncertainty about future shocks produces an inflation bias *also* in New Keynesian frameworks. Second, it shows that, in New Keynesian frameworks, there usually is an *additional* inflationary tendency and an associated positive average output gap, both of which obtain even in the absence of uncertainty about future shocks. For simplicity I abstract from persistence in the stochastic behavior of the shocks g_t and u_t by assuming that both are zero-mean white-noise processes.

Asymmetric Output Gap Losses Produce a Bias Also in New Keynesian Frameworks

The mechanism that produces the inflationary bias in the Lucas-type transmission mechanism depends mainly on the fact that the objective function is asymmetric in conjunction with the following: that, when choosing policy, the CB is uncertain about the realization of shocks at the time its policy decision is going to affect the economy. In particular, this type of mechanism will, most likely, operate within the framework of other transmission processes, including (linear) New Keynesian transmission processes, as long as the CB possesses the loss function in equation (7) and is uncertain about the relevant state of the economy. This intuitive argument is demonstrated rigorously in what follows. The hasty reader may just take note of equation

[23] Incidentally, this analogy also implies that there will be a tendency to inflate for *all* asymmetric output gap loss functions in which the marginal benefit of higher economic activity is convex in the level of output. Another specification of an asymmetric output gap loss function that satisfies this requirement appears in Ruge-Murcia (2001), who specifies losses of deviations from natural unemployment as a linex function.

(18) and go directly to proposition 1. Substituting equation (4) into equation (5),

$$\pi_t = -\lambda\varphi\left(i_t - \pi_t^e\right) + \lambda x_t^e + \beta\pi_t^e + \lambda g_t + u_t \equiv \pi_t^p + \lambda g_t + u_t, \tag{15}$$

where $x_t^e \equiv E_t x_{t+1}$, $\pi_t^e \equiv E_t \pi_{t+1}$, and π_t^p is the rate of inflation implicitly planned by the policymaker when he sets the interest rate at i_t. Solving out for the interest rate,

$$i_t = \frac{1}{\lambda\varphi}\left(-\pi_t + (\lambda\varphi + \beta)\pi_t^e + \lambda x_t^e + \lambda g_t + u_t\right). \tag{16}$$

Substituting equation (16) into equation (4), rearranging, and using the last expression in (15) to express actual inflation, π_t, in terms of its planned value, π_t^p, we obtain

$$x_t \equiv Y_t - Y_{pt} = \frac{1}{\lambda}\left(\pi_t^p - \beta\pi_t^e + \lambda g_t\right), \tag{17}$$

which states that, given expectations and the realization of the shock g_t, the output gap is more likely to be negative the lower the planned rate of inflation. Hence, equation (17) implies that if policymakers desire to reduce a negative output gap, they must plan a higher rate of inflation.

Consider now a CB whose objective is to minimize

$$E_0 \sum_{t=0}^{\infty} \delta^t L_t, \tag{18}$$

where δ is the discount factor and L_t is given by equation (7). Because there are no endogenous state variables and no persistence in shocks, the minimization problem in equation (18) reduces to a series of one-period minimization problems and the expected values of inflation and the output gap are time invariant. I shall, therefore, omit time indices from now on. Equation (7) implies that, in each period, the form of the loss function depends on whether the output gap is negative or not. Equation (17) implies that the output gap is negative if and only if

$$x = \frac{1}{\lambda}\left(\pi^p - \beta\pi^e + \lambda g\right) < 0, \tag{19}$$

which is equivalent to

$$g < \frac{1}{\lambda}\left(\beta\pi^e - \pi^p\right) \equiv g_c. \tag{20}$$

In this case the loss is given by the first line in equation (7), and otherwise it is given by the second line in that equation. Substituting (19) into equation (7) and applying the expected value operator, the typical one-period, time-invariant minimization problem is to choose π^p so as to minimize the following expression:

$$\frac{A}{2\lambda^2}\int_{-\infty}^{g_c}\left(\pi^p - \beta\pi^e + \lambda g\right)^2 dF[g] + \frac{1}{2}E\left(\pi^p + \lambda g + u\right)^2, \tag{21}$$

where $F[g]$ is the density function of g and E is the expected value operator. Differentiating with respect to π^p and rearranging yields the following policy reaction function for the rate of inflation planned by the CB:

$$\pi^p \frac{A\left\{\beta F[g_c]\pi^e - \lambda\int_{-\infty}^{g_c} g dF[g]\right\}}{\lambda^2 + AF[g_c]} = \frac{A\left\{\beta F[g_c]\pi^e - \lambda F[g_c]E\left[g \middle| g \le g_c\right]\right\}}{\lambda^2 + AF[g_c]}. \tag{22}$$

Because individuals understand the modus operandi of the CB and have rational expectations, expected inflation, π^e, equals planned inflation, π^p. Using this and $\pi^p = \pi^e$ in equation (22) and rearranging yields

$$\pi^p = \pi^e = \frac{-\lambda AF\left[\frac{\beta-1}{\lambda}\pi^p\right] E\left[g \middle| g \le \frac{\beta-1}{\lambda}\pi^p\right]}{\lambda^2 + A(1-\beta)F\left[\frac{\beta-1}{\lambda}\pi^p\right]}. \tag{23}$$

This equation determines π^p only implicitly because π^p also appears in the argument of the distribution function $F[.]$ and in the expected value on the right-hand side of (23). It is nonetheless possible to establish that π^p must be positive. The denominator in equation (23) is positive. Hence, the sign of planned inflation is determined by the sign of the numerator whose sign is opposite to that of the conditional expected value in the numerator. Thus, if

$$E\left[g \middle| g \le \frac{\beta-1}{\lambda}\pi^p\right] < 0,$$

then π^p must be positive. Because g has a zero expected value, the conditional expected value,

$$E\left[g \middle| g \le \frac{\beta-1}{\lambda}\pi^p\right],$$

is negative for all possible values of π^p, except for the extreme case in which π^p is equal to minus infinity and $\beta < 1$. In this case, the right-hand side of equation (23) implies that π^p is zero, which con-

tradicts the initial assumption that π^p is equal to minus infinity. Hence, only positive values of planned inflation are possible in an equilibrium with asymmetric preferences. The main conclusion is summarized in the following proposition.

Proposition 1. In the presence of asymmetric output gap objectives and CB uncertainty about future shocks to the economy, there is an inflation bias also in the New Keynesian framework.

This bias arises in spite of the fact that the CB does not gain anything from having a positive output gap. It arises instead, as was the case with a Lucas supply function, because of a precautionary demand for expansions by the CB. The next proposition examines the impact of the flexibility parameter, A, on this bias.

Proposition 2. The bias in proposition 1 is larger the larger is the flexibility parameter, A.

Proof: Differentiating equation (23) with respect to A,

$$\frac{\partial \pi^p}{\partial A} = -\frac{\lambda^3 F\left[\frac{\beta-1}{\lambda}\pi^p\right] E\left[g \,\middle|\, g \le \frac{\beta-1}{\lambda}\pi^p\right]}{\left(\lambda^2 + A(1-\beta)F\left[\frac{\beta-1}{\lambda}\pi^p\right]\right)^2}.$$

Because

$$E\left[g \,\middle|\, g \le \frac{\beta-1}{\lambda}\pi^p\right]$$

is negative and all the remaining terms are positive, this expression is positive. QED.

Thus, as was the case with a Lucas supply function, the bias is larger the larger is the flexibility parameter, A.

The Additional Inflationary "Tendency" of New Keynesian Frameworks

The previous subsection shows that the results obtained in Section IV for a Lucas supply function carry over to the New Keynesian framework. But in the case of the New Keynesian framework, there is an *additional* mechanism that tends to make inflation even higher. This additional inflationary tendency is directly related to the fact that, due to temporary price stickiness, the CB is able to alter the real rate of interest and through it the level of employment and production. This happens even when the CB knows future shocks to the economy with certainty. The analysis in this subsection focuses on this additional inflation-creating mechanism in isolation by assuming that the CB has full information about relevant shocks at the time policy choices are made. In terms of model 3 (from Section II on the specification of models, pp. 19-20) this means that the CB knows g_t and u_t when it picks period t's interest rate, i_t. Because there are no endogenous state variables and future expectations are not affected by current policy, the minimization of the objective function in equation (18) is again equivalent to period-by-period minimization.

In each period there are two possible alternative interest rate rules for the CB. If the realization of the cost shock, u_t, is such that, given inflationary expectations, the output gap is either positive or zero when inflation is maintained at zero, the CB picks the rate of interest that achieves the zero inflation target. In this range the CB behaves as an "inflation nutter," or strict inflation targeter. If the realization of the cost shock, u_t, is such that, given inflationary expectations, the output gap is negative at a zero rate of inflation, the CB faces a tradeoff between its output and its inflation objective. Hence, given inflationary expectations, it picks the interest rate that equalizes the marginal loss from inflation to the marginal loss from a negative output gap. In this range the CB behaves as a flexible inflation targeter. Equations (4) and (5) imply that, at a zero inflation rate,[24]

$$\begin{aligned} &x_t \ge 0 \Leftrightarrow u_t + \beta\pi_t^e \le 0 \Leftrightarrow CB \text{ is strict} \\ &x_t < 0 \Leftrightarrow u_t + \beta\pi_t^e > 0 \Leftrightarrow CB \text{ is flexible.} \end{aligned} \tag{24}$$

In the first case the CB just picks the nominal rate of interest that achieves the zero inflation target. Equations (4) and (5) imply that in this case the interest rate rule is[25]

$$i_t^s = \pi_t^e + \frac{1}{\varphi}\left[g_t + x_t^e + \frac{1}{\lambda}\left(u_t + \beta\pi_t^e\right)\right]. \tag{25}$$

In the second case there is a meaningful intra-period tradeoff between the inflation and the output gap targets. Hence, the CB picks the nominal interest rate so as to minimize

[24] Non-zero values of the demand shock, g_t, and of the expected future output gap, x_t^e, produce variability in both inflation and the output gap. Hence, non-zero realizations of these variables do not create a tradeoff between output and inflation variability and it pays to fully offset them. As a consequence, the sign of the output gap when inflation is maintained at zero is independent of g_t, and of the expected future output gap, x_t^e.

[25] The superscripts s and f that are attached to i_t indicate that equations (25) and (27) refer to the interest rate rules of strict and flexible inflation targeters, respectively.

(26) $$L_t = \frac{1}{2}\left(Ax_t^2 + \pi_t^2\right)$$

subject to equation (5). The interest rate rule that emerges in this case is given by[26]

(27) $$i_t^f = \pi_t^e + \frac{1}{\varphi}\left[g_t + x_t^e + \frac{\lambda}{A+\lambda^2}\left(u_t + \beta\pi_t^e\right)\right].$$

Comparison of equations (25) and (27) reveals that, for the same realizations of current shocks and the same values of the expected future output gap and inflation, both the nominal and the real interest rates are lower in the second case. Furthermore, the difference between the two interest rates is larger the larger is the flexibility parameter, A. Using equation (25) in the expression for inflation (equation (5)), the rate of inflation in the range $u_t + \beta\pi_t^e > 0$ is given by

(28) $$\pi_t = \frac{A}{A+\lambda^2}\left(u_t + \beta\pi_t^e\right).$$

The rate of inflation does not respond to the demand shock or to the expected future output gap because the full offsetting of those variables improves performance on both the inflation and the output gap objectives. On the other hand, some of the cost shock and inflationary expectations are allowed to pass through to inflation because, in the case of those variables, there is a tradeoff between the inflation and the output gap objectives. Because, in the range $u_t + \beta\pi_t^e \leq 0$ the CB behaves as a strict inflation targeter, inflation in this range is always at the zero target. Using the interest rate rules for the two ranges in equation (4) and rearranging, the output gaps in the two ranges are given, respectively, by

(29) $$x_t^s = -\frac{1}{\lambda}\left(u_t + \beta\pi_t^e\right)$$
$$x_t^f = -\frac{\lambda}{A+\lambda^2}\left(u_t + \beta\pi_t^e\right).$$

Thus, in the first range the output gap is always nonnegative and in the second it is always negative, but not by as much as it would have been in the absence of some output stabilization by the CB.

Demonstration That Expected Inflation Is Positive. Because there is no persistence in shocks and no endogenous state variables, the expected value of the rate of inflation is the same for any horizon and is also the same in each period.[27]

Thus,

(30) $$E_{t-1}\pi_t = E_t\pi_{t+1} = \ldots \equiv E\pi \equiv \pi^e,$$

so the time index attached to the expectation can be deleted. It follows from equation (28), and from the fact that in the range $u_t \leq -\beta\pi_t^e$ inflation is zero, that

(31) $$\pi^e = \int_{-\infty}^{-\beta\pi^e} 0.dF(u) + \int_{-\beta\pi^e}^{\infty} \frac{A}{A+\lambda^2}\left(u + \beta\pi^e\right)dF(u)$$
$$= \frac{A}{A\left[1-\beta\left(1-F\left(-\beta\pi^e\right)\right)\right]+\lambda^2}\int_{-\beta\pi^e}^{\infty} u\,dF(u),$$

where $F(u)$ is the distribution function of u and where, without risk of confusion, the time index has been suppressed because the distribution of u is time invariant. This expression determines the expected rate of inflation, π^e, but only implicitly because π^e also appears on the right-hand side of the equation. It is nonetheless possible to establish that expected inflation is positive, even without an explicit solution for it. Note that $\pi^e = -\infty$ cannot be a solution because, for that value of π^e, the right-hand side of the equation would be zero and the left-hand side $-\infty$. Hence, $-\beta\pi^e > -\infty$. Because the expected value of u is zero, it follows that the integral on the extreme right-hand side of equation (31) is positive, establishing that both average and expected inflation are positive.

At first blush one may be tempted to conclude from this finding that there is an inflationary bias. But this is premature because in the present sticky-price framework the average positive rate of inflation may also be associated with a higher level of output. It is thus more accurate to refer to it as an "inflationary tendency" rather than an inflationary bias. The following subsection shows that this inflationary tendency is associated with an output gap that may be positive on average.

The Average Value of the Output Gap. As was the case with average inflation, because there is no persistence in shocks and no endogenous state variables, the expected value of the output gap is the same for any horizon and is also the same in each period. I will therefore omit the time

[26] Equation (27) is obtained by minimizing equation (26) with respect to x_t, using the resulting first-order condition to solve for x_t, equating this expression with equation (4), and solving for the implied nominal rate of interest, i_t^f.

[27] Essentially the no-persistence assumption shuts off any adjustment in inflationary expectations in response to changes in exogenous economic conditions.

index and just denote it by $x^e \equiv Ex$. Using equation (29),

$$x^e \equiv -\frac{1}{\gamma}\int_{-\infty}^{-\beta\pi^e}\left(u+\beta\pi^e\right)dF(u) - \frac{\lambda}{A+\lambda^2}\int_{-\beta\pi^e}^{\infty}\left(u+\beta\pi^e\right)dF(u). \quad (32)$$

Expanding and using equation (31), this expression can be shown to be equal, after some algebra, to

$$x^e = \frac{1-\beta}{\lambda}\pi^e. \quad (33)$$

Thus, provided $\beta < 1$ and because average inflation is positive, the average output gap is positive as well. But if $\beta = 1$, the average output gap is zero. It is therefore important to have an idea about the meaning and magnitude of the parameter β. Gali and Gertler (1999, p. 207) refer to it as the subjective discount factor and provide empirical estimates suggesting that it is about two standard errors below 0.99, which is the typical value used for this parameter in the literature (op. cit. footnote 16). Hence, existing evidence is not incompatible with the possibility that $1-\beta > 0$. It appears therefore that in a New Keynesian world it is possible to obtain permanent gains in output at the cost of permanently higher average inflation. This obviously violates the long-run neutrality of monetary policy and may appear surprising at first sight. To understand the deeper origin of this result, it is useful to digress and characterize the behavior of the average values of inflation and of the output gap when the CB is a strict inflation targeter in the entire range of shock realizations.

Average Inflation and Output Gaps Under a Strict Inflation Targeter as a Benchmark. In this case the flexibility parameter, A, is equal to zero and the interest rate rule in equation (25) applies everywhere. Inserting the condition $A = 0$ into equations (31) and (33) we obtain

$$x^e = \pi^e = 0. \quad (34)$$

Thus, under a strict inflation stabilizer, expected inflation and the expected output gap are both at their zero target values. Inserting equation (34) into equation (25), the interest rate rule of a strict inflation stabilizer is

$$i_t^s = \pi_t^e + \frac{1}{\varphi}\left[g_t + \frac{1}{\lambda}u_t\right],$$

which implies that the expected value (as well as the average value) of the real interest rate is zero.

Implications for Degree of Flexibility in Targeting Inflation for Real Rates of Interest. What are the implications for the average value of real rates? Is it going to be above or below the average value of the real rate under strict inflation targeting? There are two offsetting effects. On one hand, because $(1/\lambda) > (\lambda/(A+\lambda^2))$, it follows from a comparison of equations (25) and (27) that, for the *same* shock realizations and expectations the real rate under flexible targeting is always lower than under strict targeting in the range of negative output gaps. This effect tends to make the average value of the real rate under flexible targeting lower than under strict targeting. On the other hand, because inflationary expectations are higher under flexible targeting, a higher real rate is needed to achieve a given rate of inflation under flexible targeting than under strict targeting. This effect tends to make the real rate higher under flexible targeting. The final relation between the average level of real rates under strict versus flexible inflation targeting depends, therefore, on the relative strength of those two effects. The high real rates experienced during periods of disinflation suggest that, at least during such periods, the second effect has dominated the first one.

Summary Thoughts on the Long-Run Nonneutrality of the New Keynesian Framework and the Implications for Transparency

The analysis above suggests that, in a New Keynesian economy, a flexible inflation stabilizer with asymmetric preferences induces more inflation, on average, but also more output (at least when $\beta < 1$) than a strict inflation stabilizer. This implies that, contrary to model 1 (from Section II on the specification of models, pp. 19-20), in such an economy the CB faces (possibly within some restricted range of low rates of inflation) a long-run tradeoff between the average level of inflation and the average level of the output gap.[28] The ability to affect output arises because, due to temporarily sticky prices, the CB can influence the real rate by means of the nominal rate of interest.

For a flexible inflation targeter with asymmetric

[28] The qualification restricting the statement to low rates of inflation refers to the possibility that, when inflation increases beyond a certain threshold, the intervals between price adjustments become shorter. This ultimately pushes β toward 1 and eliminates any long-run tradeoff between average inflation and the average output gap.

preferences it is desirable to have a positive, rather than a zero, average rate of inflation in order to be able to reduce the magnitude of negative output gaps when such gaps occur. As a consequence, the average output gap, which was zero under a strict inflation targeter, becomes positive. It is therefore not quite appropriate to refer to the higher inflation produced by the flexible targeter as a "bias." I refer to it instead as an "inflationary tendency." Ultimately, whether the CB or society prefers more inflation and more stabilization of negative output gaps to less inflation and less stabilization of such gaps is a matter of taste.

But, to my knowledge, no CB has ever publicly acknowledged that there might be such a tradeoff. Thus, to the extent that there are at least some CBs with asymmetric preferences, they have been remarkably silent and opaque about the tradeoff between output stabilization and inflation and about their attitude to alternative values of the output gap. For example, the public stance taken by most explicit inflation targeters is that there is no relation between the degree of flexibility in targeting inflation and the *average* rate of inflation.

One possible reason for this position is that public acknowledgment of asymmetric attitudes to positive and negative output gaps may raise inflationary expectations and necessitate a higher average level of real rates, which CBs fear will depress the average level of output and investment. Such a fear is irrational in the models I have presented because, by the rational expectations assumption, individuals know what the true objectives of the CB are in any case. But once this extreme informational assumption is released for at least some individual price setters in the economy, it becomes rational for the CB to de-emphasize institutional factors that might raise inflationary expectations. Simon has been emphasizing cognitive and related limitations on the individual's ability to absorb information for many years.[29] In the presence of such cognitive threshold effects within a sufficiently large fraction of price setters, it is rational for CBs to de-emphasize a high flexibility parameter and asymmetric preferences in order to maintain credibility.

VI. CONCLUDING REMARKS

The main messages of the paper can be summarized as follows. First, contemporary Western CBs are rather opaque about the economic models they use in reaching policy decisions, as well as about major attributes of their objective functions. Second, although Western CBs have recently been quite precise about their inflation targets, there is substantial haziness about output targets and about the degree of flexibility allowed in targeting inflation. Third, in a world characterized by uncertainty about the future state of the economy, the shape of the loss function over the *entire* range of inflation and of output gaps shapes policy choices. All CBs have been remarkably silent about that. This paper makes a case for the existence of asymmetric attitudes to positive and to negative output gaps, at least for some CBs.[30]

It shows, both for sticky- and for flexible-price transmission mechanisms, that in the presence of such asymmetries and uncertainty about the upcoming state of the economy there is an inflation bias even when the CB targets potential output. The reason is that such CBs are willing to tolerate some higher inflation in order to reduce the risk of unexpectedly deep recession. This precautionary demand for expansions is analogous to the precautionary saving motive in the theory of consumption under uncertainty, as generalized by Kimball (1990).

This "new inflation bias" result implies that, even if Blinder (1998), Vickers (1998), and McCallum (1995, 1997) are all right in believing that contemporary CBs target potential output, the risks of inflation are not gone. Although, as in KPBG, the bias arises because of the CB concern (at least in some states of nature) about the output gap, the new bias *does not* rely on dynamic inconsistency. The origin of the bias resides, instead, in the precautionary behavior of the CB, with respect to recessions in a world of uncertainty, in conjunction with the public's awareness of this asymmetry in CB objectives.

Fourth, in sticky-price frameworks with forward-looking pricing there is, within some range, a long-run tradeoff between average inflation and average output. Fifth, theory predicts that CBs with asymmetric preferences will locate at a point along this

[29] A summary view with implications for economics appears in Simon (1992). A recent enlightening discussion of Simon's view for transparency in monetary policy appears in Winkler (2000).

[30] Casual observation suggests that most politicians definitely have asymmetric attitudes toward positive and negative output gaps. During periods of disinflation and attempted buildups of credibility, the CB may behave as if it suffers a higher loss from an upward than from a downward deviation of inflation from target. Nobay and Peel (1998) analyze the case in which both the inflation and the output gap terms in the loss function of the CB are asymmetric. Cukierman and Muscatelli (2002) provide a general framework and related empirical work that feature both types of asymmetries and make it possible to identify the dominant asymmetry in each country.

tradeoff that is characterized by both positive average inflation and a positive output gap. This finding implies that asymmetrically inclined policymakers who believe in sticky-price models of the economy rather than in flexible-price expectations-augmented Phillips curves are inherently more inflationary. But this does not mean they have a larger bias, because their policies also bring, under sufficiently low inflation, a larger level of output.

Following conventional rational-expectations practice, the new inflation bias story presented here assumes that all agents in the economy are perfectly rational and fully aware of what central bankers are doing. Individuals familiar with the decision-making process within CBs may argue that most policymakers are not solving an explicit expected utility maximization problem as postulated here. Although probably true, this observation does not necessarily invalidate the relevance of the new inflation bias result. Policymakers can hedge against deeper-than-wanted recessions by means of various rules of thumb and institutional arrangements. The next paragraph provides an illustration of such a rule of thumb.

The view, currently held by some European CBs, that current monetary policy can affect inflation only in the second year after the implementation of the policy may be thought of as such a built-in institutional hedging device mainly against unexpected recessions. This device builds in a "flexible inflation targeting" hedging procedure into the policy process from the outset. The reason is that, given this belief, it would be foolish to immediately attempt to put inflation back on target following, say, a cost shock. But the belief leading to this policy prescription of flexible targeting may be disputed. Woodford (1999), for example, as well as many New Keynesians, appears to believe that monetary policy can have an immediate impact on current inflation via expected inflation. It thus is not unreasonable to believe that part of the "two-year lag" institutional belief is motivated by hedging behavior in the face of uncertainty and asymmetries in the attitudes of CBs about positive and negative output gaps.

Part of the haziness regarding objectives is understandable in view of the fact that, in New Keynesian models, inflationary expectations affect current pricing decisions.[31] In particular, a flexible inflation targeter with a nonnegligible flexibility parameter has good reason to appear less flexible than he really is. This may have underlied the traditional, historical public position of the Bundesbank according to which it was not concerned about output, as well as a recent observation by Mervyn King from the Bank of England. King's argument is that it is difficult to distinguish, in practice, between strict and flexible inflation targeters because both raise interest rates when inflation and output are above target. I doubt that a strict inflation targeter would have made such a statement. As a matter of fact, CBs with asymmetric output gap concerns have, in view of the new inflation bias result presented here, a credibility reason for not highlighting this fact. By contrast, simple monetary policy games with signaling imply that a strict inflation targeter would like to send messages that would make his identity clear to the public.[32] Such a "type" is unlikely to claim that it is not possible to distinguish flexible from strict inflation targeters.

Lack of transparency about objectives is probably more easily remedied than lack of transparency about economic models because the latter is largely due to lack of consensus about the true model of the economy within the economic profession. It follows that significant advances in our understanding of the channels of monetary policy are likely to substantially raise the transparency about models used and with it the accountability of CBs.

During the second part of the 1990s, many Western economies experienced remarkably low rates of inflation. Particularly striking is the experience of the United States, in which inflation was quite low in spite of the powerful and persistent expansion it went through during the last decade. Is this all due to higher CB independence and a stronger focus on price stability? It is likely that this is part of the explanation, but not the whole story.[33]

This paper suggests an additional possibility. Believing that the probability of recession is low, those banks behaved nearly as strict inflation targeters would have. This conjecture is supported by the fact that inflation was low also in countries whose CBs are flexible inflation targeters (with possibly asymmetric preferences). If correct, this conjecture also implies that, when the fears of recession

[31] Jensen (2000) shows that in such cases full transparency about objectives is not necessarily desirable.

[32] This is the implication of formal models of monetary policy games with private information. Two simple formulations appear in Vickers (1986) and in Cukierman (2000b).

[33] Cukierman and Lippi (2001) identify an additional factor. The permanent effects of the "new economy" in the United States were initially underestimated, leading to overestimates of the output gap and, consequently, to more restrictive monetary policies.

increase again, inflation may take off as the (currently latent) new inflationary bias of those banks comes back into being.

Finally, to maintain the paper within manageable proportions, I deliberately avoided a systematic discussion of two important questions. Is full transparency feasible, and is it always desirable? The answer to the first question is likely to be "no," as suggested by Vickers (1998) and Winkler (2000). This still leaves open a question about whether it is desirable to extend transparency as far as the feasibility constraints would allow. The answer to this question is by no means clear cut. Recent arguments for and against doing that appear in Faust and Svensson (2001), Geraats (1999), Jensen (2000), and Cukierman (2001) and are partially summarized in the last paper. Fuller understanding of the benefits and costs of transparency must await further economic outcomes as well as academic work.

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Commentary

Carl E. Walsh

It is very appropriate that a conference on monetary policy transparency begin with a paper by Alex Cukierman. His 1986 paper with Allan Meltzer was the first modern treatment of transparency and the model developed in that paper continues to serve as the basic framework for much of the recent work in this area.

Economists at most major central banks seem to feel the average inflation bias that occupied so much space in academic journals has been conquered. Whether it is because they now know to just do the right thing (McCallum 1995), because they target only the natural rate of output (Blinder, 1998; Svensson, 1999), or because they have gained reputations as inflation fighters through increased transparency and greater accountability is less certain. While many central banks have adopted operating procedures that are designed to provide the public with clearer and more complete information about policy decisions, and this increased transparency is often cited as critical for inflation targeters, Cukierman argues that transparency is still incomplete. This is true even among central banks that are quite transparent along some dimensions, publicly announcing inflation targets, for instance. This incompleteness limits the ability of the public to hold monetary policymakers accountable for their actions. Cukierman highlights two aspects of the policy environment that remain opaque—models and objectives. Emphasizing the role of objectives in the second half of his paper, Cukierman explores the implications for inflation of asymmetric preferences and, specifically, the case in which, at a given inflation rate, output expansions are viewed as beneficial while contractions are viewed as costly.

Cukierman notes that the different notions of the output gap implicit in alternative models is one source of policy opaqueness. First, I want to develop more formally the distinction between alternative measures of the output gap and argue that different economic models and different definitions of the output gap lead to different policy objectives. If central banks are opaque about the models because of uncertainty about the true transmission mechanism of policy, then this will also be reflected in uncertainty (and therefore opaqueness) about the objectives of policy. Thus, uncertainty about the true economic model and opaqueness about policy objectives are intertwined. I then show that a model commonly used in the recent literature to analyze policy transparency arises naturally when the central bank targets the wrong output gap. Turning to asymmetric preferences, I provide a graphical representation of Cukierman's model that helps to illustrate why a positive average inflation rate arises in equilibrium, and I then touch on the nonneutrality of money in the New Keynesian model he uses.

TRANSPARENCY: MODELS AND OBJECTIVES

Cukierman argues that even central banks such as the Bank of England—that is, central banks thought of as being very transparent—are in fact still fairly opaque because they are not transparent about either their exact policy objectives or the models they use in the decisionmaking process. It might seem hard to reconcile this view of central banks with the general perception that monetary policymaking in many countries has become more transparent—after all, if we think of policymakers as solving an optimizing problem, that problem is characterized by the policymakers' objectives and the constraints they face, given by their model of how the economy operates. So if central banks are not transparent about either their objectives or their constraints, what is there for them to be transparent about? Clearly inflation targeters are transparent about at least some of their objectives. As Cukierman notes, however, even inflation targeters appear to care about output objectives, yet none have made these concerns explicit.

The Lucas Supply Curve Versus New Keynesian Inflation Adjustment

Opaqueness about models and opaqueness about objectives are not independent—the choice of a particular model can determine the appropriate objectives of policy. I want to illustrate this point using two of the alternative models Cukierman sets out. Cukierman actually discusses three alternative models of the monetary transmission mechanism to make his point that one reason central banks are

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not transparent about the models they use is that economists have not reached agreement on the "correct model" of the economy. The three models are (i) a monetarist model based on a Lucas-type transmission process in which it is monetary surprises that matter, (ii) a backward-looking model of sticky price adjustment, and (iii) a forward-looking New Keynesian model of sticky prices. I will focus on the first and third of these models. In their most basic form, these models imply different objectives for monetary policy. Thus, a lack of transparency about the central bank's model inevitably also reduces the transparency of its objectives.

The key equation that distinguishes the alternative frameworks links inflation and output. In the Lucas supply curve, one has

$$x_t^L = \alpha(\pi_t - E_{t-1}\pi_t) \tag{1}$$

and

$$x_t^L = y_t - y_{nt},$$

where inflation is denoted by π, the actual (log) level of real output is y_t, y_{nt} is the log natural rate of output (both defined as deviations around the steady-state level of output), and x_t^L is the gap between actual output and the natural rate. In the basic New Keynesian model,

$$\pi_t = \beta E_t \pi_{t+1} + \kappa x_t^{NK} \tag{2}$$

and

$$x_t^{NK} \equiv y_t - y_{ft},$$

where y_{ft} is the log output level that would arise in the absence of nominal rigidities (expressed as a deviation around the steady-state level) and x_t^{NK} is the gap between actual output and the flexible-price equilibrium output level.[1]

As Cukierman notes, the two models do not necessarily imply the same definition of the output gaps x_t^L and x_t^{NK}, nor do either of these theoretical constructs correspond closely to standard empirical methods of measuring output gaps. The first issue to address is the relationship between these alternative definitions of the output gap. The appropriate objective of monetary policy implied by these two models differs; so, if central banks, perhaps because of uncertainty about the structure of the economy, are opaque about their model, it will be difficult to be transparent about their objectives.

Output Gaps. The output gap is the difference between actual output and some reference output level. Cukierman draws a distinction between the appropriate definition of this reference level in the Lucas neo-monetarist approach and in the New Keynesian approach. While measurement issues arise in trying to make operational any concept of the output gap, I think economic theory provides some guidance as to which one should be the focus of policy.

To contrast alternative interpretations of the output gap, it will be useful to add some more structure to the model. Suppose the aggregate production function takes the form

$$Y_t = e^{z_t} N_t^a, \tag{3}$$

where z is an aggregate productivity disturbance and N_t is aggregate employment. The utility of the representative agent is

$$U = \sum_{i=0} \beta^i \left[\left(\frac{C_{t+i}^{1-\sigma}}{1-\sigma} \right) - \chi \left(\frac{N_{t+i}^{1+\eta}}{1+\eta} \right) \right]. \tag{4}$$

In the absence of any nominal rigidities, labor market equilibrium would be determined by the two conditions

$$a e^{z_t} N_t^{a-1} = \theta \left(\frac{W_t}{P_t} \right) \tag{5}$$

and

$$\mu \left(\frac{\chi N_t^{\eta}}{C_t^{-\sigma}} \right) = \left(\frac{W_t}{P_t} \right), \tag{6}$$

where $1 \leq \theta < \infty$ and $1 \leq \mu < \infty$ are mark-ups in the goods and labor markets arising from the presence of monopolistic competition. If both the goods and labor markets are characterized by perfect competition, $\theta = \mu = 1$ and (5) and (6) reduce to the familiar condition that the marginal product of labor equals the marginal rate of substitution between leisure and consumption.

Letting a subscript f denote the equilibrium in the absence of nominal rigidities, and noting that in the absence of investment and government purchases $C_t = Y_t = e^{z_t} N_t^a$, the flexible-wage and flexible-price equilibrium level of output is

[1] The inflation adjustment equations in recent New Keynesian models imply that inflation is related to expected future inflation and real marginal cost. Real marginal cost is then related to the output gap to yield an equation such as (2) (see Galí and Gertler, 1999). Cukierman identifies the gap in the New Keynesian model as output minus potential. However, the standard definition of the gap in recent New Keynesian models is the difference between (log) output and the log of the flexible-price equilibrium level of output. This does not correspond to "potential output" in the sense that Cukierman uses it as reflecting long-run supply factors.

$$Y_{ft} = e^{z_t} N_{ft}^{a} = \left[\frac{a}{\theta\mu\chi}\right]^{\frac{a}{1+\eta-a(1-\sigma)}} e^{\left(\frac{1+\eta}{1+\eta-a(1-\sigma)}\right)z_t}.$$

Expressed in log terms as a deviation around the steady-state,[2]

$$y_{ft} = \left(\frac{1+\eta}{1+\eta-a(1-\sigma)}\right) z_t \equiv \gamma z_t. \tag{7}$$

Recall that in New Keynesian models, the output gap is identified with the deviation of actual output around this flexible-price output level, or

$$x_t^{NK} = y_t - y_{ft} = y_t - \gamma z_t.$$

How does this gap variable compare with the gap between output and the natural rate in models based on a Lucas supply curve? According to Friedman (1968),

> The "natural rate of unemployment," in other words, is the level that would be ground out by the Walrasian system of general equilibrium equations, provided there is imbedded in them the actual structural characteristics of the labor and commodity markets, including market imperfections, stochastic variability in demands and supplies, the costs of gathering information about job vacancies and labor availability, the costs of mobility, and so on.

At one level, this definition could be taken to mean the level of employment in a New Keynesian model is always at the natural rate. After all, the costs of adjusting prices and wages are part of the "structural characteristics" of the economy. Fluctuations in demand induced by monetary policy alter the level of employment ground out by the general equilibrium model. Yet this is clearly not what economists have interpreted the natural rate to mean. Earlier in the same paragraph from which the quotation above is drawn, Friedman speaks of the unemployment rate "consistent with equilibrium in the structure of *real* wage rates" (emphasis in original). This definition seems more consistent with the notion of the flexible-price equilibrium level of employment. Under that interpretation, the output gap in the New Keynesian models is, in fact, equal to the gap between output and the natural level of output, and the Lucas supply curve and New Keynesian gaps are the same.

A more common interpretation of the natural level of output, however, corresponds to the equilibrium output in the absence of inflation surprises, i.e., when $x_t^L = 0$. How does output in the absence of inflation surprises compare with the flexible-price equilibrium level, and what is the relationship between the gap measure x_t^L and the measure x_t^{NK}? To answer this question, one needs to know where the Lucas supply function comes from.

The standard motivation for the Lucas supply function is not the information-based story originally developed by Lucas (1972). Instead, it is based on Fischer (1977), who shows that equation (1) can arise when prices are flexible and goods markets are perfectly competitive but nominal wages are set at the start of the period, prior to observing the current shocks (including innovations to monetary policy).

With competitive goods markets and flexible prices, firms adjust employment to ensure the real wage is equal to the marginal product of labor. If $\overline{W}_t$ is the period t nominal wage set at the end of period $t-1$, employment satisfies

$$a e^{z_t} N_t^{a-1} = \theta\left(\frac{\overline{W}_t}{P_t}\right).$$

In log deviations around the steady-state,

$$n_t = \left(\frac{1}{1-a}\right)\left(p_t - \overline{w}_t + z_t\right).$$

Assume the nominal wage is set to ensure that the expected marginal rate of substitution between leisure and consumption is equal to the expected marginal product of labor:

$$\mu E_{t-1}\left(\frac{\chi N_t^{\eta}}{C_t^{-\sigma}}\right) = E_{t-1}\left(\frac{W_t}{P_t}\right) = \left(\frac{a}{\theta}\right) E_{t-1}\left(e^{z_t} N_t^{a-1}\right).$$

This implies, in terms of a log-linear approximation around the steady-state, that the nominal wage is set equal to

$$\overline{w}_t = E_{t-1} p_t + \left[\frac{\eta+\sigma}{1+\eta-a(1-\sigma)}\right]\rho\, z_{t-1}.$$

Note that I have assumed the productivity disturbance z_t follows an AR(1) process $z_t = \rho z_{t-1} + e_t$, where e_t is a white noise process. Equilibrium employment is given by

$$n_t = \left(\frac{1}{1-a}\right)\left[e_t + \left(p_t - E_{t-1} p_t\right)\right] + \left[\frac{1-\sigma}{1+\eta-a(1-\sigma)}\right]\rho\, z_{t-1},$$

[2] The log steady-state level of output is $\{a/[1+\eta-a(1-\sigma)]\}\ln[a/\theta\mu\chi]$.

and output is

$$y_t = z_t + an_t$$
$$= \left(\frac{a}{1-a}\right)(p_t - E_{t-1}p_t) + \left(\frac{1}{1-a}\right)e_t + \gamma\rho z_{t-1}.$$

Therefore, the natural rate of output defined as output in the absence of price surprises is

$$y_{nt} = \left(\frac{1}{1-a}\right)e_t + \gamma\rho z_{t-1}.$$

With nominal wages fixed, a policy that stabilizes the price level (eliminates price surprises) keeps the real wage unchanged in the face of productivity innovations. Employment rises with a positive productivity shock ($e_t > 0$) as firms hire more workers until the marginal product of labor is again equal to the (fixed) real wage. The impact of e_t on y_{nt} is $e_t/(1-a)$. In contrast, the efficient, flexible-price response is equal to γe_t (see equation (7)). Since

$$\gamma \equiv \left(\frac{\eta+\sigma}{1+\eta-a(1-\sigma)}\right) \leq \left(\frac{1}{1-a}\right),$$

the natural rate fluctuates more in responses to productivity innovations than does the flexible-price equilibrium output level. A policy of price stability, when nominal wages are sticky, leads to too much output variability. Stabilizing the output gap defined by x_t^L is not the optimal policy when nominal wages are sticky.

The flexible-price equilibrium will be replicated if

$$\pi_t - E_{t-1}\pi_t = -\left(\frac{\eta+\sigma}{1+\eta-a(1-\sigma)}\right)e_t. \tag{8}$$

This fall in prices in the face of a productivity shock raises the real wage, reducing the demand for labor. This ensures that the marginal rate of substitution between leisure and consumption remains equal to the real wage. As one would expect from the analysis of Erceg, Henderson, and Levin (2000), the policy given by (8) would, in a sticky-wage environment, ensure that the nominal wage remains constant, thereby undoing the distortion generated by sticky nominal wages.

Of course, the converse results arise if prices are sticky and policymakers attempt to avoid wage surprises.

How does the gap between output and the natural level of output compare with the gap between output and the flexible-price equilibrium level of output? It is straightforward to show

$$x_t^{NK} = x_t^L + \left(\frac{a}{1-a}\right)\left(\frac{\eta+\sigma}{1+\eta-a(1-\sigma)}\right)e_t.$$

Consider the impact of a positive productivity disturbance, $e_t > 0$. A policy that tries to stabilize x_t^L needs to let x_t^{NK} rise. That is, output will expand above the flexible-price equilibrium level. In contrast, if the central bank focuses on stabilizing x_t^{NK}, it will allow output to fall below the natural rate in the face of a positive productivity shock.

Which output gap measure should the central bank focus on? The policy recommendation from the Lucas model would seem to be "avoid inflation surprises." Yet such a policy is inefficient because it generates economic fluctuations that are too large in response to productivity shocks. The natural rate is not the appropriate output benchmark for stabilization policies when nominal wages are sticky. On the other hand, if wages are flexible and prices are sticky, eliminating inflation surprises by maintaining zero inflation would be optimal. If the central bank is uncertain whether the economy is characterized by sticky wages or sticky prices, it will also be uncertain about the optimal policy is should follow. If this uncertainty means the central bank is opaque about its views of the monetary transmission mechanism, then it is also likely to be opaque with respect to its objectives.

The general lesson is that policy objectives are not independent of the structure of the economy. In a Lucas supply curve model based on nominal wage rigidity, price stability is not the optimal policy, although it is in a New Keynesian model of sticky prices. Both these models are based on a key simplifying assumption—only one nominal variable is sticky. With a single monetary distortion, optimal policy calls for undoing that distortion. If both wages and prices are sticky, then neither price stability nor nominal wage stability will be optimal.

Targeting the Wrong Gap and Models of Transparency. Cukierman lists another gap measure—the difference between output and potential. Since potential is a constant in my simple example, this gap measure is just

$$y_t = x_t^{NK} + \gamma z_t.$$

Suppose the central bank does focus on output relative to potential and the economy is actually characterized, as in New Keynesian models, by flexible nominal wages and sticky prices. In this case, inflation is given by

$$\pi_t = \beta E_t \pi_{t+1} + \kappa x_t^{NK}, \tag{9}$$

while the central bank's loss function is

$$\begin{aligned} L_t &= (1-\beta) E_t \sum_{i=0}^{\infty} \beta^i \left[\pi_{t+i}^2 + A y_{t+i}^2 \right] \\ &= (1-\beta) E_t \sum_{i=0}^{\infty} \beta^i \left[\pi_{t+i}^2 + A\left(x_{t+i}^{NK} + \gamma z_{t+i} \right)^2 \right]. \end{aligned} \tag{10}$$

Notice that, by focusing on y_t rather than x_t^{NK}, we have a situation in equation (10) that is equivalent to the presence of a stochastic output target equal to γz_t. Alternatively, the central bank's decision problem can be written in terms of y_t. In this case, the loss function is

$$L_t = (1-\beta) E_t \sum_{i=0}^{\infty} \beta^i \left(\pi_{t+i}^2 + A y_{t+i}^2 \right),$$

and this is minimized subject to

$$\pi_t = \beta E_t \pi_{t+1} + \kappa y_t + \kappa \gamma e_t.$$

This reveals how the productivity shock e_t appears as a cost shock (and therefore leads to a policy trade-off—see Clarida, Galí, and Gertler, 1999) because the central bank employs the wrong measure of the output gap. In the present model, the socially optimal policy would set $\pi_t = 0$ and $x_t^{NK} = 0$; but, when the central bank targets output relative to potential, it is straightforward to show that inflation fluctuates too much.

Transparency and a Stochastic Output Target. When the central bank incorrectly targets output relative to potential, we have a situation that is equivalent to the presence of a stochastic output target. What is interesting about this case is that recent work on central bank transparency has often been based on the assumption that the central bank has a stochastic output target. Models with stochastic output targets have been used by Faust and Svensson (2001), Jensen (2000), and Walsh (2002) to study the role of transparency. As just shown, this situation can arise when the central bank targets the wrong measure of the output gap, perhaps because of the sort of model uncertainty that Cukierman emphasizes.[3]

Faust and Svensson (2000) conclude that transparency is desirable. In their model, transparency takes the form of better information about the central bank's control error— transparency is increased if the central bank provides more information about its forecasts. Thus, greater transparency improves the ability of the public to monitor the central bank by distinguishing between control errors and stochastic shifts in the central bank's output objective. Improved transparency means that any deliberate attempt by the central bank to expand output would quickly be discovered and lead to a rise in expected inflation. This rise in expected inflation increases the marginal cost of an expansion, inducing the central bank to refrain from trying to overly expand real economic activity. Transparency acts as a disciplinary device (see also Walsh 2000).

Cukierman (2000) and Jensen (2000) point out that transparency may come at a cost. By making expected inflation more sensitive to central bank actions, the cost of engaging in policies aimed at stabilizing output rises. This can distort stabilization policy and lead to excessive fluctuations in real economic activity.

This type of distortion is common in many systems based on an imperfect measure of performance. Announcing a target for inflation, for example, establishes a measure by which the central bank's performance can be measured. If too much stress is placed on achieving the target (essentially making inflation targeting a high-powered incentive scheme), the central bank may downplay other potentially desirable objectives. However, greater transparency by publishing the central bank's forecasts would allow the public to more easily verify whether the central bank's short-run target for inflation is appropriate, given the central bank's forecast of economic conditions. In other words, greater transparency allows the public to more closely monitor the central bank.[4] Better monitoring improves the public's ability to hold the central bank accountable for achieving its inflation target. Thus, greater transparency is consistent with a stricter inflation targeting regime (i.e., a high-powered incentive scheme with more weight placed on achieving the target) because the public is able to determine the appropriate state-contingent target inflation rate.

THE ROLE OF ASYMMETRIC PREFERENCES

The second part of Cukierman's paper develops the implications for inflation of asymmetric central bank preferences. Cukierman questions the assumption of symmetric preferences that is implied by the standard quadratic specification for the central

[3] For a survey of the recent literature on central bank transparency, see Geraats (2002).

[4] Walsh (2002) relates transparency to the ability to monitor the central bank.

Figure 1

Asymmetric Preferences and Cost Shocks When Expected Future Inflation Is Zero

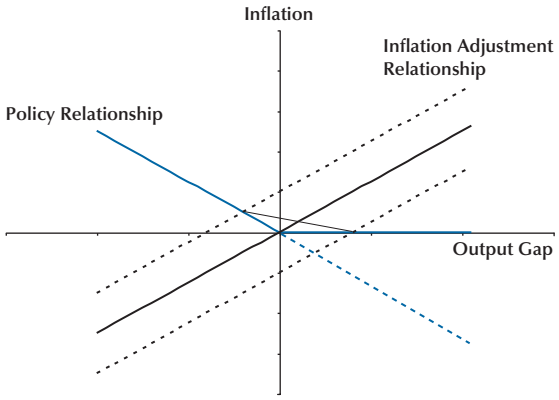
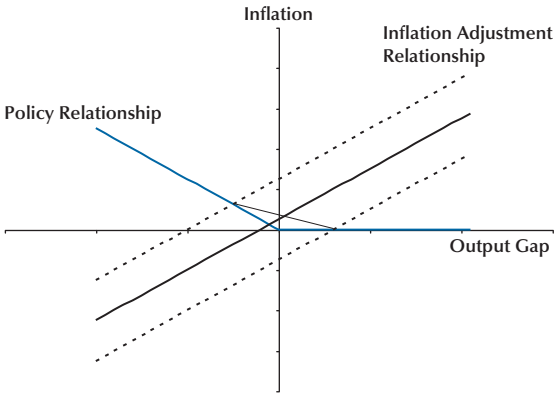


Figure 2

Equilibrium Inflation with Asymmetric Preferences



bank's loss function. Instead, he argues that, given the rate of inflation, central banks prefer a 1 percent output gap to a –1 percent gap. This assumption strikes me as quite reasonable, and there are a number of ways of modeling it. Perhaps the simplest is to subtract a linear term in the output gap from the standard quadratic loss function. This makes the marginal benefit of an expansion positive when evaluated at a zero output gap. Ruge-Murcia (2001) uses a linex function to allow for asymmetric preferences, although he assumes this applies to inflation, not output.

Cukierman employs a specification that is very simple but that captures the basic idea—he assumes that as long as the output gap is positive, the central bank cares only about inflation stabilization. When the gap is negative, then the familiar quadratic preferences kick in. In his neo-monetarist model, the central bank must act prior to observing the current shocks. To ensure against a bad output realization, the policymaker sets the nominal money supply above the zero inflation level. As a consequence, an average inflation bias appears.

A Graphical Analysis in the New Keynesian Model

As Cukierman notes, a similar effect arises in his New Keynesian model, even if the central bank can observe the shocks. It is easy to illustrate this graphically. In Figure 1, the line labeled "Policy Relationship" illustrates the inflation and output gap combinations that are consistent with the central bank's first order condition.[5] Also shown in the figure is the inflation adjustment curve, drawn as a solid line for the case of zero expected inflation and a zero cost shock. Inflation occurs where the policy relationship and the inflation adjustment curve intersect. Assume the cost shock takes on the values $\varepsilon > 0$ and $-\varepsilon < 0$ with equal probability, as indicated by the dashed lines. Since inflation is zero when the cost shock is $-\varepsilon$ and positive when the shock is ε, on average, inflation will be positive. Since private agents will anticipate this inflation bias, expected inflation rises, shifting the inflation adjustment curves upward until equilibrium is established at $(\bar{x}, \bar{\pi})$, as shown in Figure 2 where the inflation adjustment equation for zero shock intersects the vertical axis at $\beta\bar{\pi}$. As Cukierman also notes, the equilibrium involves positive average inflation *and* a positive average output gap.

Figure 3 illustrates the effects of an increase in the weight the central bank places on its output objectives (an increase in the parameter A). With a larger A, the central bank is willing to accept higher inflation to limit declines in the output gap. As a consequence, average inflation rises. In addition to depending positively on A, the average inflation rate is increasing in the variance of the cost shock. This can be seen by increasing the distance between the inflation adjustment curves for $\varepsilon > 0$ and $-\varepsilon < 0$.

[5] For $x > 0$, the central bank sets $\pi = 0$. For $x < 0$, the central bank equates the marginal rate of substitution between the output gap and inflation, $-Ax/\pi$, to the marginal rate of transformation, κ, or $\kappa\pi + Ax = 0$, where A is the weight on output fluctuations in the objective function and κ is the marginal effect of output on inflation.

Are Preferences Asymmetric?

Asymmetric preferences over output is one possibility, but there are other ways in which the central bank's preferences may be asymmetric. Ruge-Murcia (2001) models the asymmetry as applying to inflation. He assumes that inflation-targeting central banks are more concerned about overshooting their inflation target than they are about undershooting the target. As a consequence, he finds there is a deflationary bias. That is, average inflation will be systematically below the announced target. This is the opposite of Cukierman's conclusion that inflation will be systematically above target.[6]

The presence and form of asymmetric preferences seems to me an empirical issue. Cukierman cites some evidence that supports his specification. For instance, Gerlach (2000) finds some support for a positive association between variability and the level of inflation. For the inflation targeting countries he studies, Ruge-Murcia (2001) finds that average inflation is negatively related to the variance of inflation, evidence that he interprets as supportive of his specification. Clearly, there cannot be both an inflation bias and a deflation bias, so this is an area that will need to be resolved by further empirical testing.

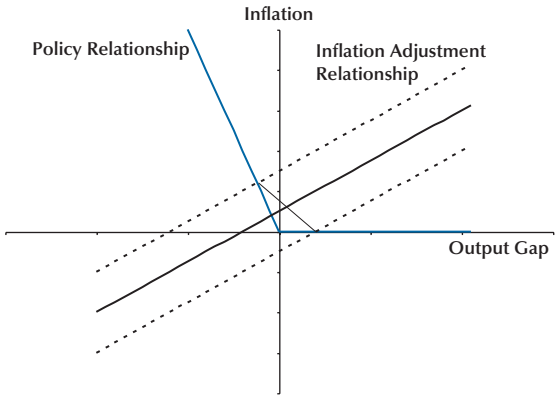
IS THERE LONG-RUN NONNEUTRALITY IN THE NEW KEYNESIAN MODEL?

Finally, I want to comment on the presence of a long-run trade-off between average inflation and the output gap in the New Keynesian model Cukierman employs. Cukierman notes that the existence of this trade-off leads to what he labels an "inflation tendency." A positive average rate of inflation produces an output gap that is also positive on average. If the average rate of inflation is $\bar{\pi} > 0$, then equation (2) implies the average output gap is $\bar{x} = (1-\beta)\bar{\pi}/\kappa > 0$. This situation was illustrated in Figures 2 and 3 by the positive output gap that accompanies the positive equilibrium inflation rate.

This apparent trade-off arises in some, but not all, derivations of the inflation equation given by (2). For example, suppose prices are set according to a Calvo mechanism in which a randomly drawn fraction $1-\theta$ of all firms adjust their prices each period. Adjusting firms set prices to maximize the present discounted value of profits, subject to a constant elasticity demand for their goods. Following Erceg, Henderson, and Levin (2000) and Christiano, Eichenbaum, and Evans (2001), assume that the other θ fraction of firms simply update their prices based on the average rate of inflation.[7] One could think of the costs of adjusting as reflecting decision-making costs so that each period not all firms decide to fully optimize in setting their price.

Figure 3

Equilibrium Inflation with a Larger Weight on Output



Let $\hat{\psi}_t$ be the firm's real marginal cost, with $\hat{}$ denoting percentage deviation from the steady-state, and β the discount factor. Then one obtains

$$\hat{\pi}_t = \beta E_t \hat{\pi}_{t+1} + \left[\frac{(1-\beta\theta)(1-\theta)}{\theta}\right]\hat{\psi}_t .$$

By using the production function and the household's marginal rate of substitution between leisure and consumption, real marginal cost can be eliminated to yield a standard New Keynesian inflation-adjustment equation[8]:

$$\hat{\pi}_t = \beta E_t \hat{\pi}_{t+1} + \kappa x_t^{NK}. \tag{11}$$

[6] In Figure 1, make the policy relationship concave, rather than convex, to illustrate the resulting deflationary bias.

[7] Christiano, Eichenbaum, and Evans (2001) characterize this as static pricing. They also analyze "dynamic" pricing in which firms update price based on the lagged inflation rate.

[8] The marginal cost variable can be related to the output gap by noting that from (3) and (4),

$$\hat{\psi}_t = \hat{w}_t - \hat{p}_t - (a-1)\hat{n}_t = \eta\hat{n}_t + \sigma x_t^{NK} - (a-1)\hat{n}_t$$
$$= [\eta a + \sigma + a(1-a)]x_t^{NK}.$$

So in (11),

$$\kappa \equiv \left[\frac{(1-\beta\theta)(1-\theta)}{\theta}\right][\eta a + \sigma + a(1-a)].$$

The critical point to note is that equation (11) does not involve the *level* of the inflation rate. It is expressed in terms of the deviation of inflation from the steady-state. By definition, $\hat{\pi}$ equals zero in the steady-state, and (11) then implies that the output gap will also be zero, regardless of the average steady-state rate of inflation. Thus, in this version of the New Keynesian model there is no long-run trade-off between the average rate of inflation and the output gap.

CONCLUSIONS

Central banks are not transparent about their models, for the reasons Cukierman highlighted. If policymakers are uncertain about the true model of the economy, then opaqueness about objectives is not surprising, since a choice of model serves to define the appropriate objectives. In the models Cukierman uses to illustrate differences in the transmission process, different policies are optimal. Under the standard Lucas supply curve a la Fischer, monetary policy should stabilize nominal wages; in the basic New Keynesian model, prices should be stabilized. Greater transparency about objectives is likely to arise, therefore, only when there is greater agreement on models.

Transparency is important if policymakers are to be held accountable. It is difficult to monitor the central bank's performance if little information is available about the economic outlook that forms the basis for the central bank's policy decisions. Greater transparency, by improving the ability to monitor the central bank, contributes to making policymakers more accountable for achieving the central bank's inflation target.

As for asymmetric preferences, I find it plausible that central bankers are not indifferent between expansions and recessions or between inflation target overshoots and undershoots. How important this is empirically, however, is an open question.

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Central Bank Structure, Policy Efficiency, and Macroeconomic Performance: Exploring Empirical Relationships

Stephen G. Cecchetti and Stefan Krause

I. INTRODUCTION

All economists agree that more information is better than less. When people are better informed, they make better decisions, enhancing the efficiency of the economy in allocating resources and improving overall welfare. It would be difficult to find an area of economic life where this line of argument has carried more weight than it has in central banking circles in recent years.

The job of central bankers is to conduct monetary policy in order to promote price stability, sustainable growth, and a stable financial system. They do this in an environment fraught with unavoidable uncertainties. But in conducting policy, there is one uncertainty that policymakers can reduce: the uncertainty they themselves create. Everyone agrees that monetary policymakers should do their best to minimize the noise their actions add to the environment. The essence of good, transparent policy is that the economy and the markets respond to the data, not to the policymakers.

The result of this agreement is that today we have the nearly universal and immediate public broadcast of all interest rate changes. As everyone in financial markets around the world knows, the Federal Reserve's Federal Open Market Committee (FOMC) makes a public statement at 2:15 p.m. EST following each meeting. But the first public announcement of a move in the federal funds rate target was made on February 4, 1994, and the regular issuance of a statement became an official feature of the FOMC's procedures only on January 19, 2000. Before that, it was customary for FOMC policy changes to be communicated to market participants through actions rather than words.

There are still people who argue for the efficacy of central bank secrecy in various forms, claiming that surprises are more effective and that even accurate information can be misinterpreted, resulting in undesirable financial market volatility. We think that it is fair to say that these arguments have not been persuasive and that the advocates of policy transparency have won the day. We have been reduced to arguments about the mechanics and exact timing of the release of information. Should the minutes of a meeting be released as soon as physically possible following the meeting, as done by the Bank of England's Monetary Policy Committee; or should there be a modest delay until just after the following meeting, which is the FOMC's practice; or is it acceptable to wait for years, as the European Central Bank is planning to do? Is it necessary or advisable for the head of the interest rate–setting body to hold regularly scheduled news conferences? Should the policymakers be required to appear before legislative bodies to provide descriptions of their decisionmaking processes and justifications for their actions? How public should the inputs—forecasts, models, and anecdotes—into interest rate decisions be? All of these questions concern minor issues about the availability of information.

As for general principles, we have now progressed to the point where on September 26, 1999, the Interim Committee of the Board of Governors of the International Monetary Fund issued the Code of Good Practices on Transparency in Monetary and Financial Policies: Declaration and Principles (which we will refer to as the IMF Code). As in the case of other standards and codes promulgated under the auspices of the IMF,[1] the expectation is that they will be adhered to by all of the countries in the world.

We take the statements in the IMF Code to represent a rough version of the consensus on the value of monetary policy transparency. Paragraph 4 of the IMF Code states:

> The case for transparency of monetary and financial policies is based on two main premises. First, the effectiveness of monetary

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[1] The IMF monitors compliance with codes and standards on data dissemination, fiscal transparency, banking supervision, accounting, and auditing that are issued by a variety of international agencies.

> and financial policies can be strengthened if the goals and instruments of policy are known to the public and if the authorities can make a credible commitment to meeting them. In making available more information about monetary and financial policies, good transparency practices promote the potential efficiency of markets. Second, good governance calls for central banks and financial agencies to be accountable, particularly where the monetary and financial authorities are granted a high degree of autonomy.[2]

This is a concise statement of the view that the key ingredients for an effective central bank are independence, credibility, transparency, and accountability. Going one step further, there is general agreement that independent, transparent, accountable, and credible central banks are able to deliver better overall policy outcomes.[3]

Many people have concluded that the substantial changes undertaken in the operational framework of central banks over the past decade or more have produced better overall policy outcomes. And there is substantial prima facia evidence to support the case. Looking at a broad array of industrialized, transition, and emerging market economies, we see institutional reforms that have increased both the independence and accountability of central banks and, in addition, made monetary policy more transparent through clear public statement of instruments, methods, and objectives. Not only this, but over the same decade or so, many central banks have succeeded in establishing significant reputations for competence, acquiring considerable credibility in the process.

The data that we study here bear out that, as the institutional framework was evolving, macroeconomic performance was improving. Both the level and variability of inflation were lower over the past five years than they were in the previous ten. Looking at a broad cross-section of 63 countries, we see that median inflation has dropped from 7.04 percent in 1985:Q1–1994:Q4 to 2.97 percent in 1995:Q1–1999:Q4. The decrease in average inflation has been even sharper, going from 83.19 percent to 8.59 percent. Inflation rose in only 10 of the 63 countries, and in the bulk of those the increase was small—only in Ghana, Indonesia, and Turkey did average inflation rise by more than 2 percentage points.

Successful policymaking usually means more than just reducing inflation. It means stabilizing inflation and output as well. Looking at a somewhat narrower sample of 24 countries, we see that 20 experienced lower inflation variability while output variability was lower in 15.[4] Again, this occurred as the institutional framework for policymaking was changing, suggesting at least the possibility of a relationship.

The remainder of the paper explores the empirical relationship between economic performance and the monetary policy framework. For reasons that will become clear later, the data on transparency, accountability, credibility, and independence force us to study a cross-section of countries. That is, we examine the extent to which contemporaneous differences in institutional design are able to explain the observed variation in performance across countries during a fixed period of time. We are not able to study how changes in the structure of policymaking have affected changes in macroeconomic outcomes.

With the exception of the measure of credibility, our data on the monetary policy framework in each country are from the Bank of England's Center for Central Bank Studies survey of 93 central banks reported in Fry et al. (2000). This survey contains an incredible wealth of information, including measures of the degree of independence, accountability, and transparency of central banks. But Fry et al. (2000) did their survey only once in 1998 (with revisions in 1999), and so that is all that is available.

Our starting point in Section II is the development of measures of macroeconomic performance and monetary policy efficiency. These measures turn out to be related, and we describe how both

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[2] The "Code of Good Practices on Transparency in Monetary and Financial Policies: Declaration and Principles" is available in its entirety at < www.imf.org/external/np/mae/mft/code/index.htm > .

[3] Empirical studies by Alesina (1988), Grilli, Masciandaro, and Tabellini (1991), Cukierman (1992), Cukierman, Webb, and Neyapti (1992), and Alesina and Summers (1993), among others, find evidence of a negative correlation of central bank independence with lower and more stable inflation, within industrialized countries. Also, Chortareas, Stasavage, and Sterne (2002) examine the association between the cross-country differences in macroeconomic outcomes and the degree of transparency exhibited by monetary policy, measured by the detail with which central banks publish economic forecasts. Their results suggest that a high degree of transparency in economic forecasts is associated with a lower inflation for all countries (with the exception of the ones that target the exchange rate, for which the publication of forecasts has no significant impact on inflation).

[4] See Cecchetti, Flores-Lagunes, and Krause (2002) for details on these calculations.

of them arise from an optimal policy problem. Following our previous work with Flores-Lagunes (Cecchetti, Flores-Lagunes, and Krause, 2002), we measure performance as a weighted average of output and inflation variability, while our measure of policy efficiency (or inefficiency) is related to the distance of the economy's performance point to the inflation-output variability frontier.

In Section III we discuss how we measure the credibility of monetary policy. This is clearly a difficult undertaking and there are a number of possible ways to proceed. One possibility would be to use surveys or press reports to examine what people think about the actions of central bankers. But since we study a large number of countries, collecting such data is an almost impossible task. Instead, we have adopted the view that credibility comes from what you do, not what you say or what someone else says about it. This premise led us to measure credibility by looking at past inflation performance, and here we define a credible central bank as one that has successfully delivered low inflation.

The remainder of the paper puts all of these pieces together and looks for correlations among them. This is the subject of Section IV, and our findings are somewhat discouraging. In the end, we conclude that credibility trumps virtually everything else: countries with a history of high inflation exhibit comparatively worse macroeconomic and policy performance, regardless of the framework in which their central banks operate.

II. MEASURING MACROECONOMIC PERFORMANCE AND EFFICIENCY OF MONETARY POLICY

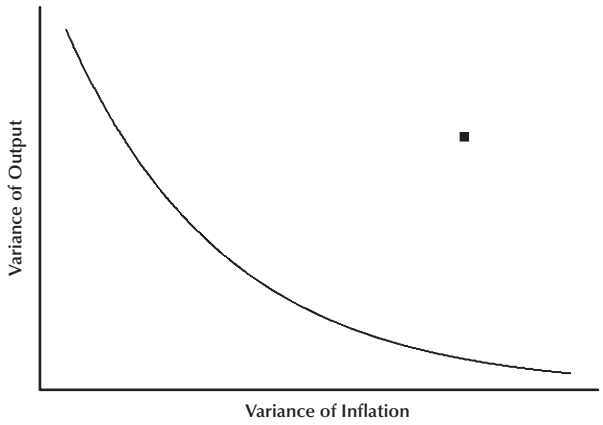
Following Cecchetti et al. (2002), we derive measures of macroeconomic performance and policy efficiency using the inflation-output variability trade-off, or efficiency frontier. To obtain these measures, we first summarize how Cecchetti et al. perform the theoretical derivation and then proceed to briefly describe the estimation method used in constructing the measures. Finally, we report the results on macroeconomic performance and policy efficiency loss for the period of 1991:Q1–1998:Q4.

Theoretical Derivation of the Measures

The measures of interest can be derived using a two-dimensional graph, and so we begin with a simple intuitive explanation. The concept of an inflation-output variability frontier is easiest understood by considering a simple economy that is affected by two general types of disturbances, both of which may require policy responses. These are aggregate demand shocks—which move output and inflation in the same direction—and aggregate supply shocks—which move output and inflation in opposite directions. Since monetary policy can move output and inflation in the same direction, it can completely offset the effect of aggregate demand shocks. By contrast, aggregate supply shocks will force the monetary authority to face a trade-off between the variability of output and that of inflation.[5]

Figure 1

Efficiency Frontier and Performance Point



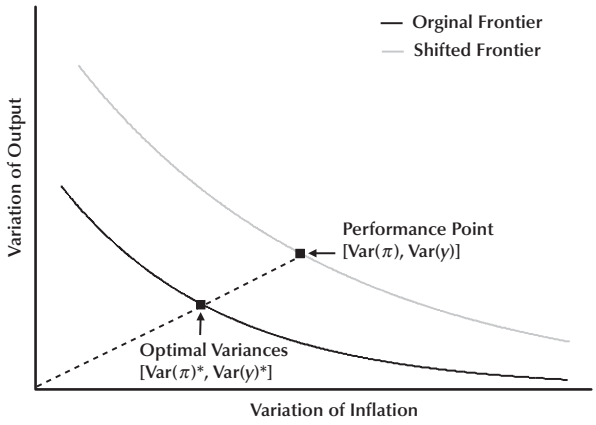
This trade-off allows us to construct an efficiency frontier for monetary policy that traces the points of minimum inflation and output variability. This is the curved line in Figure 1, known in the literature as the Taylor curve (Taylor, 1979). The location of the efficiency frontier depends on the variability of aggregate supply shocks—the smaller such variability, the closer the frontier will be to the origin. If monetary policy is optimal, the economy will be on this curve. The location of the economy on the frontier depends on the policymaker's preferences for inflation and output stability.

When policy is suboptimal, the economy will not be on this frontier. Instead, the performance point will be up and to the right, with inflation and output variability both in excess of other feasible points. Movements of the performance point toward the

[5] For a simple algebraic model and a discussion of the derivation of the output-inflation variability frontier, see Cecchetti and Ehrmann (2001).

Figure 2

Derivation of the Optimal Variances



frontier are an indication of improved policymaking.

We require measures of an economy's performance, in terms of output and inflation variability, as well as the distance of that point from the efficiency frontier. To compute these, we assume that the objective of the central banker is to minimize a weighted sum of inflation and output variability. This is the standard quadratic loss function used in most contemporary analyses of central bank policy. We can summarize this loss through the following specific representation:

$$(1) \qquad Loss = \lambda Var(\pi) + (1-\lambda) Var(y), \ 0 \le \lambda \le 1,$$

where π is inflation, y is output, and λ is the policymaker's preference parameter—Cecchetti and Ehrmann (2001) call this the policymaker's inflation variability aversion.

But measuring the loss associated with a particular performance point requires that we have an estimate of the preference parameter, λ. Our approach is to consider a set of plausible values of λ for each of the analyzed countries based on the estimates obtained elsewhere by Cecchetti and Ehrmann (2001) and Krause (2002). This procedure means that we do not have to identify a single value of this parameter for each individual country. In the following section, we show that our results are robust to this choice. With this in mind, we set λ equal to 0.8 for all countries, with the exception of Israel, Mexico, Chile, and Greece, for which we choose a value of 0.3. These four countries experienced very high levels of inflation during the 1980s, suggesting that inflation variability must have had a much lower weight in the policymaker's loss function.

Before we proceed with describing the measure of policy efficiency, we need to discuss how we derive the optimal variances of output and inflation. Beginning with Figure 1, we shift the efficiency trade-off homothetically outward until it passes through the performance point representing the observed variances of inflation and output. Figure 2 shows the original and shifted frontiers. Graphically, the optimal variances are at the intersection of the original frontier with a line from the origin to the performance point. Cecchetti et al. show with more detail how to derive these variances analytically.

We can now define the measures of performance and policy efficiency that we will use in our empirical computations. To compute macroeconomic performance, we combine the observed variances of output and inflation together to construct a single measure of stability. We define performance, P, as

$$(2) \qquad P = \lambda Var(\pi) + (1-\lambda) Var(y).$$

The lower P, the more stable the economy.

We gauge monetary policy efficiency by looking at how close the actual performance is to the performance under optimal policy. Policy *inefficiency* is measured by

$$(3) \qquad E = \lambda\left[Var(\pi) - Var(\pi)^*\right] + (1-\lambda)\left[Var(y) - Var(y)^*\right],$$

where $Var(\pi)^*$ and $Var(y)^*$ are the variances of inflation and output under optimal policy, respectively. The more efficient policymakers are at implementing the optimal policy, the closer E will be to zero.

Estimating the Efficiency Frontier

As we described above, in Cecchetti et al. we construct an efficiency frontier for the countries in the sample in order to compute macroeconomic performance and policy efficiency loss. The basic procedure is as follows. Beginning with the quadratic loss function representing trade-offs among combinations of inflation and output variability, we treat policy as a solution to a control problem in which the interest rate path is chosen to place the economy at the point on the variability frontier that minimizes the loss. Formally, we compute the policy reaction function that minimizes the loss, subject to the constraint that is imposed by the structure of the

economy. For a given loss function, with a particular weighting of inflation and output variability, we are able to plot a single point on the efficiency frontier. As we change the relative weight assigned to the variance of inflation and output in the loss function, we are able to trace out the entire efficiency frontier.

Our econometric procedure has two main steps. First, we estimate simple structural models of inflation and output for each of the 24 countries in our sample. Next, we describe the construction of the efficiency frontier from the model estimates. This will allow us to compute the macroeconomic performance and policy efficiency loss.

We consider linear two-equation systems for each country based on a dynamic aggregate demand/aggregate supply model. The basic model consists of the following two equations:

$$y_t = \sum_{l=1}^{2} \alpha_{1l} i_{t-l} + \sum_{l=1}^{2} \alpha_{1(l+2)} y_{t-l} + \sum_{l=1}^{2} \alpha_{1(l+4)} \pi_{t-1} + \alpha_{17} x_{t-1} + \varepsilon_{1t} \quad (4)$$

$$\pi_t = \sum_{l=1}^{2} \alpha_{21} y_{t-1} + \sum_{l=1}^{2} \alpha_{2(l+2)} \pi_{t-1} + \alpha_{25} x_{t-1} + \varepsilon_{2t}. \quad (5)$$

The first equation represents an aggregate demand curve. It relates (demeaned and detrended) log industrial production, y, to two of its own lags; to two lags of the nominal interest rate, i; to two lags of demeaned inflation, π; and to one lag of demeaned external price inflation, x. The second equation is an aggregate supply curve. Here, inflation is assumed to be a function of two of its own lags, representing inflation expectations, two lags of (demeaned and detrended) log industrial production, and one lag of demeaned external price inflation. The error terms ε_1 and ε_2 are assumed to be mean zero and constant variance.

We estimate equations (4) and (5) for each country separately using ordinary least squares.[6] The Durbin h test allows us to determine whether additional lags of the variables were required to correct for autocorrelation.[7] In some cases we also include dummy variables to account for currency crises, sharp recessions, or structural changes.

The next step consists of employing the estimated model to construct the efficiency frontier. We assume that the policymaker's objective is to minimize an objective function (given by the loss function in (1)) subject to the constraints imposed by the dynamic structure of the economy given by equations (4) and (5). This optimization allows us to obtain a pair of optimal variances of inflation and output for a given value of λ. By varying the λ over the interval [0.001, 0.999] with an increment of 0.001, we are able to trace out an entire frontier similar to the one in Figure 1.

Finally, given the values chosen for λ and the optimal variances for each country, we can compute the measures of interest.

Estimates of Macroeconomic Performance and Policy Efficiency Loss

We now look at the estimates of performance and efficiency loss for the 24 countries in the Cecchetti et al. study, using data for 1991:Q1–1998:Q4. The results are plotted in Figures 3A and 3B and the estimates of the measures are reported in Table A1 in the appendix.[8] For each country, the vertical height of the bar measures the performance loss, P. This is divided into two portions: (i) the minimal performance loss, which measures what would be attained if the economy were on its inflation-variability frontier, and (ii) the remainder, which measures policy inefficiency. The differences in scale require that we divide the countries into two groups: those with relatively stable performance in Figure 3A and those with higher output and inflation variability in Figure 3B.

Overall, the results suggest that there is high variation in both performance and policy efficiency. The Netherlands, for example, has the lowest value for both P and E, while Israel has the most inefficient policymakers and most volatile economy. There are also cases between these, such as Finland, where policy is efficient but the economy is relatively

[6] Since we are estimating a system of two equations separately, there might exist some cross-correlation between the error terms of the equations that can be exploited to obtain more efficient estimators with a system estimator such as seemingly unrelated regressions (SUR). To check whether the separate estimation of each equation is efficient relative to system estimation, we tested the contemporaneous correlation of the error terms of the two-equation model for each period in each of the countries in our sample. We were not able to reject the null hypothesis of zero contemporaneous correlation at a 10 percent level or higher in both periods for all countries with the exception of two. Still, in neither of these two cases are the SUR coefficients and standard errors significantly different from the ones obtained through the OLS estimation.

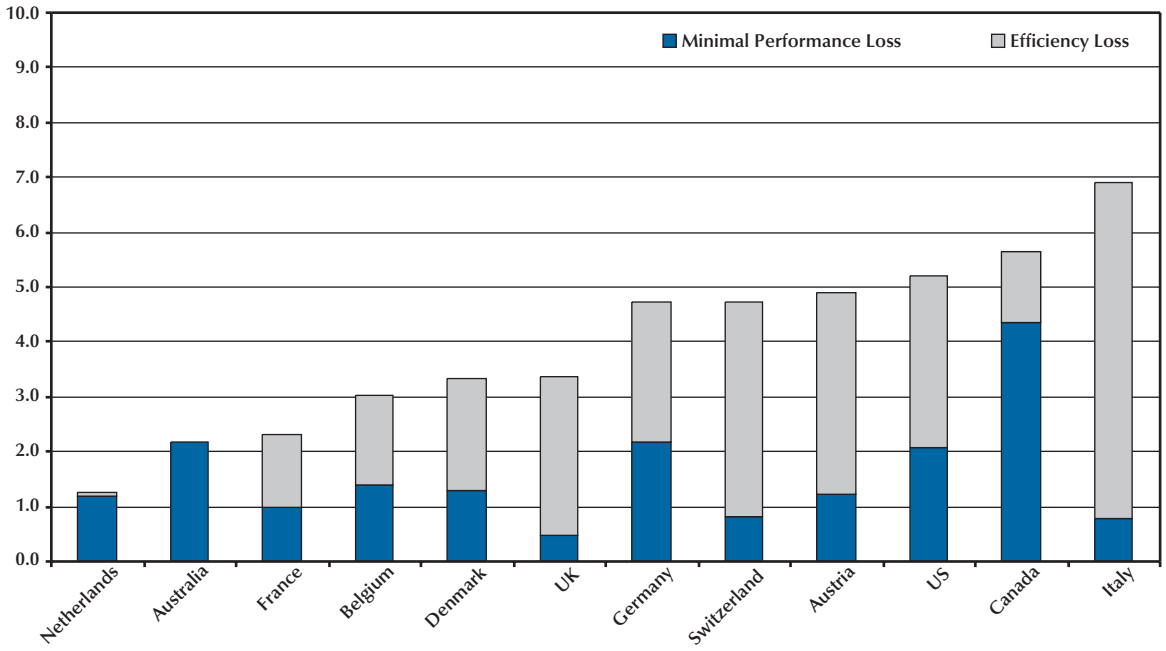
[7] We tested for nonstationarity of the error terms in both equations using the Phillips-Perron test. We were able to reject the null hypothesis of nonstationarity at the 1 percent significance level in all countries for both subperiods.

[8] Both the performance loss and efficiency measure have been scaled up by a factor of 100.

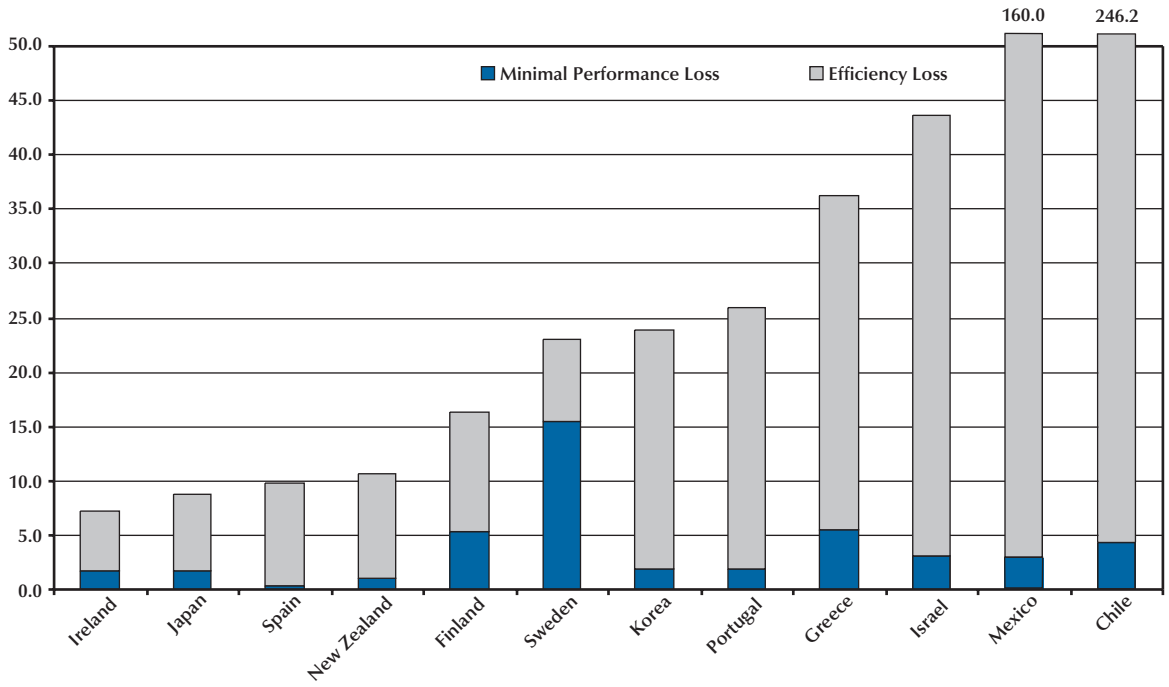
Figure 3

Macroeconomic Performance Loss

A.



B.



unstable, and Switzerland, where performance is good but policy is not.[9]

Our goal is to examine whether the cross-sectional variation in these measures of performance and policy efficiency can be explained by differences in central bank independence, accountability, transparency, and credibility. Before undertaking this task, we need to describe the data on monetary policy framework variables, which we do in the following section.

III. MEASURES OF MONETARY FRAMEWORK CHARACTERISTICS

In order to relate macroeconomic performance and policy efficiency to central bank features, we require quantitative measures of the several institutional characteristics of the central bank. For this purpose we employ the measures of central bank independence, accountability, and transparency derived by Fry et al. (2000) and based on survey information. We first describe these and then proceed to discuss our construction of a measure of policy credibility that is based on past inflation performance.[10]

Central Bank Independence

Fry et al. construct a weighted index for independence by studying the responses to five questions on their survey. These questions look at the following elements: how important is price stability as an objective; how important is the role of the central bank in choosing the levels of the target variable (goal independence) and the policy instrument (instrument independence); to what extent does the government rely on central bank financing; and how long is the term of office of the governor/chairman?

Central Bank Accountability

The Fry et al. survey looks at two main forms of accountability. First, it asks whether the policy contract between the government and the central bank incorporates a numerical target for the goal variable, what the role of the government is in setting this target, and which procedures take place if the target is missed. Second, accountability measures how the government and parliament monitor the central bank. The index of accountability is constructed by taking the average of these two measures.

Central Bank Transparency

To derive a measure of transparency or policy explanations, Fry et al. look at the responses to the degree and frequency at which each central bank provides reports on its policy decisions, assessments about the state of the economy, and public explanations of forecasts. The index of transparency is obtained as a simple average of these three criteria.

Central Bank Credibility

We now turn to the derivation of the credibility index. Cukierman and Meltzer (1986) define monetary policy credibility as "the absolute value of the difference between the policymaker's plans and the public's beliefs about those plans."[11] The further realized inflation is from the announced target level, the less credible is the policymaker. If the monetary authority has an explicit inflation target, credibility can be measured by the distance from the expected inflation to the target (Svensson, 1999).

Consistent with these suggestions, we construct an index of policy credibility that takes into account the deviations of expected inflation from the central bank's target level. In order to normalize this index between 0 and 1, we define it as

(6)
$$IC = \begin{Bmatrix} 1 & \text{if } E(\pi) \le \pi^t \\ 1 - \frac{1}{0.2 - \pi^t}\left(E(\pi) - \pi^t\right) & \text{if } \pi^t < E(\pi) < 20\% \\ 0 & \text{if } E(\pi) \ge 20\% \end{Bmatrix}.$$

The index of credibility takes a value of 1 if expected annual inflation is less than or equal to the target level of inflation, π_t, and it decreases linearly as expected inflation rises. If expected inflation is greater than 20 percent, we assign the index a value of 0.

Finally, to compute this index we assume that the target level for inflation is equal to 2 percent for all countries and we proxy $E(\pi)$ as the average realized inflation for the period between 1985:Q1 and 1989:Q4 for all 63 countries in our sample. The data on the index of credibility is presented in Table A2 in the appendix.

IV. EMPIRICAL RESULTS

We now turn to an examination of all of the information on performance, efficiency, and insti-

[9] For a more detailed discussion of these results, as well as an examination of changes in performance and policy efficiency over time, see Cecchetti et al. (2002).

[10] We report the values of these indices in Table A2 in the appendix.

[11] Cukierman and Meltzer (1986, p. 1108).

Table 1

Performance, Efficiency, and Monetary Policy Framework (Correlation Coefficients)

	Average inflation (1995-99)	Macro performance (1990-97)	Policy inefficiency (1990-97)
Independence	–0.129 (0.17)	0.072 (0.74)	0.055 (0.80)
Accountability	–0.093 (0.48)	0.019 (0.93)	0.012 (0.96)
Transparency	–0.349 (0.04)	–0.254 (0.24)	–0.257 (0.24)
Credibility	–0.571 (0.00)	–0.757 (0.00)	–0.753 (0.00)

NOTE: Better macroeconomic performance and more efficient policy are identified with values closer to zero, while higher independence, accountability, transparency, and credibility are identified with higher values. The heteroskedasticity-corrected p values are in parentheses.

tutional structure. We expect that countries with more independent, transparent, accountable, and credible central banks will in general exhibit better macroeconomic outcomes. We take this hypothesis to the data and consider the relationships between macroeconomic performance (as measured by *P* and by average inflation) and policy efficiency (measured by *E* and by policy framework variables described in the previous section). We look at both simple correlations and multivariate analysis.

Simple Correlations

Table 1 displays the simple correlations among the four indices of central bank framework and our measures of macroeconomic performance and policy efficiency, as well as average inflation for the period of 1995:Q1–1999:Q4.

First, we observe that there is a positive correlation between central bank independence and the performance and efficiency loss measures, while for the broader cross-section of countries independence is negatively correlated with average inflation. This relationship has been extensively documented for industrialized countries, and it is still present when considering transition and developing economies. Nevertheless, none of these correlations is significantly different from zero at even the 10 percent level.

Proceeding down the table, we see that the index of central bank accountability is negatively correlated with average inflation and positively correlated with performance and efficiency loss. But as with the case of independence, neither of these correlations is significant, suggesting that this particular characteristic of the monetary framework, at least by itself, does not play a crucial role in explaining the cross-country differences in inflation, performance, and policy efficiency.

Looking at the one-dimensional relationship with transparency, we see that all of the correlations are negative. The result for average inflation is also significantly different from zero at the 5 percent level. Furthermore, our point estimate of –0.35 in this case is basically indistinguishable from the correlation between average log inflation and the alternative (Guttman) index of transparency reported in Chortareas, Stasavage, and Sterne (2002).[12]

Finally, we find that the correlation between the index of credibility and the three outcome measures is negative and significant at the 1 percent level. This is our most clear result. Countries that maintained low inflation in the past are expected to exhibit lower current inflation and less variable inflation and output. Good policymaking is positively serially correlated.

Multivariate Analysis

We now turn to a simple multivariate analysis. Table 2 reports the results of regressing, simultaneously, average inflation, macroeconomic performance, and policy efficiency on the four monetary framework variables and compares these results with the ones arising from excluding the credibility index as an explanatory variable. All three regressions are dominated by the presence of the credibility measure, which enters with a negative coefficient and is estimated very precisely.[13] The coefficients

[12] Chortareas, Stasavage, and Sterne (2002) also use a larger data set, which includes 87 countries.

[13] This result is even sharper when we use the data on average inflation for the period 1990:Q1–1994:Q4 to construct the index of credibility. Under these circumstances, both the R^2 and the coefficients associated with credibility rise, giving further support to the argument that countries with high past inflation exhibit poor performance regardless of their framework.

Table 2

Performance, Efficiency, and Monetary Policy Framework (Regression Results)

	Average inflation (1995-99)		Macro performance (1990-97)		Policy inefficiency (1990-97)	
Intercept	0.289 (0.00)	0.222 (0.01)	0.439 (0.63)	0.514 (0.73)	0.545 (0.55)	0.619 (0.67)
Independence	0.003 (0.97)	0.026 (0.74)	0.970 (0.38)	–0.059 (0.97)	0.803 (0.47)	–0.206 (0.90)
Accountability	–0.062 (0.28)	–0.030 (0.60)	0.478 (0.37)	0.313 (0.72)	0.479 (0.38)	0.318 (0.71)
Transparency	–0.108 (0.23)	–0.217 (0.05)	–0.444 (0.17)	–0.563 (0.29)	–0.462 (0.16)	–0.579 (0.27)
Credibility	–0.172 (0.00)		–1.405 (0.00)		–1.378 (0.00)	
R^2	0.364	0.121	0.677	0.072	0.665	0.073
No. of observations	60	60	22	22	22	22

NOTE: Better macroeconomic performance and more efficient policy are identified with values closer to zero, while higher independence, accountability, transparency, and credibility are identified with higher values. The heteroskedasticity-corrected p values are in parentheses.

on the remaining three regressors are negative in only four of the nine cases, and they are all estimated very imprecisely, as indicated by the relatively high p values reported in Table 2. If we drop the credibility measure from the specification, then we observe, as expected, a sharp drop in the goodness of fit. The other variables remain insignificant, with the exception of transparency, which enters the regression of average inflation on the framework variables with a negative sign and a significant (to the 5 percent level) coefficient. These results provide further evidence supporting the view that central bank credibility—represented by past inflation performance—is the main determinant of current macroeconomic performance and policy efficiency.[14]

Since our results suggest that credibility and, to a somewhat lesser extent, transparency are the two factors that explain most of the cross-country variation in macroeconomic outcomes, it is interesting to ask how large the impact is. To address this, we calculate the extent to which changes in the levels of transparency and credibility translate into lower average inflation. That is, we find the inflation that would have had to take place (as a deviation from 2 percent) after these changes, holding output variation in the loss function constant. For the case of Spain, an increase in transparency from 0.59 to the sample median, 0.79, is equivalent to a drop of 0.53 percentage points in average inflation. An increase in credibility for the United Kingdom from 0.82 to 0.91 percentage points (estimated value for the United States and France) would represent a drop in average inflation of 1.19 percentage points.

Interpreting the Results

Our findings suggest that credibility is the primary factor explaining the cross-country variation in macroeconomic outcomes, trumping the contribution of the other framework variables. This result is consistent with Jensen's (2000) argument that a committed (i.e., credible) central bank will not necessarily provide economic agents with substantial information about the behavior of instruments and targets. He derives an optimal level of transparency, which will depend on the initial credibility of the bank and the amount of information available to the agents. The model suggests that a high degree of transparency need not always be an advantage to the central bank.

On the other hand, it is reasonable to believe that independence, accountability, and transparency actually lead to increased central bank credibility. Given that we lack a time-series for the data on the policy framework, we are unable to examine this claim head on. All we can do is see whether credibility is highly correlated with accountability, independence, and transparency. We find that credibility and transparency have a correlation of 0.31, but that credibility is virtually uncorrelated with the measures of accountability and independence.

Looking back at the performance and efficiency

[14] We also tested whether the policy framework variables were associated with the cross-country differences in the sacrifice ratio (which we approximate using the estimated efficiency frontier for 24 countries), but we failed to find any significant relationship.

measures plotted in Figure 3B, we see that Chile and Mexico are substantial outliers. This naturally leads us to ask whether our results are dominated by these two countries. Deleting them from the sample, we find that the general character of the results is largely unchanged. While coefficients on the other framework variables remain statistically insignificant, the coefficient associated with the credibility index changes from –1.405 to –0.429 in the macroeconomic performance regression (with the R^2 actually increasing from 0.677 to 0.811) and from –1.378 to –0.386 in the policy efficiency regression (with the R^2 rising from 0.665 to 0.852). The coefficients still remain significant at the 1 percent level.

V. CONCLUSIONS

This paper explores the empirical relationships between economic outcomes and the monetary policy framework. Our findings suggest that a better macroeconomic performance and more efficient policy are present in more credible and, to some extent, more transparent central banks. Independence and accountability, to the extent that we are able to measure them, do not seem to explain much of the cross-country variation in macroeconomic outcomes, either individually or in conjunction with other variables. Further exploration of the relationship of macroeconomic performance awaits new time-series data.

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Appendix

Table A1 presents the estimates for the measures of *macroeconomic performance* and *policy inefficiency* obtained by Cecchetti et al. (2002).

Table A2 reports the data on inflation and the monetary policy framework variables. *Average inflation* is obtained from the simple mean of quarterly data of consumer price index (CPI) inflation for the period 1995:Q1–1999:Q4, from the IFS statistics. The data for the indices used for *independence* and *accountability* are obtained from the weighted total scores in Tables A.5 and A.6 of Fry et al. (2000), respectively, while *transparency* is measured using the unweighted total score for explaining policy, presented in Table A.7 of Fry et al. Finally, the index of policy *credibility* is constructed as specified in Section III, using the average CPI inflation for the period between 1985:Q1 and 1989:Q4, from the IFS statistics.

Table A1

Macroeconomic Performance and Monetary Policy Inefficiency

Country	Macro performance (1991-98)	Policy inefficiency (1991-98)
Australia	0.0217	0.0001
Austria	0.0491	0.0369
Belgium	0.0301	0.0161
Canada	0.0566	0.0130
Chile	2.4625	2.4188
Denmark	0.0333	0.0202
Finland	0.1630	0.1103
France	0.0232	0.0134
Germany	0.0473	0.0254
Greece	0.3620	0.3062
Ireland	0.0716	0.0551
Israel	0.4360	0.4048
Italy	0.0689	0.0610
Japan	0.0880	0.0707
Korea	0.2383	0.2200
Mexico	1.6003	1.5711
Netherlands	0.0127	0.0008
New Zealand	0.1059	0.0957
Portugal	0.2598	0.2413
Spain	0.0971	0.0930
Sweden	0.2311	0.0757
Switzerland	0.0473	0.0391
UK	0.0338	0.0292
US	0.0521	0.0313
Average	0.2747	0.2479

NOTE: Better macroeconomic performance and more efficient policy are identified with values closer to zero.

Table A2

Average Inflation and Policy Framework Variables

Country	Average inflation (%) (1995-99)	Index of independence	Index of accountability	Index of transparency	Index of credibility
Argentina	0.77	0.79	1.00	0.53	0.00
Australia	1.97	0.73	0.83	0.78	0.68
Austria	1.38	0.68	0.67	0.27	0.99
Bahamas	1.32	0.39	1.00	0.50	0.83
Bahrain	1.08	0.54	0.75	0.18	1.00
Barbados	2.46	0.24	0.92	0.73	0.89
Belgium	1.45	0.77	0.33	0.68	0.98
Belize	1.66	0.43	0.42	0.48	0.97
Canada	1.61	0.91	1.00	0.79	0.87
Chile	6.04	0.93	0.17	0.83	0.00
China, P.R.	5.20	0.68	1.00	0.63	0.28
Croatia	4.53	0.79	0.83	0.42	0.00
Cyprus	2.62	0.77	0.58	0.48	0.93
Denmark	2.15	0.88	0.75	NA	0.87
Eastern Caribbean	2.17	0.49	0.92	0.48	0.98
Ecuador	33.14	0.93	0.75	0.59	0.00
Egypt	7.09	0.53	0.83	0.47	0.06
Fiji	3.26	0.73	0.17	0.64	0.78
Finland	1.07	0.91	0.92	0.74	0.84
France	1.24	0.90	0.83	0.53	0.91
Germany	1.31	0.96	0.17	0.70	1.00
Ghana	32.44	0.60	0.58	0.36	0.00
Greece	6.02	0.86	0.33	0.36	0.16
Hungary	18.85	0.86	0.83	0.49	0.51
Iceland	2.13	0.59	0.92	0.65	0.00
India	8.89	0.83	0.67	0.75	0.68
Indonesia	21.03	0.66	0.83	0.83	0.73
Ireland	1.95	0.87	0.83	0.78	0.90
Israel	8.22	0.66	1.00	0.68	0.00
Italy	2.97	0.88	0.58	0.81	0.77
Jamaica	14.19	0.39	0.42	0.65	0.33
Japan	0.41	0.93	NA	0.89	1.00
Jordan	3.39	0.74	0.75	0.60	0.72
Kenya	6.06	0.66	0.67	0.52	0.56
Korea	4.42	0.73	0.83	0.88	0.88
Kuwait	2.01	0.63	0.67	0.38	1.00
Malaysia	3.92	0.75	0.67	0.71	1.00
Malta	2.82	0.83	0.83	0.67	1.00
Mauritius	6.63	0.70	0.33	0.20	0.77

Table A2 cont'd

Average Inflation and Policy Framework Variables

Country	Average inflation (%) (1995-99)	Index of independence	Index of accountability	Index of transparency	Index of credibility
Mexico	24.67	0.82	0.92	0.69	0.00
Namibia	8.33	0.50	0.33	0.56	0.36
Netherlands	2.06	0.91	0.83	0.79	1.00
New Zealand	1.68	0.89	1.00	0.92	0.48
Nigeria	26.08	0.42	0.92	0.37	0.00
Norway	2.18	0.57	0.50	0.89	0.75
Peru	8.41	0.89	0.92	0.38	0.00
Poland	16.47	0.86	0.58	0.69	0.00
Portugal	2.90	0.85	0.83	0.78	0.41
South Africa	7.34	0.85	0.75	0.70	0.24
Sierra Leone	27.53	0.62	0.83	0.47	0.00
Singapore	0.97	0.90	0.25	NA	1.00
Spain	2.87	0.80	0.83	0.59	0.73
Sri Lanka	9.49	0.54	0.58	0.48	0.64
Sweden	0.77	0.97	0.83	0.95	0.80
Switzerland	0.80	0.90	0.17	0.86	1.00
Tanzania	17.12	0.60	0.92	0.51	0.00
Thailand	5.11	0.82	0.50	0.67	0.93
Tonga	2.86	0.52	0.00	0.30	0.46
Turkey	81.60	0.70	0.42	0.24	0.00
UK	2.79	0.77	1.00	0.94	0.82
Uruguay	21.54	0.70	0.83	0.04	0.00
US	2.36	0.92	0.83	0.95	0.91
Zambia	35.17	0.66	0.17	0.57	0.00

Commentary

K. Alec Chrystal

This paper builds on earlier work by Steve Cecchetti and his colleagues that looks at the institutional characteristics of central banks and the regimes they operate and analyzes their influence on macroeconomic performance. This is stimulating work that makes considerable progress in monetary policy analysis. It is also elegant in the sense that it makes a great deal of progress with simple tools logically applied. I have learned a lot from reading this paper and some earlier related work by the same authors and their collaborators.

The job of a discussant, of course, is to point out problems and limitations of the research. I cannot criticize much of the data on which the study is based, as it was collected by my former colleagues at the Bank of England; and I agree with the main conclusion of the current paper, which is that credibility matters a lot for monetary policy. However, I shall argue that the way in which credibility is measured leaves a lot to be desired, and so the main empirical result in the paper should be treated with some caution. There is, as usual, plenty of room for further work on this fascinating issue.

The current paper builds on measures of macro performance and efficiency derived in a previous paper (Cecchetti, Flores-Lagunes, and Krause, 2001 [CFK]). As the meaning and measurement of these terms bears directly on the results obtained in the current paper, it is worth discussing briefly what these concepts mean and how they are measured. "Macroeconomic performance" relates to whether a preference-weighted average of inflation and output variances has increased or decreased, i.e., in effect whether the Taylor curve has shifted closer to the origin. "Efficiency" relates to the extent to which a performance gain can be attributed to policy better offsetting demand shocks as opposed to being a result of reduced variance of supply shocks.

CFK estimate a two-equation linear aggregate supply/aggregate demand (AS/AD) model for 23 countries and then use the estimated structure in a Theil-Tinbergen type policy optimization exercise to solve for the optimal policy rule. The optimum is compared with the actual outcome; by comparing 1980s and 1990s results, they derive estimates of the extent to which the improvements in actual performance can be attributed to more efficient policy and the extent to which they are due to reduced supply shocks. The conclusion according to the CFK estimates is that nearly all countries in their sample showed an improvement in performance between the 1980s and 1990s, and the bulk of this improvement was due to increases in the efficiency of policy rather than to reductions in supply shocks.

These are interesting and important results. But as with all empirical work there are some questions one can ask about implicit assumptions on which the key results depend. My first question relates to time periods. The authors have compared two time periods of equal length, but these represent different and partial phases of two different business cycles. Roughly speaking the 1980s cycle is measured trough to peak while the 1990s cycle is close to being peak to peak (or at least peak to more then half way back up). This distinction may not be critical, but it would surely be desirable when the ultimate historical research on these topics is done to compare complete cycles in terms of policy impacts.

My second question relates to the spillovers between countries. Is it really a coincidence that most countries have improved their macroeconomic performance at the same time? It could be that central bankers have all been on the same courses or attended the same conferences where they have learned the secrets from their colleagues in other countries. However, it could also be that successful stabilization policy in one country makes policy much easier for neighboring countries. This does not diminish the achievement of better performance but it does affect who should get the credit. CFK do make allowances for external prices in their empirical models, but there are no other ways in which it is apparent that a more stable external environment makes domestic policymaking easier.

This point is given greater force when one looks at the countries with the lowest policy inefficiency loss in the 1990s (as shown in Appendix Table A1 of Cecchetti and Krause as derived from the estimates in CFK). Five of the six most efficient central banks are those of the Netherlands, Belgium, Denmark, Ireland, and France, all members of the exchange rate mechanism (ERM) with mutually pegged exchange rate bands. In the cases of France, the Netherlands, and Belgium especially, these were pegged in a narrow fluctuation band and thus they had minimal

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discretionary ranges for domestic monetary policy. Since they were not free to alter monetary policy to offset demand shocks, what should we make of this result? Certainly we could not conclude that it was the optimal manipulation of the domestic policy interest rate that delivered the efficient outcome, since policy rates in these countries were focused on the exchange rate target rather than domestic aggregate demand or inflation.

So how can we claim that policy was efficient if there was no room for activist policy? Surprisingly, CFK do not comment on this outcome. It could be that the optimal policy is indeed to tie the hands of the authorities, but then it would be hard to argue that they were being efficient in offsetting demand shocks when they have no way of doing so. Could it be instead that a pegged exchange rate regime has some role in reducing shocks? If so, how can we explain the improvements in policy outcomes in those countries that had pegged rates in both the 1980s and the 1990s? An alternative interpretation for the European Monetary Union (EMU) member countries is that it was German monetary policy that improved between the 1980s and 1990s and by pegging to the Deutsche mark they imported this policy gain. This of course requires us to alter the analysis of each country optimizing its policy in isolation, and it raises the further question of how policy could be more efficient in the five countries pegged to the Deutsche mark (mentioned above) than in Germany itself.

What is new in the paper presented to this conference (Cecchetti and Krause, 2001) is the bringing together of the results from CFK with some measures of institutional differences between central banks. Three of these measures—independence, accountability, and transparency—are taken directly from indexes constructed by Maxwell Fry et al. (2000) for the Bank of England study on which this paper draws. A new measure of credibility is constructed, and, since this (and the results associated with it) is the key innovation of the paper, I shall concentrate on discussing this variable. It turns out that, of the other factors, transparency is the only one that has even marginal significance.

The credibility index is based on actual average inflation in the period 1985:Q1 to 1989:Q4. Credibility is zero if inflation in this period exceeded 20 percent and it is unity if it was less that 2 percent. Otherwise, credibility is assigned a number between 0 and 1 depending on where inflation sits in the range of 2 to 20 percent.

The key results are (i) that, for those 23 countries studied in CFK, the measure of credibility is highly correlated (negatively) with macroeconomic performance and with policy efficiency and (ii) that, for a larger sample of countries, credibility is the characteristic that most contributes to lower inflation in the 1995-99 period.

The key issue is whether we think this measure of credibility is itself credible. I do not. Why, for example, should the credibility of the U.K. Monetary Policy Committee (MPC) after 1997 be judged by inflation in the United Kingdom ten years before the MPC was established and even several years before inflation targeting was first contemplated? The answer surely is that it makes no sense at all.

It is no real surprise that macroeconomic performance and this measure of credibility should be highly correlated because credibility (by this measure) and performance are both related to the level of inflation—those countries with high inflation in the late 1980s will still have had relatively high inflation in the 1990s. Furthermore, the fact that this "credibility" (as measured by the inflation of the late 1980s) appears to cause lower inflation in the late 1990s could simply mean that that inflation is autocorrelated—high-inflation countries in the late 1980s are still, on average, high-inflation countries in the late 1990s. Two particular countries stand out as being clearly misrepresented by this credibility measure. The first is Indonesia, which is rated as having high credibility on the basis of its relatively low inflation in the late 1980s. But could there be any country with lower credibility after 1997? The other is Chile, which managed a highly credible (and creditable) disinflation in the late 1990s yet is accorded zero credibility on the basis of its high inflation in the late 1980s.

Another obvious point is that virtually no country had an inflation-targeting regime in the late 1980s, and yet many did have such regimes by the late 1990s. How can it make sense to judge the credibility of these new regimes from the outcomes in some earlier regime?

So how should we measure credibility? I would suggest that it has to be some measure that can be taken within the period of operation of a regime rather than from earlier periods. Also it cannot be based purely upon economic outcomes because that fails to identify the separate effects of beliefs and actions. In an inflation-targeting regime, credibility must surely be measured by the deviations between expectations of inflation and the stated

target. These expectations could be measured either from expectation surveys or from inflation expectations implied by comparisons between nominal and indexed bonds. Of course these measures are not available for many countries. But this does not alter the fact that using actual inflation from some time ago doesn't do it. Any measure based upon inflation outcomes in backward-looking data fails to identify the separate influences of credibility, policy actions, shocks, and history.

Any convincing attempt to measure the impact of credibility must also surely do more than look at a one-shot cross section of countries. In the paper under discussion it is just about acceptable to calculate policy efficiency in a first stage and then see if it correlates with "credibility" later. However, in a panel study in which credibility within individual countries was allowed to evolve over time, it would be important to calculate efficiency conditional on credibility. Only this way could we potentially answer the most interesting question relating to successful monetary policies: To what extent was the actual policy outcome achieved due to the interest rate changes themselves and to what extent was it due to the credibility of the authorities? It is no great surprise to find that in a one-off cross section the countries that had the best macro performance (lowest weighted combination of inflation and output variance) also had the most efficient policy (closest outcome to the optimum) and the most credible regimes. However, we cannot say from this work whether credibility was a by-product of the good policy outcome or whether credibility helped produce it.

One argument in defense of the specific measure of credibility used by Cecchetti and Krause might be that, because it is measured prior to the years in which the inflation impact and policy efficiency are estimated, then it must be credibility that causes the outcomes and not vice versa. However, this is not very convincing because most of the leverage in the regressions reported (in column 1 of Table 2 of Cecchetti and Krause) is achieved by the extreme classification (in effect a 0,1 dummy variable) of totally credible and totally incredible countries, and most who fit these extreme categories would continue to be in the same class in the late 1990s as they were in the 1980s. For all of such countries we cannot say that their better policy outcome was due to credibility because their credibility was identical in both decades (according to the measure used in this study). At best we can only attribute credibility as the cause of an improved policy outcome where some *increase* in credibility has been demonstrated. And a measurement exercise along these lines has not been attempted; we only have an index of credibility at one point in time. Credibility surely does matter, but more work needs to be done to answer the question: How much?

So why am I persuaded that credibility matters while being skeptical about the apparently strong results achieved by Cecchetti and Krause? As I have stressed, the doubts about the Cecchetti and Krause results relate to the way they measure credibility. My belief that credibility must matter comes from a related perspective on the same issue. Is the macroeconomic performance of the 1990s superior to that of the 1980s simply because the monetary authorities learned how to pull the strings of the monetary puppet show in a more timely and accurate manner than their predecessors? The order of magnitude of interest elasticities that come out of most macro models makes it difficult to conclude that interest rate decisions more accurately offset demand shocks, and so central bankers just learned to be better optimal controllers. The Bank of England model, for example, suggests that a 100-basis-point change in the official rate today will have a 30-basis-point effect on output growth after about one year and a 30-basis-point effect on inflation after about another year. It is highly implausible that the relatively modest official rate changes we have seen in the last decade could have been sufficient to control the aggregate economy if the demand and supply shocks had been of similar magnitudes to those experienced in earlier periods.

A much more likely explanation is that, at the world level, most aggregate demand and supply shocks are endogenous and influenced by the policy regime. The greater monetary policy credibility across the world (but especially in major countries) has significantly reduced the demand and supply "shocks" to which monetary authorities have to react. This has meant that the macro outcome has been improved even though the policy responses (in terms of interest rates changes) needed to achieve this outcome have been relatively modest.

Some might call this the "Greenspan effect." U.S. inflation has stayed under control even at a high level of activity because agents have confidence that the FOMC, and Chairman Greenspan in particular, has things under control. Surely this belief is not based solely on the direct effects of specific policy rate decisions and the fact that they worked in some

mechanistic way. Rather, it is based on the self-fulfilling prophesy—if enough people believe that the Fed will successfully stabilize output and inflation, that will generate the desired outcome on its own irrespective (almost) of what the Fed actually does.

Some day the world will find out if there really is a "Greenspan effect." I hope that we will not settle this issue for many years yet. Good health, Mr. Chairman.

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Market Anticipations of Monetary Policy Actions

William Poole, Robert H. Rasche, and Daniel L. Thornton

The purpose of this paper is to investigate the extent to which market participants anticipate Federal Reserve policy actions. The topic is central to macroeconomics. Since the early 1970s theorists have emphasized that a complete model of the economy requires a full specification of the behavior of policymakers. Otherwise, there is no way to model the expectations upon which private agents base their decisions.

The recent trend in monetary policy has been toward greater transparency, accountability, and credibility. This trend is largely explained by two ideas. First, the economics profession has accepted the proposition that monetary policy is the fundamental determinant of inflation in the long run.[1] Second, central bank credibility and clear market expectations about monetary policy are critical to policy success.[2]

The key theoretical development in this context was the application of rational expectations to macroeconomics and the statement of the famous Lucas critique. Lucas (1976) argued that the economy and policymakers are interdependent. Specifically, the public forms expectations of the dynamic feedback rule that policymakers follow to implement policy. This line of argument led naturally and immediately to the distinction between expected and surprise policy actions and a number of papers exploring their different effects on the economy.[3] For example, the more transparent the central bank, the less likely that it will be able to institute a surprise inflation to temporarily raise output growth.

Our purpose is not to add to the extensive theoretical literature, but instead to document in considerable detail the extent to which U.S. monetary policy has become increasingly open and transparent. The trend toward greater transparency has been especially evident in recent years.[4] In 1994, the FOMC began the practice of announcing policy actions immediately upon making them, and in 1995 the practice was formally adopted.[5] Since August 1997 the FOMC has included a numeric value of the "intended federal funds rate" in each directive. Since May 1999 a press statement has been released at the conclusion of every meeting. These press statements initially included a numeric value for the "intended federal funds rate" and a statement of the "policy bias."

In February 2000 the FOMC replaced the "policy bias" in the Directive that had been used since February 1983 with a statement of the "balance of risks."[6] In this statement the FOMC indicates its beliefs about how the risks of heightened inflation pressure and economic weakness are balanced over the foreseeable future. The new language was not intended to indicate the likely direction or timing of future policy moves.

These moves toward greater openness and transparency should have increased the ability of markets to anticipate policy actions. Poole and Rasche (2000) and Kuttner (2001) used data from the federal funds futures market to estimate the extent to which the market has anticipated the Fed's actions. While their methodologies differ slightly,

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[1] There is a continuing debate, however, about exactly how central banks control the long-run inflation rate and the relative importance of money. For further discussion, see McCallum (2001).

[2] In the final analysis, credibility is earned—central banks will be known by their actions, not by their words. The Swiss National Bank and the Bundesbank had considerable credibility because they kept the inflation rate low. See Meyer (2001) for a discussion of the need to earn credibility.

[3] A number of arguments have been advanced for why only surprise policy actions matter. Recently, Woodford (2001) presented arguments against several of these propositions. Indeed, he shows that in models with forward-looking expectations, what matters is the market's expectation of future policy. The remaining argument against expected policy having real effects occurs if prices adjust very rapidly to expected policy actions. In such an environment, policymakers would be unable to change the stock of real money and, consequently, unable to affect any real variable. For a recent attempt to differentiate empirically between the effects of expected and unexpected policy actions, see Hoover and Jorda (2001).

[4] In its landmark Freedom of Information Act case (Merrill vs. FOMC) that was argued before the U. S. Supreme Court in 1976, the Fed vigorously defended the need for secrecy. See Goodfriend (1986) for a discussion of the Merrill case and the Fed's arguments.

[5] For a detailed history of the Fed's disclosure practice, see Rasche (2001).

[6] See Thornton and Wheelock (2000) for a detailed analysis of the policy bias statement.

both looked at the reaction of the federal funds futures rate on days when the Fed changed the funds rate target; in this way, they estimated the extent to which the market was surprised by Fed actions. The expected target change is obtained by subtracting this estimate from the actual target change. These measures were then used to estimate the response of market rates to unexpected changes in policy. Both analyses find that Treasury rates responded significantly to unexpected target changes, but not to expected target changes.

This paper extends this literature in several important directions. First, because this methodology requires that market participants know that the Fed has changed the funds rate target, we perform the analysis separately over the two periods: pre-1994 and post-1993. (Pre-1994 refers to the period before the February 4, 1994, FOMC meeting; post-1993 refers to the period after that meeting.) As of February 4, 1994, there is no doubt that the market has been aware each time the target was changed because each change has been announced. Before 1994 the market's knowledge of Fed actions cannot be taken for granted. Consequently, we undertake a detailed analysis of what the market knew about Fed policy actions before 1994 to determine instances when market participants were and were not aware that the target had changed.

Second, we show that the Poole/Rasche and Kuttner methodology eliminates part, but not all, of the measurement error associated with identifying unexpected changes in the funds rate target. Failure to account for the remaining source of measurement error results in a downward bias in the estimate of the response of the Treasury rates to unexpected target changes. We implement an errors-in-variables estimator to correct for this bias.

Third, we attempt to identify the extent to which market participants were surprised by the Fed's *inaction*. That is, we identify dates when the market expected the Fed to act but no action was taken. This is particularly relevant for the post-1993 period. Given the FOMC's practice since 1993 of changing the target primarily at regularly scheduled meetings, it is reasonable to assume that there may have been instances when the market was expecting an action that the FOMC did not take. The absence of action may have prompted market participants to revise their expectation for the future funds rate.

Fourth, we investigate how far in advance the market appeared to correctly anticipate a policy action. The Poole/Rasche and Kuttner methodology indicates only whether the market anticipated the Fed's action at the time the action was taken; it does not provide information about how far in advance the market expected the action. This measurement required a detailed analysis of what the market expected and the behavior of longer-term federal funds futures rates.

Finally, we provide additional evidence that the recent trend toward greater transparency has significantly increased market participants' ability to anticipate Fed actions.

IDENTIFYING UNEXPECTED MONETARY POLICY ACTIONS

One problem in estimating the response of the economy to exogenous policy actions of the Fed has been that it has been difficult to isolate a variable that measures such actions. The search for a single measure of exogenous Fed policy actions has been hampered by the fact that the Fed has changed its emphasis in conducting monetary policy over the years.

The practice of changing operating procedures, and in some instances changing policy objectives, combined with the lack of transparency about either the Fed's objectives or its operating procedure makes it very difficult to isolate one variable that reflects Fed policy actions. It is hardly surprising that a number of variables—growth rates of monetary and reserve aggregates, changes in the discount rate, and short-term interest rates, particularly the overnight federal funds rate—have been used as measures of Fed policy actions.

Knowing the Fed's policy instrument is an important element for assessing the effect of monetary policy actions, but it is not the only element. If markets are efficient, anticipated policy actions are already reflected in economic variables—markets respond only to unexpected policy actions. To identify the effect of policy actions on the economy, the observed policy instrument must be partitioned into its expected and unexpected components. Failure to distinguish between expected and unexpected policy actions gives rise to a measurement problem, which biases downward the estimated response of economic variables to a change in the policy instrument. To correctly assess the impact of policy actions, then, the policy instrument must be known, observed, and partitioned into its expected and unexpected components.

There is little difficulty in identifying policy

actions since the late 1980s. For one thing, the Fed has explicitly targeted the federal funds rate during this period and there is evidence that the market was aware that the Fed targeted the funds rate as early as 1989. In addition, in October 1988 the Chicago Board of Trade began trading federal funds futures contracts. A federal funds futures contract is a bet on the average effective federal funds rate for the month in which the contract matures. Consequently, the federal funds futures rate reflects the market's expectation for the average level of the federal funds rate for that month. In this environment, the federal funds futures rate is a nearly ideal measure of the market's expectation of Fed policy. To illustrate, let fff_t^h denote the rate on the h-month federal funds futures contract on day t. Note that

$$(1) \qquad fff_t^h \equiv (1/m)\sum_{i=1}^{m} E_t ff_i^h ,$$

where ff_i^h denotes the federal funds rate on day i of the hth month, E_t denotes the expectation on day t, and m denotes the number of days in the month.

Now assume that the Fed is targeting the federal funds rate and that the funds rate stays very close to the target, i.e.,

$$(2) \qquad ff_t = ff_t^* + \eta_t ,$$

where ff_t^* denotes the Fed's target for the federal funds rate on day t and η_t denotes a mean zero, but not necessarily i.i.d., random variable.[7] Substituting (2) into (1) yields

$$(3) \qquad fff_t^h \equiv (1/m)\sum_{i=1}^{m} E_t ff_i^{*h} .$$[8]

On day t, the change in the h-month federal funds futures rate would be

$$(4) \qquad \Delta fff_t^h \equiv (1/m)\sum_{i=1}^{m} (E_t ff_i^{*h} - E_{t-1} ff_i^{*h}) .$$

Suppose that on day t there is a change in the intended funds rate that is expected to persist for h months or longer. If market participants correctly anticipate both the timing and the magnitude of the Fed's action, the h-month-ahead federal funds futures rate would not respond to the action, i.e., $\Delta fff_t^h = 0$. The change in the h-month-ahead federal funds futures rate on days when the market knows that the Fed has changed its funds rate target is a measure of the unexpected change in the target, so long as the new target is expected to persist for the term of the futures contract. The expected target change can be calculated by subtracting this number from the actual target change.

Poole/Rasche and Kuttner use this procedure to identify unexpected policy actions. Poole and Rasche use the change in the 1-month federal funds futures rate on the day the target was changed. On the first day of the month fff_{t-1}^1 is replaced by the futures rate on the 2-month contract for the last day of the previous month.

In contrast, Kuttner estimates the unexpected target change using the current month's futures rate contract. Specifically, Kuttner's estimate of the unexpected target change is

$$(5) \qquad \Delta ff_t^{*u} \equiv \frac{m}{m-t}(fff_t^0 - fff_{t-1}^0),$$

where fff_t^0 is the value of the current month's federal funds futures rate on the tth day of the month and m is the number of days in the month. On the first day of the month, fff_{t-1}^0 is replaced by the futures rate on the 1-month contract on the last day of the previous month. On the last three days of the month, Kuttner uses the Poole/Rasche measure of the unexpected target change.

Knowledge of Fed Actions

These measures presume that market participants are aware of the target change. If the market participants are unaware that the target has changed, expectations for the funds rate would not necessarily reflect expectations for the Fed's policy instrument. Even if market participants were aware that the Fed had taken some policy action, evidenced, for example, by a change in the discount rate, the change in the federal funds futures rate would not necessarily reflect the "unexpected change in the funds rate target."

Likewise, if market participants do not know that the target has changed on a particular day, that day's change in the federal funds futures rate could not measure the unexpected change in the funds rate target. Indeed, on such days the change in the futures rate would normally be relatively small, which might be interpreted as the market having expected the target change. In truth, however, market participants would be simply unaware that the target had changed.

After 1994, knowledge of FOMC actions is not an issue. As previously stated, at its February 4, 1994,

[7] There is some well-documented persistence in deviations of the funds rate from the funds rate target. For example, see Taylor (2001).

[8] This and subsequent analyses ignore the possibility of a small premium in the futures market, documented by Robertson and Thornton (1997), because any such premium is so small that its existence would have a negligible impact.

meeting, the FOMC began the practice of announcing target changes immediately.[9] Knowledge of target changes before 1994, when target changes were not announced, is problematic. The process of knowing when the target was changed was further complicated by the fact that during this period most target changes were made between, rather than at, FOMC meetings. Furthermore, until late 1989 (when the Fed appears to have adopted the practice of changing the target only in multiples of 25 basis points), target changes of various amounts smaller than 25 basis points were common.

THE MARKET REACTION TO UNEXPECTED TARGET CHANGES—POST-1993

In this section we estimate the response of market rates to unanticipated changes in the funds rate target. We begin by analyzing the post-1993 period. The policy action on February 4, 1994, is excluded from our analysis because this is the first time that the FOMC announced its decision. Since there was no information prior to the conclusion of that meeting to indicate that such an announcement would be forthcoming, market reaction was conditioned on less information than at subsequent meetings.

To estimate the response of various Treasury rates to changes in the funds rate target, Poole/Rasche and Kuttner estimated the equation

$$\Delta i_t = \alpha + \beta_1 \Delta ff_t^{*e} + \beta_2 \Delta ff_t^{*u} + \varepsilon_t, \tag{6}$$

where Δi_t denotes the change in the selected Treasury rate and Δff_t^{*e} denotes the expected change in the funds rate target, i.e., $\Delta ff_t^{*e} = \Delta ff_t^{*} - \Delta ff_t^{*u}$.

Ordinary least-squares (OLS) estimates of β_1 and β_2 are biased because the measures of the unexpected target change suffer from measurement error. The measurement error arises because each day markets process information that comes in various forms. While special attention is paid to *headline news*—reports of major government statistics, announcements of funds rate target changes, etc.—market participants process information from a variety of other sources that are less easily identified. Hence, federal funds futures rates change even on days when there is no headline news or a target change. Such ambient news is included in the Poole/Rasche and Kuttner measures of the unexpected change in the funds rate target.

We adjust for the errors-in-variable bias using a classic econometric approach. It is convenient to rewrite (6) so there is only one variable that is measured with error:

$$\Delta i_t = \alpha + \beta_1 (\Delta ff_t^{*} - \Delta ff_t^{*u}) + \beta_2 \Delta ff_t^{*u} + \varepsilon_t, \tag{7}$$

which simplifies to

$$\Delta i_t = \alpha + \beta_1 \Delta ff_t^{*} + (\beta_2 - \beta_1) \Delta ff_t^{*u} + \varepsilon_t. \tag{8}$$

Classic Errors-in-Variables Model

Errors-in-variables bias arises when one of the variables is measured with error. To illustrate the problem and the corresponding errors-in-variables estimation, assume that

$$\Delta ff_t^{*um} = \Delta ff_t^{*u} + u_t, \tag{9}$$

where Δff_t^{*um} is an estimate of the true unexpected change in the funds rate target and u_t is a random measurement error that is uncorrelated with Δff_t^{*u}. Substituting (9) into (8) yields

$$\begin{aligned} \Delta i_t &= \alpha + \beta_1 \Delta ff_t^{*} + (\beta_2 - \beta_1) \Delta ff_t^{*um} - u_t + \varepsilon_t \\ &= \alpha + \beta_1 \Delta ff_t^{*} + (\beta_2 - \beta_1) \Delta ff_t^{*um} + \varpi_t. \end{aligned} \tag{10}$$

It is clear from (10) that Δff_t^{*um} is negatively correlated with ϖ_t, which will bias the estimate of $(\beta_2 - \beta_1)$ down. The classic errors-in-variables estimator makes use of the assumptions that $Eu_t = E\varepsilon_t = 0$ and $Eu_t\varepsilon_t = 0$. Under these assumptions, the covariance between $(\beta_2 - \beta_1)\Delta ff_t^{*um}$ and ϖ_t is $-(\beta_2 - \beta_1)\sigma_u^2$, where σ_u^2 is the variance of the measurement error.[10]

Identifying Ambient Variation in the Futures Rate

The application of the classic errors-in-variables estimation technique requires a measure of the variance of the shock associated with the ambient news. We accomplish this by identifying all of the policy *events* since 1994. A policy event is either a meeting of the FOMC or an intermeeting target change. During this period all but four of the target changes occurred at regularly scheduled FOMC meetings. There were 62 such events from March 1994 through May 2001. We then read the front page and the *Credit Markets* column of the *Wall Street Journal* (*WSJ*) at least two days before each of these events to infer what the market anticipated would happen on "event days."

[9] The FOMC formally adopted this practice as a procedure at its January-February 1995 meeting.

[10] For more details, see Johnston (1963, pp. 168-70).

On meeting days when the target was not changed, we concluded that the market anticipated that no action would be taken if the commentary suggested that market analysts overwhelmingly believed that no action would be taken. We inferred that the market anticipated no action when the *WSJ* reported there was a "consensus" or "unanimity" among market analysts.

When the funds rate target was changed, we required market analysts to correctly anticipate the magnitude of the target change. In many cases the *WSJ* reported the results of a survey. In these instances, we inferred that the market correctly anticipated the FOMC's action if more than three-fourths of the survey respondents correctly predicted the action.

This procedure resulted in the contingency table shown in Table 1. The dates for each of these groups and the corresponding Poole/Rasche and Kuttner shock measures are presented in Table 2.[11] Of the 62 events since March 1994, we conclude the market fully anticipated 44. For most of these events the FOMC did not change the funds rate. On only four occasions when there was no target change did we conclude the market was surprised. The target was changed 24 times during this period. We conclude market participants were surprised on 14 of these occasions.

Our classification using the *WSJ* is generally supported by the shock measure. There are only two occasions when the Poole/Rasche shock measure was larger than 5 basis points when our reading of the *WSJ* indicated that the market expected the FOMC's action. On both of these occasions, the target was changed. Moreover, when our reading of the *WSJ* indicated that the market was surprised by the action, the Poole/Rasche shock measure is larger than 5 basis points on all but three occasions. Market participants appear to have been surprised by all four of the intermeeting target changes. Indeed, three of the four largest shocks by either measure occurred on these days. This suggests that, while the market may be able to anticipate the direction and size of the next target change, predicting the timing of an action is difficult unless the FOMC follows a rule, such as only adjusting the funds rate target at regularly scheduled meetings.

The Results

The variance of the observed change in the 1-month federal funds futures rate for the 44 events in the second row of Table 1 is our estimate of σ_u^2, the variance of the measurement error. OLS estimates and estimates obtained using a classic errors-in-variables estimation technique (EV) are presented in Tables 3 and 4 for the post-1993 period using the Poole/Rasche and Kuttner shocks, respectively. Not surprisingly, the OLS estimates suffer from errors-in-variables bias. In all cases, EV estimates of β_2 are larger than the corresponding OLS estimates. The response of these rates to target shocks is larger with the Poole/Rasche measure than with the Kuttner measure, but the differences are generally small. Figure 1, which shows the two measures of target shocks, reveals that there is close correspondence between these measures.[12] Hence, it is hardly surprising that these measures yield very similar results. As a result, only the Poole/Rasche shock will be presented in the remainder of the paper.

Table 1

Contingency Table of Anticipated and Unanticipated Events Obtained from the *Wall Street Journal*

	No target change	Target change	Total
Surprise	4	14	18
No surprise	34	10	44
Total	38	24	62

Do Markets Respond to Expected Target Changes?

One unexpected result is the finding that the 3-month rate responds significantly to actual target changes, suggesting that the market responds to expected changes. The estimated coefficient on the target change in the regression for the 3-month rate is statistically significant at the 5 percent level. This result is at odds with the efficient markets hypothesis and with Poole/Rasche and Kuttner, who found that markets did not respond to anticipated target changes. It is also at odds with our findings (presented in the next section) for the pre-1994 period.

Kuttner (2001) reports a similar result when he used monthly average data. Specifically, he found that both the 3- and 6-month T-bill rates responded significantly to his measure of the surprise target

[11] As Kuttner (2001) has noted, the change on October 15, 1998, was announced at 3:15 p.m. Eastern time, after the markets closed. Consequently, for the purpose of the empirical analysis, this change is dated as October 16.

[12] The simple correlation between these measures is 0.98.

Table 2

Dates and Poole/Rasche and Kuttner Shock Measures Corresponding to Table 1

Date	Poole/Rasche	Kuttner	Figure reference number
Surprise/no target change			
9/27/94	–0.08	–0.20	Figure 7
12/20/94	–0.11	–0.17	Figure A1-A
9/24/96	–0.13	–0.12	Figure 6
5/20/97	–0.09	–0.11	Figure A1-B
Surprise/target change			
3/22/94	–0.04	–0.03	Figure 4
4/18/94*	0.10	0.10	Figure 2
5/17/94	0.05	0.13	Figure 3
8/16/94	0.10	0.14	Figure A2-A
11/15/94	0.09	0.14	Figure A2-B
7/06/95	–0.07	–0.01	Figure A2-C
12/19/95	–0.11	–0.10	Figure A2-D
1/31/96	–0.07	–0.07	Figure A2-E
10/16/98*	–0.20	–0.26	Figure A2-F
11/17/98	–0.06	–0.06	Figure A2-G
11/16/99	0.08	0.09	Figure A2-H
1/03/01*	–0.29	–0.38	Figure A2-I
3/20/01	0.03	0.06	Figure 5
4/18/01*	–0.42	–0.43	Figure A2-J
No surprise/no target change			
7/06/94	–0.02	–0.05	NA
3/28/95	0.00	0.10	NA
5/23/95	0.01	0.00	NA
8/22/95	0.02	0.00	NA
9/26/95	0.04	0.00	NA
11/15/95	0.01	0.06	NA
3/26/96	0.01	–0.03	NA
5/21/96	0.01	0.00	NA
7/03/96	–0.05	–0.05	NA
8/20/96	–0.01	–0.04	NA
11/13/96	0.01	0.00	NA
12/17/96	0.00	0.10	NA
No surprise/no target change cont'd			
2/05/97	–0.02	–0.03	NA
7/02/97	–0.01	–0.02	NA
8/19/97	0.01	–0.01	NA
9/30/97	0.00	0.00	NA
11/12/97	–0.02	–0.04	NA
12/16/97	–0.01	–0.01	NA
2/04/98	0.01	0.00	NA
3/31/98	0.00	0.00	NA
5/19/98	–0.02	–0.03	NA
7/01/98	–0.01	–0.01	NA
8/19/98	0.00	0.00	NA
12/22/98	0.00	0.00	NA
2/03/99	–0.01	0.00	NA
3/30/99	0.00	0.00	NA
5/18/99	–0.01	–0.02	NA
10/05/99	0.00	–0.04	NA
12/21/99	0.00	0.03	NA
6/28/00	–0.02	–0.02	NA
8/22/00	0.00	0.00	NA
10/03/00	0.00	0.00	NA
11/15/00	0.00	0.00	NA
12/19/00	0.05	0.05	NA
No surprise/target change			
2/01/95	0.02	0.05	Figure A3-A
3/25/97	0.04	0.03	Figure A3-B
9/29/98	0.06	0.06	Figure A3-C
6/30/99	–0.04	–0.04	Figure 9
8/24/99	0.03	0.02	Figure 10
2/02/00	–0.04	–0.05	Figure A3-D
3/21/00	–0.01	–0.03	Figure 8
5/16/00	0.04	0.05	Figure A3-E
1/31/01	0.00	0.00	Figure A3-F
5/15/01	–0.07	–0.08	Figure A3-G

NOTE: *Indicates an intermeeting target change.

Table 3

OLS and EV Estimates of the Response of Treasury Rates to Target Surprises Using the Poole/Rasche Measure (Post-1993)

$$\Delta i_t = \alpha + \beta_1 \Delta ff_t^* + (\beta_2 - \beta_1)\Delta ff_t^{*u} + \varepsilon_t$$

	OLS				EV			
Rate	α	β_1	β_2	$\bar{R}^2/se$	α	β_1	β_2	$\bar{R}^2/se$
$\Delta tb3$	–0.112 (0.01)	0.083 (0.03)	0.757 (0.24)	0.600/0.086	–0.122 (0.01)	0.071 (0.03)	0.808 (0.28)	0.597/0.086
$\Delta tb6$	–0.035 (0.01)	0.056 (0.03)	0.586 (0.18)	0.531/0.074	–0.035 (0.01)	0.045 (0.04)	0.635 (0.20)	0.528/0.074
$\Delta tb12$	–0.035 (0.01)	0.034 (0.03)	0.502 (0.17)	0.384/0.080	–0.035 (0.01)	0.024 (0.03)	0.546 (0.19)	0.381/0.080
$\Delta T2yr$	–0.027 (0.02)	0.023 (0.04)	0.334 (0.18)	0.115/0.096	–0.027 (0.02)	0.015 (0.04)	0.364 (0.20)	0.114/0.096
$\Delta T5yr$	–0.029 (0.02)	–0.023 (0.04)	0.159 (0.22)	0.000/0.106	–0.028 (0.02)	–0.028 (0.04)	0.182 (0.23)	0.000/0.106
$\Delta T10yr$	0.025 (0.02)	–0.049 (0.04)	0.014 (0.21)	0.000/0.098	–0.024 (0.02)	–0.052 (0.04)	0.027 (0.22)	0.000/0.098
$\Delta T30yr$	–0.029 (0.01)	–0.048 (0.03)	–0.083 (0.13)	0.003/0.073	–0.029 (0.01)	–0.050 (0.04)	–0.075 (0.13)	0.003/0.073

NOTE: Estimated standard errors are in parentheses.

Table 4

OLS and EV Estimates of the Response of Treasury Rates to Target Surprises Using the Kuttner Measure (Post-1993)

$$\Delta i_t = \alpha + \beta_1 \Delta ff_t^* + (\beta_2 - \beta_1)\Delta ff_t^{*u} + \varepsilon_t$$

	OLS				EV			
Rate	α	β_1	β_2	$\bar{R}^2/se$	α	β_1	β_2	$\bar{R}^2/se$
$\Delta tb3$	–0.017 (0.01)	0.077 (0.03)	0.662 (0.20)	0.607/0.085	–0.018 (0.01)	0.065 (0.04)	0.706 (0.23)	0.604/0.085
$\Delta tb6$	–0.040 (0.01)	0.059 (0.04)	0.489 (0.15)	0.506/0.076	–0.040 (0.01)	0.048 (0.04)	0.528 (0.17)	0.502/0.076
$\Delta tb12$	–0.041 (0.01)	0.044 (0.03)	0.392 (0.16)	0.332/0.083	–0.041 (0.02)	0.034 (0.04)	0.426 (0.17)	0.329/0.084
$\Delta T2yr$	–0.034 (0.02)	0.046 (0.04)	0.204 (0.17)	0.053/0.010	–0.034 (0.02)	0.041 (0.05)	0.224 (0.19)	0.052/0.100
$\Delta T5yr$	–0.035 (0.02)	0.008 (0.04)	0.027 (0.21)	0.000/0.108	–0.035 (0.02)	0.005 (0.04)	0.038 (0.23)	0.000/0.108
$\Delta T10yr$	–0.029 (0.02)	–0.021 (0.04)	–0.087 (0.20)	0.000/0.097	–0.029 (0.02)	–0.022 (0.04)	–0.083 (0.21)	0.000/0.097
$\Delta T30yr$	–0.032 (0.01)	–0.028 (0.03)	–0.142 (0.11)	0.035/0.072	–0.031 (0.01)	–0.029 (0.03)	–0.141 (0.12)	0.035/0.072

NOTE: Estimated standard errors are in parentheses.

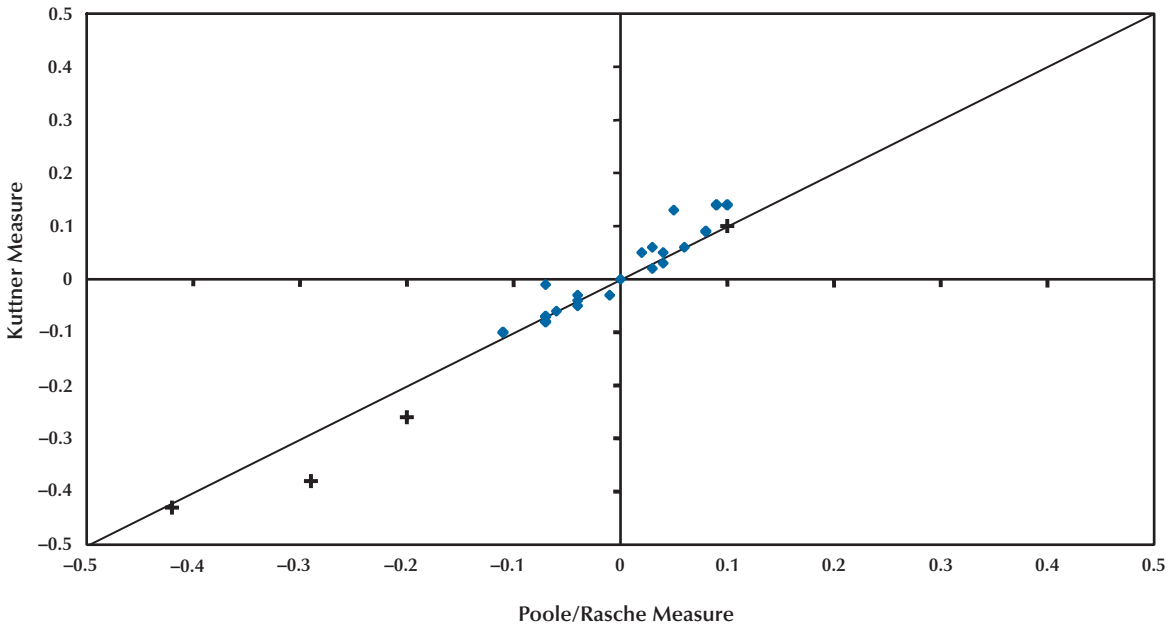
change when monthly data were used. He interprets this result as being consistent with the expectations theory of the term structure, suggesting that "the anticipated rate changes are associated with expectations of further actions in subsequent months."[13] While market participants may revise their expectation of future rate changes in response to an unanticipated target change, we do not believe that they would do so in response to an expected target change. Consequently, we suspect there is another explanation for this result.

One possible explanation comes from noting that before 1994 there were relatively few occasions when the funds rate target and the discount rate were changed simultaneously. After 1994 things are very different. Of the 24 target changes considered in the post-1993 period, 16 were accompanied by a change in the discount rate. Thornton (1996) found that the 3-month T-bill rate responded differently to target changes when the discount rate was

[13] Kuttner (2001, p. 541).

Figure 1

Poole/Rasche and Kuttner Measures of Unexpected Funds Rate Target Changes (Post-1993)



NOTE: ✚ Denotes unexpected target changes associated with intermeeting changes in the funds rate target.

changed. Discount rate changes appear to have an independent effect on market rates. Hence, it is possible that the significant response to expected target changes (reported in Tables 3 and 4) is due to the fact that, on some occasions, the Fed provided additional information by simultaneously changing the discount rate.

To investigate this possibility, the equations were reestimated with target changes partitioned into those when the discount rate was changed and those when it was not. Specifically, the equation

(11)
$$\Delta i_t = \alpha + \beta_1 \Delta ff_t^* \mid \Delta dr + \beta_1' \Delta ff_t^* \mid no\Delta dr + \beta_3 \Delta ff_t^{*u} + \varepsilon_t$$

was estimated.

EV estimates of equation (11) are reported in Table 5. They suggest that changes in the funds rate target that are accompanied by changes in the discount rate provide additional (unanticipated) information. In the absence of such additional information, the market does not respond significantly to expected target changes. The market only responds to "expected" target changes when new information is simultaneously provided. In this case, the new information comes in the form of a discount rate change.

THE MARKET REACTION TO UNEXPECTED TARGET CHANGES—PRE-1994

To apply the Poole/Rasche and Kuttner methodology to target changes before 1994, we must first identify whether the market realized on the day of the event that a target change had occurred. To determine the market's knowledge of a target change, we read the front page and the *Credit Markets* column from the *WSJ* for at least two days after each change in the funds rate target. This procedure is complicated by the fact that there is some difference of opinion about when the funds rate target was changed. We started with a widely used series of target changes reported by the Federal Reserve Bank of New York. Recently, however, Thornton and Wheelock (2000) presented an alternative series prepared by the staff of the FOMC Secretariat's office. Before 1989 these series sometimes differ in the dating and magnitude of Fed actions. The dates considered are the union

Table 5

EV Estimates with Target Changes Partitioned into Those That Were and Were Not Accompanied by a Change in the Discount Rate

$$\Delta i_t = \alpha + \beta_1 \Delta ff_t^* \mid \Delta dr + \beta_1' \Delta ff_t^* \mid no\Delta dr + \beta_3 \Delta ff_t^{*u} + \varepsilon_t$$

Rate	α	β_1	β_1'	β_3	$\bar{R}^2$/se
$\Delta tb3$	–0.122 (0.11)	0.071 (0.03)	0.075 (0.06)	0.738 (0.30)	0.577/0.088
$\Delta tb6$	–0.035 (0.01)	0.033 (0.04)	0.098 (0.08)	0.605 (0.23)	0.509/0.076
$\Delta tb12$	–0.036 (0.01)	0.005 (0.05)	0.112 (0.08)	0.546 (0.21)	0.370/0.081
$\Delta T2yr$	–0.029 (0.02)	–0.016 (0.05)	0.161 (0.13)	0.388 (0.22)	0.127/0.096
$\Delta T5yr$	–0.030 (0.02)	–0.064 (0.05)	0.142 (0.14)	0.256 (0.25)	0.000/0.105
$\Delta T10yr$	–0.026 (0.02)	–0.083 (0.05)	0.093 (0.11)	0.118 (0.24)	0.000/0.097
$\Delta T30yr$	–0.030 (0.01)	–0.072 (0.04)	0.055 (0.10)	0.002 (0.10)	0.014/0.107

NOTE: Estimated standard errors are in parentheses.

of the two data sets. As a further check on the dating of the target change, we consulted the *Report of Open Market Operations and Money Market Conditions* (hereafter *ROMO*), which is prepared biweekly by the Manager of the Trading Desk of the Federal Reserve Bank of New York (the Desk). A detailed analysis of these differences led us to use the Secretariat's date of July 6, 1989, rather than the New York Fed's date of July 7. The boxed insert provides a discussion of the more interesting dating conflicts, including the July 1989 conflict.

The market began to focus more attention on interest rates, including the federal funds rate, in 1987. Earlier in the decade of the 1980s, much of the discussion of policy was in terms of the effect of policy actions on the rate of money growth. Aware that Fed actions to increase or decrease reserve pressure influenced the federal funds rate, the market increasingly gauged policy by movements in the funds rate. However, market analysts frequently were unable to determine whether changes in the funds rate signaled a monetary policy action. In the early part of 1988, it appears that the market became more aware that the Fed was relying heavily on the funds rate to implement policy and market analysts began to surmise the Fed's intentions for the funds rate by observing Desk operations relative to the behavior of the funds rate.

Table 6 reports the amounts and dates of all funds rate target changes and the new effective target level reported by the Federal Reserve Bank of New York between August 1987 and December 1993.[14] If there is a difference between the New York series and the Secretariat's series, the Secretariat's dating of the action is also indicated. The table also indicates whether the discount rate was changed. Under Chairman Greenspan the funds rate target was changed whenever the discount rate was changed. This was not the case previously; more often than not the discount rate and the funds rate target were changed on different days.

Despite the increased awareness that the Fed was paying attention to the funds rate in conducting monetary policy, there is little indication that the market was aware that the Fed was setting an explicit objective for the federal funds rate before 1989. We believe that the first time in the 1980s that market participants knew that policy action occurred was May 9, 1988, when the Desk injected fewer reserves than analysts expected. This action sparked speculation that the Fed was increasing its fight against inflation, and market analysts concluded that the action would cause the funds rate to trade at 7 percent or slightly higher.[15]

[14] As Kuttner (2001) has noted, the target change that occurred at the December 1990 FOMC meeting was effectively revealed to the market with the announcement of a 50-basis-point cut of the discount rate on December 18. The announcement was made at 3:30 p.m., however, after the markets had closed. Consequently, this change is dated as December 19. It should also be noted that there are two dates in Table 6 that differ from those reported in Thornton and Wheelock (2000, Appendix B). The first is October 16, 1989; Thornton and Wheelock originally used October 18. The second is January 9, 1991, originally dated January 8.

[15] This is also one of the dates where there is discrepancy on exactly when the change was implemented. The Secretariat's series suggests that the change took place on May 7. There is no indication that the market was aware of an action on that date, however.

CONFLICT IN THE DATING OF TARGET CHANGES

There are a few cases, deserving of special attention, where there is conflict in the dating of the change in the federal funds rate target as reported by the New York Fed compared with the dating provided by the staff of the Secretariat. The first occurred in January 1989. The New York Fed suggests the funds rate target was increased by 25 basis points on January 5, 1989. The staff of the Secretariat is less precise, putting the change early in January. From our reading of the *WSJ*, it is apparent that the market was aware that the Fed changed policy before January 5; however, the precise date cannot be determined. On January 5 the *WSJ* merely indicates that analysts thought that the Fed had tightened credit earlier in the week. The *Report of Open Market Operations and Money Market Conditions* (hereafter, *ROMO*), however, clearly indicates that "on the second Thursday—January 5—the borrowing allowance was increased to $600 million, in line with the Committee's decision at the December meeting." Hence, while the market thought that the Desk took actions consistent with changing policy in the first few days of January, the Desk indicates that the action was not taken until January 5.

The second case occurred in July 1989. The New York Fed dates the change on July 7, the Secretariat on July 6. Market analysts agree with the Secretariat staff's dating of the action and thought the Fed moved on the 6th, when the funds rate traded significantly below its previous trading range of 9.5 percent and the Desk made no attempt to offset the rate move. The *ROMO* indicates that "after the Committee's July 5-6 meeting, the borrowing allowance was set at $600 million. This adjustment represented a slight intended easing of pressures on reserve positions, while also recognizing the recent rise in seasonal borrowing. (In the FOMC's discussion, 'unchanged' conditions of reserve availability were associated with a borrowing level of $650 million; at any event, the Desk continued to view the borrowing allowance with some flexibility.)" The July 5-6 FOMC meeting adjourned at 11:50 a.m. Eastern time on July 6. Hence, it is very unlikely the Desk implemented the FOMC's decision on the 6th. Because of this, the New York Fed dates the change on July 7, but because the decision was made on July 6, the staff of the Secretariat dates the change on the 6th. Nevertheless, the market interpreted the Desk's failure to act on July 6, when the funds rate traded significantly below the previous trading level, as a policy action. While the decision is somewhat arbitrary, we have decided to use the Secretariat's dating of this target change.

The third case occurred in October 1989. The New York Fed dates the change on October 16 and the staff of the Secretariat dates it on October 19. Market analysts thought that the Fed had taken a

(*Continued on p. 75*)

The market was not consistently aware of target changes at the time they happened until late 1989. This is about the time that the Fed began the practice of making target changes in multiples of 25 basis points. After late 1989 market analysts appear to have become adroit at identifying target changes when they occurred. In most cases analysts determined that the target had changed based on signals from the Desk. In many cases, however, the precise nature of the signal was not specified.

Did Market Analysts Anticipate Fed Actions?

In order to make the EV adjustment, we must again identify days on which the market was affected only by ambient news. Hence, the relevant question is, did market analysts anticipate Fed actions? The answer is yes, and no. There were many occasions when actions to increase or decrease pressure in the reserve market came as no surprise. Information on the state of the economy, inflation, or movements in the short-term interest rate fueled speculation that the Fed would soon change the discount rate or take other actions to alter the availability of credit. In this sense, there appears to be relatively few cases where the market was completely surprised by an action.

On the other hand, the precise dating of the Fed action nearly always surprised the market. Unlike the post-1993 period, we could find few instances where there was a widespread expectation that the Fed would take an action on a particular day. Moreover, we found no instance where there was a widespread expectation that the Fed would take an

(*Continued from p. 74*)
policy action on October 16, when the Desk did not attempt to offset a significant decline in the federal funds rate. Indeed, *fff*[1] declined by 16 basis points on October 16, suggesting that a very significant revision in the market's expectation for the federal funds rate occurred on that day. Market analysts also thought that the Fed took an action on the 19th, when the Desk added reserves despite the fact that the funds rate had drifted below the previous trading level.

The *ROMO* points to the source of the confusion. The *ROMO* for the maintenance period ending October 19, 1989, indicates that

> The financial markets were jittery after the second weekend, in the wake of the 190-point plunge in the Dow Jones Industrial Average in late afternoon trading on October 13. New reports over the weekend had cited a "Fed official" as saying that the System would assure the provision of adequate liquidity. As a result, market participants widely expected a reserve injection on Monday and these anticipations appeared to exert additional downward pressure on the funds rate. The Desk responded to the unsettled conditions in financial markets by executing customer-related repurchase agreements on the second Monday and Tuesday [October 16 & 17]. A final round of customer RPs was arranged on the settlement date [October 18], against the background of a bit firmer Federal funds rate that morning—8 3/4 percent—which appeared to stem partly from market uncertainties in the wake of Tuesday night's earthquake in San Francisco. Also, a background factor by this point was the decision discussed at Wednesday's FOMC conference call to begin implementing a slightly more accommodative reserve posture in light of recently incoming economic information: it was now expected that Fed funds trading would tend to center around 8 3/4 percent.

The New York Fed and the staff of the Secretariat are obviously disputing the dating of the same policy action that could not have occurred on the same day. The discussion in the *ROMO* gives rather weak support to the Secretariat's dating, but the Desk's action of injecting reserves on October 16 when the funds rate was declining suggests that the Desk was pursuing a lower funds rate on Monday. Consequently, we use the New York Fed's dating of this action.

action on the day the funds rate target was actually changed. Hence, in this respect, all target changes before 1994 were unexpected. Because the market frequently saw the need for an action, not all "unexpected" target changes resulted in large adjustments to federal funds futures rates.

We were unable to identify any occasion when the market correctly anticipated the Fed's action on a particular day, other than at scheduled FOMC meetings. Consequently, we determined the variance of the ambient news, σ_u^2, by using days when there was no headline announcement, no FOMC meeting, and no change in either the funds rate target or the discount rate.

The OLS and EV estimates for the pre-1994 period are presented in Table 7. The response of Treasury rates for the pre-1994 period is somewhat larger than for the post-1993 period, especially at the longer end of the term structure. Moreover, the $\bar{R}^2$s indicate that a much larger proportion of the variance in Treasury rates on days when the market knew that the Fed changed the funds rate target is explained by unexpected target changes. This is particularly true at the very long end of the term structure where all rates respond significantly to unexpected target changes. Furthermore, as the efficient market hypothesis suggests, none of the rates responds significantly to anticipated target changes.

INTERPRETING THE RESPONSE OF TREASURY RATES

Interpreting the response of Treasury rates to unexpected changes in the funds rate target requires an economic structure. While the simple expectations hypothesis (EH) of the term structure of interest rates is nearly always rejected, longer-term instruments are clearly forward looking.[16] Consequently,

[16] For evidence of the EH when the short-term rate is the effective federal funds rate, see Hardouvelis (1988), Simon (1990), Roberds, Runkle, and Whiteman (1996), and Thornton (2002).

Table 6

Knowledge of Fed Actions Obtained from Reading the *Credit Markets* Column of the *Wall Street Journal*

Date	*ff**	Δ*ff**	Secretariat	Poole/Rasche shock	Knowledge
8/27/87	6.7500	0.1250		NA	No
9/03/87	6.8750	0.1250		NA	No
9/04/87†	7.2500	0.3750		NA	No
9/22/87			0.1250	NA	No
9/24/87	7.3125	0.0625		NA	No
10/22/87	7.1250	–0.1875		NA	No
10/23/87			–0.3750	NA	No
10/28/87	7.0000	–0.1250		NA	No
11/04/87	6.8125	–0.1875		NA	No
1/28/88	6.6250	–0.1875		NA	No
2/10/88			–0.1250	NA	No
2/11/88	6.5000	–0.1250		NA	No
3/29/88			0.2500	NA	No
3/30/88	6.7500	0.2500		NA	No
5/07/88			0.2500	NA	No
5/09/88	7.0000	0.2500		NA	Yes
5/25/88	7.2500	0.2500		NA	No
6/22/88	7.5000	0.2500		NA	No
7/19/88	7.6875	0.1875		NA	No
8/08/88	7.7500	0.0625		NA	No
8/09/88†	8.1250	0.3750		NA	Yes
10/20/88	8.2500	0.1250		0.00	No
11/17/88	8.3125	0.0625		0.07	No
11/22/88	8.3750	0.0625		0.07	No
12/14/88			0.4000	0.02	No
12/15/88	8.6875	0.3125		0.05	Yes
12/29/88	8.7500	0.0625		–0.06	No
Early 1/89			0.3125	NA	Yes
1/05/89	9.0000	0.2500		0.00	No
2/09/89	9.0625	0.0625		0.01	No
2/14/89	9.3125	0.2500		0.04	Yes
2/23/89	9.5625	0.2500		0.14	Yes
2/24/89†	9.7500	0.1875		0.14	Yes
5/04/89	9.8125	0.0625		0.02	No
6/06/89	9.5625	–0.2500		0.01	Yes
7/06/89			–0.2500	0.03	Yes
7/07/89	9.3125	–0.2500		–0.05	No
7/27/89	9.0625	–0.2500		–0.06	No
8/10/89	9.0000	–0.0625		0.02	No

Table 6 cont'd

Knowledge of Fed Actions Obtained from Reading the *Credit Markets* Column of the *Wall Street Journal*

Date	ff^*	Δff^*	Secretariat	Poole/Rasche shock	Knowledge
10/16/89	8.7500	–0.2500		–0.16	Yes
10/19/89			–0.2500	0.00	Yes
11/06/89	8.5000	–0.2500		0.03	No
12/19/89			–0.2500	0.00‡	No
12/20/89	8.2500	–0.2500		–0.17‡	Yes
7/13/90	8.0000	–0.2500		–0.09	Yes
10/29/90	7.7500	–0.2500		–0.02	Yes
11/14/90	7.5000	–0.2500		0.02	No
12/07/90	7.2500	–0.2500		–0.14	Yes
12/19/90†	7.0000	–0.2500		–0.16	Yes
1/08/91	6.7500	–0.2500		–0.10	Yes
2/01/91†	6.2500	–0.5000		–0.20	Yes
3/08/91	6.0000	–0.2500		–0.13	Yes
4/30/91†	5.7500	–0.2500		–0.17	Yes
8/06/91	5.5000	–0.2500		–0.09	Yes
9/13/91†	5.2500	–0.2500		–0.04	Yes
10/31/91	5.0000	–0.2500		–0.05	No
11/06/91†	4.7500	–0.2500		–0.12	Yes
12/06/91	4.5000	–0.2500		–0.11	Yes
12/20/91†	4.0000	–0.5000		–0.26	Yes
4/09/92	3.7500	–0.2500		–0.21	Yes
7/02/92†	3.2500	–0.5000		–0.32	Yes
9/04/92	3.0000	–0.2500		–0.20	Yes

NOTE: †Indicates the target change was accompanied by a change in the discount rate.
‡The Poole/Rasche measure is unavailable on these days, so the Kuttner measure is reported.

it is reasonable to assume that the long-term rate is determined, at least in part, by the market's expectation of the funds rate target. The simple EH hypothesizes that the long-term rate is equal to the market's expectation for the overnight federal funds rate over the holding period of the long-term rate plus a constant risk premium, π, i.e.,

$$(12) \qquad i_t^n = (1/n)\sum_{i=0}^{n-1} E_t ff_{t+i} + \pi^n ,$$

where i_t^n denotes the n-day maturity Treasury rate on day t and π^n denotes a maturity-specific constant risk premium. It is perhaps more reasonable to assume that there is a time-varying component to the risk premium, so that the EH can be more generally written as

$$(13) \qquad i_t^n = (1/n)\sum_{i=0}^{n-1} E_t ff_{t+i} + \pi^n + \omega_t + v_t^n ,$$

where ω_t denotes the unobserved time-varying component of the risk premium and v_t^n denotes a random idiosyncratic shock to the n-day maturity Treasury rate.

Substituting (2) into (13) and taking the first difference yields

$$(14) \qquad \Delta i_t^n = (1/n)\sum_{i=0}^{n-1}[E_t ff_{t+i}^* - E_{t-1} ff_{t+i-1}^*] + \Delta\omega_t + \Delta v_t^n .$$

To see how our results can be interpreted, we

Table 7

OLS and EV Estimates of the Response of Treasury Rates to Target Surprises Using the Poole/Rasche Measure (Pre-1994)

$$\Delta i_t = \alpha + \beta_1 \Delta ff_t^* + (\beta_2 - \beta_1)\Delta ff_t^{*u} + \varepsilon_t$$

	OLS				EV			
Rate	α	β_1	β_2	$\bar{R}^2$/se	α	β_1	β_2	$\bar{R}^2$/se
$\Delta tb3$	–0.017 (0.01)	0.067 (0.06)	0.774 (0.09)	0.844/0.042	–0.017 (0.01)	0.027 (0.07)	0.823 (0.10)	0.840/0.042
$\Delta tb6$	–0.023 (0.02)	–0.012 (0.11)	0.840 (0.09)	0.816/0.047	–0.023 (0.01)	–0.059 (0.12)	0.899 (0.11)	0.811/0.048
$\Delta tb12$	–0.006 (0.01)	0.014 (0.05)	0.860 (0.09)	0.861/0.042	–0.006 (0.01)	–0.032 (0.06)	0.918 (0.10)	0.856/0.042
$\Delta T2yr$	0.002 (0.01)	0.040 (0.08)	0.715 (0.12)	0.545/0.078	0.003 (0.01)	0.003 (0.09)	0.761 (0.14)	0.543/0.078
$\Delta T5yr$	0.002 (0.01)	0.021 (0.08)	0.534 (0.13)	0.413/0.073	0.002 (0.01)	–0.007 (0.09)	0.569 (0.14)	0.411/0.074
$\Delta T10yr$	0.010 (0.01)	0.008 (0.07)	0.399 (0.10)	0.304/0.067	0.011 (0.01)	–0.014 (0.07)	0.426 (0.11)	0.302/0.067
$\Delta T30yr$	0.008 (0.01)	0.062 (0.07)	0.264 (0.09)	0.187/0.072	0.008 (0.01)	0.051 (0.07)	0.277 (0.10)	0.186/0.065

NOTE: Estimated standard errors are in parentheses.

impose the restriction that the market only responds to unexpected target changes so that equation (6) can be rewritten as

(15) $$\Delta i_t^n = \alpha + \beta_2 \Delta ff_t^{*u} + \varepsilon_t .$$

Given these assumptions, the OLS estimator of β_2 is equal to

(16)
$$\hat{\beta}_2 = \frac{\frac{1}{T}\sum_{t=1}^{T}[(1/n)\sum_{i=0}^{n-1}[E_t ff_{t+i}^* - E_{t-1} ff_{t+i-1}^*] + \omega_t + \nu_t][\Delta ff_t^{*u}]}{\frac{1}{T}\sum_{t=1}^{T}[\Delta ff_t^{*u}]^2}.$$

The problem is that ff_t^{*u} is unobservable. To see the potential problems associated with using the federal funds futures rate, assume that the h-month-ahead federal funds futures rate is equal to the market's expectation for the average effective federal funds rate h months into the future, adjusted for term premiums and idiosyncratic shocks, i.e.,

(17) $$fff_t^h = (1/m)E_t \sum_{k=1}^{m} ff_k^h + \varphi^h + \theta_t^h + \eta_t^h ,$$

where $\varphi^h + \theta_t^h$ denotes the potential constant and time-varying components of a term premium for the h-month-ahead federal funds futures rate, ff_k^h denotes the effective federal funds rate on day k of month h in the future, and η_t^h denotes an idiosyncratic shock to the h-month federal funds futures rate. Taking the first difference of (17) yields

(18) $$\Delta fff_t^h = (1/m)\sum_{k=1}^{m}[E_t ff_k^h - E_{t-1} ff_k^h] + \Delta\theta_t^h + \Delta\eta_t^h .$$

Assuming that the target change (γ) is expected to be constant over the next month and that $E_t ff_k^1 = E_t ff_k^*$, the Poole/Rasche measure of the unexpected target change is $\Delta fff_t^1 = \gamma + \Delta\theta_t^1 + \Delta\eta_t^1$, so that $\gamma = \Delta fff_t^1 - \Delta\theta_t^1 - \Delta\eta_t^1$. Substituting this expression into (16) yields

(19)
$$\hat{\beta}_2 = \frac{\frac{1}{T}\sum_{t=1}^{T}[(1/n)\sum_{i=0}^{n-1}[E_t ff_{t+i}^* - E_{t-1} ff_{t+i-1}^*] + \Delta\omega_t + \Delta\nu_t][\gamma - \Delta\theta_t - \Delta\eta_t]}{\frac{1}{T}\sum_{t=1}^{T}[\gamma - \Delta\theta_t - \Delta\eta_t]^2}.$$ [17]

Assume that (i) the idiosyncratic shocks are independent of each other and of the time-varying term premiums, (ii) $\hat{\rho}$ is an estimate of the coefficient of the correlation between the change in the time-varying components of the term premiums, and (iii) $s_{\Delta\varpi}^2$ and $s_{\Delta\theta}^2$ are estimates of the variance of the time-varying components for the Treasury and federal funds futures rates, respectively. If participants in the Treasury market revise their expectation for the funds rate target permanently, i.e., $E_t ff_{t+i}^* - E_{t-1} ff_{t+i-1}^* = \gamma$, for all i, (19) can be rewritten as

[17] The maturity superscripts have been dropped for notational convenience.

$$\hat{\beta}_2 = \frac{\frac{1}{T}\sum_{t=1}^{T}[\gamma + \Delta\omega_t + \Delta v_t][\gamma - \Delta\theta_t - \Delta\eta_t]}{\frac{1}{T}\sum_{k=1}^{N}[\gamma - \Delta\theta_t - \Delta\eta_t]^2} = \frac{T\gamma^2 - \hat{\rho}s_{\Delta\omega}s_{\Delta\theta}}{T\gamma^2 + s^2_{\Delta\theta} + s^2_{\Delta\eta}}. \quad (20)$$

If there are neither time-varying risk premiums nor idiosyncratic shocks to the federal funds futures rate, $\hat{\beta}_2 = 1$. To the extent that we have corrected for the bias due to common shocks, the estimate of $\hat{\beta}_2$ should be close to 1 if the market participants permanently revise their expectation for the funds rate target point-for-point with the unexpected target change and if the idiosyncratic variation in the 1-month futures rate is relatively small.

Estimates of $\hat{\beta}_2$ will be less than 1 if the market believes that the change in the target will last for a period that is shorter than the maturity of the instrument. Note that the estimate of $\hat{\beta}_2$ could also be greater than 1. This could occur if market participants believe that the unexpected target change will lead to further changes in the same direction.[18] If the market correctly anticipates the magnitude of the Fed's action but misses the timing, the size of the response will depend on the extent to which the market missed the timing—the larger the miss, the larger the response.

The estimates of β_2 in Tables 3 and 7 for the post-1993 and pre-1994 periods suggest that Treasury rates respond significantly to unexpected changes in the Fed's funds rate target. For both the 3- and 6-month T-bill rates the estimated coefficient is not significantly different from 1, suggesting that the market revises its expectation for the funds rate target several months into the future point-for-point with the unexpected change in the target. During the pre-1994 period, the estimated coefficients on the 12-month and 2-year rates are also not significantly different from 1, suggesting that the market revised its expectation for the funds rate target over a longer horizon before 1994. In most of these instances, however, the point estimates are quite different from 1. It is impossible to say whether this is due to missing the timing of the Fed's action or to the relative importance of idiosyncratic variation in the futures rate.

For both periods, the response of the Treasury rate to unexpected target changes declines as the term lengthens. For the post-1993 period, the response is not significantly different from zero for maturities beyond 12 months. Indeed, for the 10- and 30-year rates the point estimates are essentially zero. In contrast, for the pre-1994 period the response is statistically significant for all maturities.

One possible interpretation for the general result that the response declines as the maturity lengthens is that the market believes that the funds rate will stay at its new level for a relatively short period of time. For the pre-1994 period, the response is nearly the same for maturities up to 12 months and then declines. Kuttner (2001) and Cook and Hahn (1989) interpret this result to "mean reversion" of the federal funds rate. Specifically, they suggest that beyond one year, the market expects the funds rate to revert to its mean level. The cycles in the nominal federal funds rate are very long, however. It seems unlikely that the market would anticipate that the funds rate would start to return to its mean level in just over a year. Moreover, for the post-1993 period, the estimated coefficients begin to decline after three months. For this explanation to account for the post-1993 results, the market would have to anticipate mean reversion after three months—an incredibly short period.

CASE STUDIES

A potential problem in interpreting the estimate of β_2 arises from the fact that all interest rates are affected by publicly available information. Case studies can shed light on this and several other issues.

To illustrate the potential problem, note that (15) is actually

$$\Delta i_t^n = \alpha + \beta[\Delta fff_t^1 \mid \Delta ff_t^{*u} \neq 0] + \varepsilon_t. \quad (21)$$

Now assume that equation (21) is mistakenly estimated using days when there were no unexpected changes in the funds rate target, i.e.,

$$\Delta i_t^n = \alpha + \beta[\Delta fff_t^1 \mid \Delta ff_t^{*u} = 0] + \varepsilon_t. \quad (22)$$

Substituting (14) and (18) into (22), it is easy to show that the OLS estimate of β is equal to

$$\hat{\beta} = \frac{\hat{\rho}s_{\Delta\omega}s_{\Delta\theta}}{s^2_{\Delta\theta} + s^2_{\Delta\eta}}. \quad (23)$$

Estimates of β will be zero if and only if $\hat{\rho} = 0$. If the term premiums are positively correlated, the estimate of β will be larger the larger is $\hat{\rho}$ and the smaller is the idiosyncratic variance in the federal funds

[18] It cannot be exactly zero because the term of the bill rate shortens from one day to the next.

Figure 2

Funds Futures for April 1994 FOMC Event

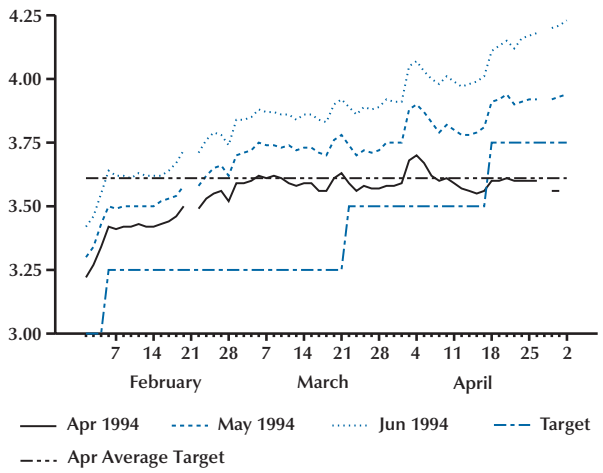
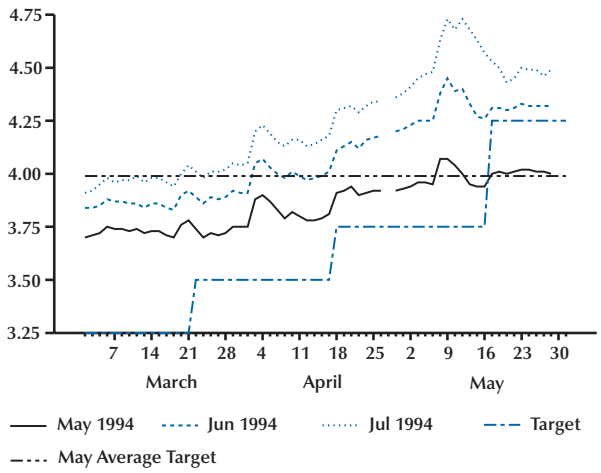


Figure 3

Funds Futures for May 1994 FOMC Event



futures rate. If the magnitude of $\hat{\rho}$ declines as the term to maturity on Treasury rates lengthens, so too will estimates of β.

Identifying times where there were unexpected changes in the funds rate target is critical for interpreting the results, because of the potential for correlation between changes in Treasury rates and changes in the federal funds futures rate even when there are no changes in the funds rate target or expectations thereof. We have been careful; nevertheless, it is important to check the robustness of our interpretation of the results. As a check on our interpretation, we undertook a case-by-case investigation of the response of federal funds futures rates to each unexpected target change noted in Table 2. In each instance, we examined the rates on federal funds futures contracts for the month of the event and for the months leading up to and just after the surprise events identified in Table 2.

Before discussing the findings in general, it is useful to get an idea of the methodology with two illustrative examples (a detailed analysis of each of the surprise events is presented in the appendix). The first example is for the intermeeting target change that occurred on April 18, 1994. The commentary indicated that the market anticipated that the Fed would raise the funds rate, but the timing of the April move was unexpected. For the period leading up to and just after the April 18, 1994, increase in the funds rate target, Figure 2 shows the rates on the April, May, and June federal funds futures contracts, the funds rate target, and the average funds rate target for April. The average target is the weighted average of the target of 3.5 percent for 18 days and 3.75 percent for 12 days.

During March (at least as early as the release of the report on the employment situation for February 1994 on March 4), the prevailing expectation was as follows: there was a high probability of a 50-basis-point increase before the beginning of May, with an even higher intended funds rate on average during June. The increase in the funds rate target that occurred in March was expected and there was no revision of the market's expectation for the future funds rate target.

The situation after the April intermeeting move is very different. Figure 3 shows that there was a significant revision in the market's expectation for the funds rate in May and June immediately upon the Fed's April action. For most of the period subsequent to the intermeeting change in the intended funds rate in April, market participants assigned a high probability to an additional increase of 50 basis points at the May FOMC meeting. Market participants had come to expect that a 50-basis-point increase over the target established in April would prevail during May and were assigning a high probability of an additional 25-basis-point increase at the June FOMC meeting. In late March, expectations of even higher intended funds rates for April, May, and June prevailed; however, these expectations were reversed by early April. Consistent with our interpretation of the regression results, the April action appears to have caused market participants to significantly

Figure 4

Funds Futures for March 1994 FOMC Event

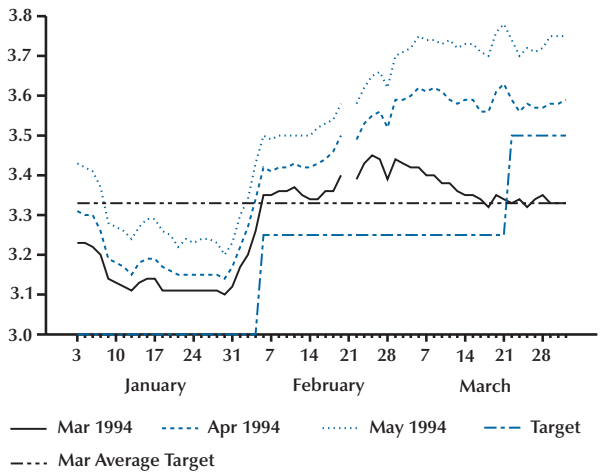
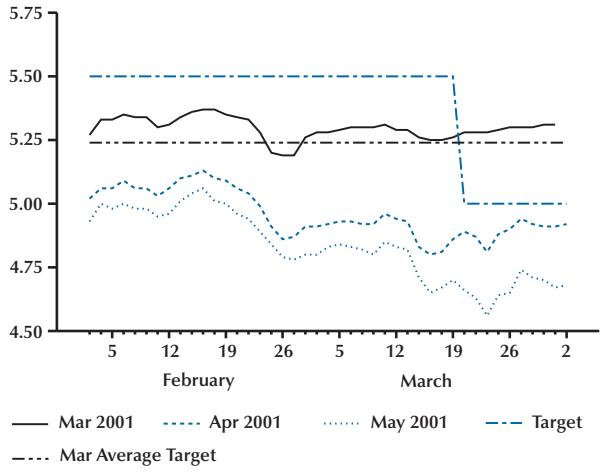


Figure 5

Funds Futures for March 2001 FOMC Event



revise their expectations for the funds rate in May and June.

For 9 of the 14 target changes where our analysis of market commentary suggested that the market was surprised by the Fed's action, there was a clear indication that the market revised its expectation for the funds rate out two months. On one of these occasions (July 6, 1995), however, the market's expectation for the funds rate out two months was significantly revised in the weeks following the target change.

There appeared to be no significant revision of the market's expectation for the funds rate out two months on five occasions. One of these occasions occurred on March 22, 1994, shown in Figure 4. The market had revised its expectation for the funds rate in May, a couple of weeks prior to the March FOMC meeting. While our analysis of the commentary suggested that the March action was a surprise, both the Poole/Rasche and Kuttner measures of the unexpected target change were very small. Hence, it may be that the commentary did not reflect the true market expectations at the time of the action.

Another instance when there was no revision of the market's expectation occurred on March 20, 2001, shown in Figure 5. At the time the FOMC reduced the funds rate target by 50 basis points, market participants were anticipating a 75-basis-point reduction; however, there was no immediate revision of the market's expectation following the announcement.

On three of the five occasions, the Poole/Rasche measure of the unexpected target change was 6 basis points or less—about two standard deviations of the variation in this measure associated with ambient news, suggesting that these actions were perhaps less of a surprise than the market commentary suggested. Moreover, on all occasions when the Poole/Rasche measure was larger than 10 basis points, the market appeared to revise its expectation for the funds rate at least two months out, suggesting that market participants might not revise their longer-run outlook for the funds rate target except in cases where they make a relatively large error in forecasting the Fed's action.

Market participants should not only revise their expectations when there is a surprise change in the funds rate, but also when they are surprised that the target was not changed. We identified only four such events. Our analysis suggests that of these four cases, three were instances when market participants revised their expectations for the future federal funds rate when the Fed failed to act as expected.

The most dramatic of these occurred in September 1996. The commentary indicated that market participants expected an FOMC action. Figure 6 shows the rates on the September, October, and November futures rate contracts before and after the September 1996 meeting. Both the futures rates and the market commentary suggest that market participants were expecting the FOMC to raise the target at the September FOMC meeting and were expecting additional subsequent increases. When the FOMC unexpectedly left the target unchanged,

Figure 6

Funds Futures for September 1996 FOMC Event

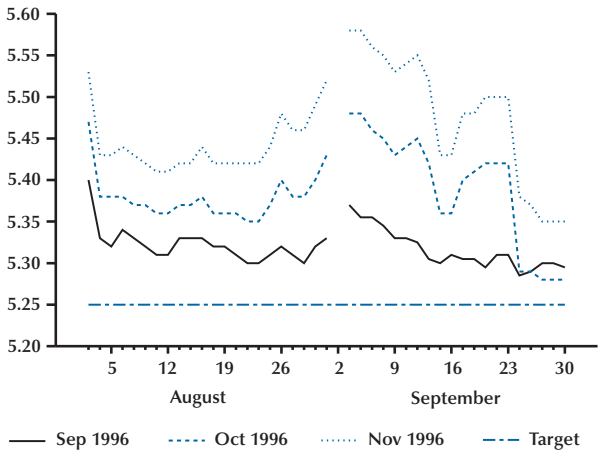
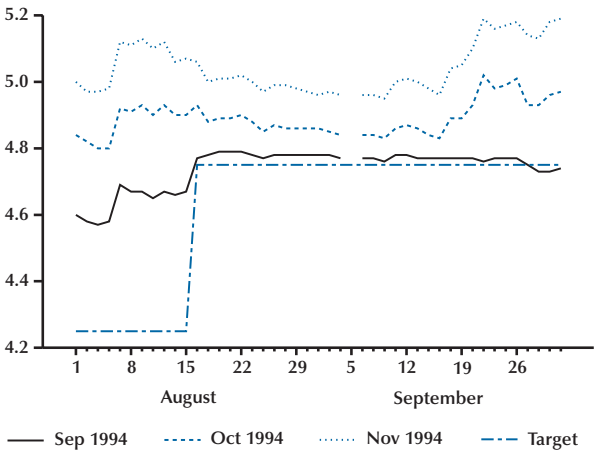


Figure 7

Funds Futures for September 1994 FOMC Event



market participants significantly revised down their expectations for the funds rate in October and November. In the three cases where the Fed's inaction prompted markets to revise their longer-term expectations for the funds rate, the revision in expectations appears to be large relative to those cases where the FOMC took a surprise action. This finding is consistent with our previous interpretation in that, if the market expects a 25-basis-point change in the target and the FOMC does nothing, the unexpected action is relatively large.

The exception occurred in September 1994, shown in Figure 7, when the surprise decision not to change the rate at the FOMC meeting of September 27, 1994, had essentially no effect on the market's expectation for the federal funds rate in October and November.

DOES GREATER TANSPARENCY HELP?

The FOMC has made a number of procedural changes that should have helped the market anticipate policy actions. Analysis of the period before the 1994 implementation of the practice of announcing target changes is hampered by the fact that most target changes were made during the intermeeting period. Because the market could never be sure when a change was most likely to occur, market commentary never predicted the date or the magnitude of Fed actions before 1994. Hence, market commentary at that time cannot be used to determine target changes that were or were not expected, as was done for the post-1993 period. Table 2, however, shows that for actions since 1994 that were not surprise actions, the Poole/Rasche measure of the unexpected target change was nearly always less than 6 basis points (about two estimated standard deviations of the variation in the 1-month futures rate associated with ambient news). Hence, one way to determine expected target changes is to assume that the market anticipated the Fed's action when the Poole/Rasche measure of the unexpected target change is 6 basis points or smaller. Using this criterion, of the 24 target changes before 1994 that the market was aware had occurred, only 6 were anticipated; 18 target changes were unanticipated.

Moreover, if one assumes that changes in the current or 1-month federal funds futures rate measures the degree of the unexpected target change, there were only three instances, on days when the market knew that the target had been changed, when there were large unexpected target changes. All three of these are associated with intermeeting target changes.

Using the same criterion for the post-1993 period indicates that 10 of the 24 target changes were unanticipated. Our analysis of market commentary suggested that 14 target changes were unanticipated, but we concluded that the market anticipated the FOMC's action only if market participants correctly anticipated the size and the timing of the action.

While the above analysis is simple, it suggests that the market has been able to better forecast Fed

Figure 8

Funds Futures for March 2000 FOMC Event

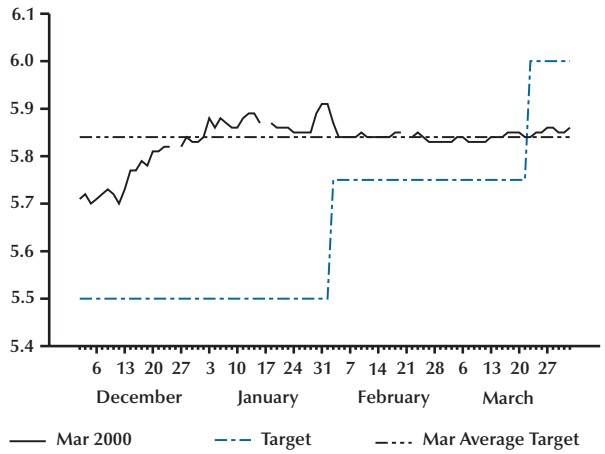
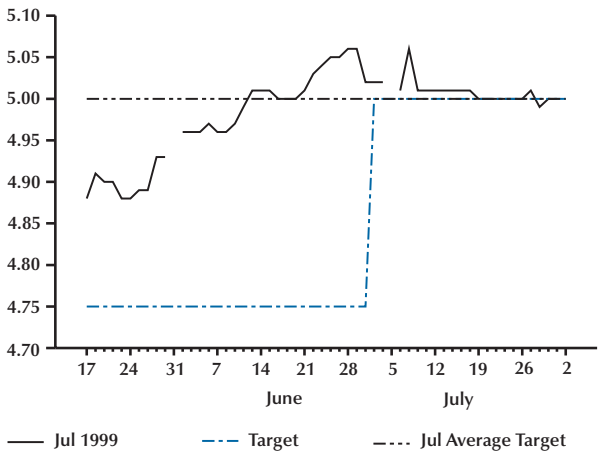


Figure 9

Funds Futures for June 1999 FOMC Event



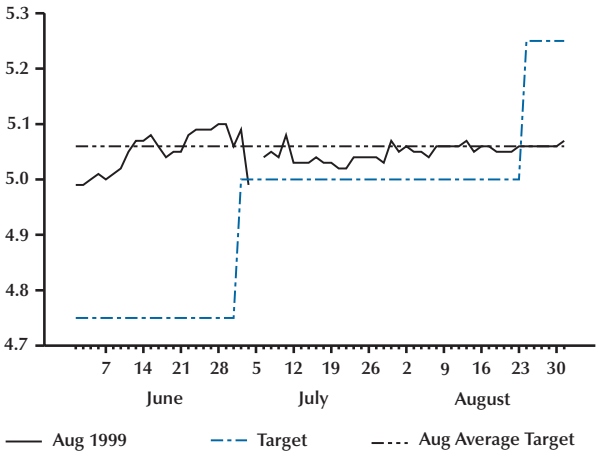
actions since the 1994 procedural change. In this regard, more transparency appears to help. This finding is not too surprising, however, since it is reasonable to expect that the market does a better job of anticipating policy actions when the timing of those actions is somewhat constrained by the FOMC's practice. Hence, somewhat more compelling evidence of the value of transparency can be obtained by determining whether the market is better able to predict Fed actions further in advance.

How Far in Advance Does the Market Anticipate Fed Actions?

Our results suggest that after 1994, market participants usually have anticipated changes in the funds rate target by the time they have occurred. The more transparent the Fed is, the further in advance the market should be able to predict policy actions. To get an idea of how far in advance the market anticipates Fed actions, we once again use the case study approach. Specifically, we plot (i) the rate on the federal funds futures contract for the month of target changes that we classified as "no surprise" in Table 2 and (ii) the average federal funds rate target for that month. Care must be taken because of the possibility of changes in the term premium. Nevertheless, if the market correctly anticipates the event, the rate on the federal funds futures contract for the month of the event should move to the level of the average effective federal funds rate before the event and stay close to that rate until the time of the event.

Figure 10

Funds Futures for August 1999 FOMC Event

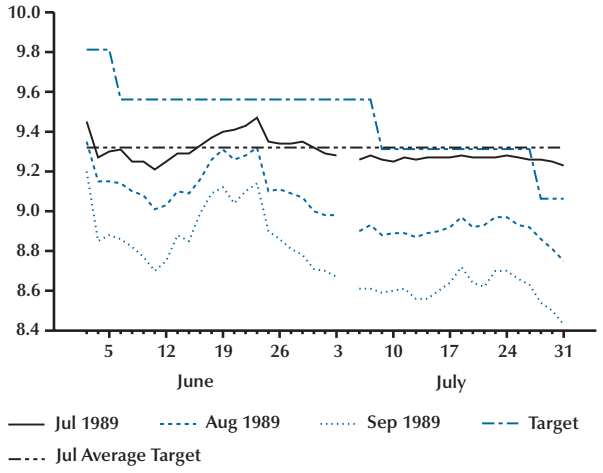


There were ten such events during the post-1993 period. Of these, our analysis suggests that on seven of these occasions the market anticipated the change two or more weeks in advance. For the change on March 21, 2000, shown in Figure 8, market participants appear to have anticipated the action about 12 weeks in advance. Indeed, before Christmas 1999 market participants correctly anticipated both the February and March actions.

Two of the more remarkable cases are associated with the target changes that occurred on June 30 and August 24, 1999. Figures 9 and 10 show the July

Figure 11

Funds Futures for July 1989 FOMC Event



and August federal funds futures rates and the average effective funds rate target for those months, respectively. By early June the market had come to expect not only the action taken on June 30, but the action taken on August 24 as well.

On the remaining three occasions, the actions appear not to have been expected until just days prior to the meetings. Hence, while the commentators were correct that these actions were widely anticipated, it appears that the market did not figure out what the FOMC was about to do until just days before the meeting.

To see whether the market's ability to predict Fed actions has improved since the beginning of 1994, we considered the six instances prior to 1994 where the market expected the Fed's action, using the criterion that the market expected the action if the Poole/Rasche measure of the unexpected target change is 6 basis points or less. Trading in the federal funds futures contracts began only two months prior to one of these occasions, December 1988. Moreover, there was no evidence that the market was aware that the Fed was targeting the funds rate at that time. For both of these reasons, analysis of this event is inappropriate.

Of the remaining five instances, there is only one instance, July 6, 1989, when the market appears to have anticipated the Fed's action well in advance.[19] Figure 11 suggests that the 25-basis-point target change made at that time was anticipated by early June.

This analysis also supports the conclusion that transparency is important. After 1994, not only is the market better able to anticipate when the Fed will act, but, more importantly, there is some evidence that the market is able to predict those actions further in advance. Greater clarity should enable the market to better predict how the Fed is likely to respond to incoming information about economic fundamentals.

DISCUSSION

This paper investigates the extent to which market participants anticipate Fed actions, focusing on the period since the late 1980s. This period is nearly ideal. The Fed has been explicitly targeting the overnight federal funds rate during the entire period that the federal funds futures rate has been available to measure the market's expectation for the federal funds rate and, consequently, the funds rate target.

A natural way to proceed in this environment is to use the change in the futures rate as a proxy for the unexpected change in the funds rate target and then estimate the response of longer-term rates to the unexpected target change. A significant response of longer-term rates suggests that the unexpected change in the funds rate target caused markets to revise their longer-term expectations for the funds rate. While this procedure can provide useful information about how market participants revise their longer-run expectations, we note that care is required. For one thing, there is a measurement error associated with using the change in the futures rate to proxy the unexpected target change; it arises because idiosyncratic and other shocks cause variation in federal funds futures rates even when there are no changes in the funds rate target. This measurement error also can bias down the estimated response of other rates to the unexpected target change. In addition, this procedure requires that market participants know that the Fed has changed its funds rate target. If market participants do not know that the target has been changed, the change in the futures rate does not reflect the unexpected target change. This problem, of course, applies to the pre-1994 period when target changes were not announced.

Accounting for both of these problems, we estimate the response of Treasury rates of various maturities from 3 months to 30 years to unexpected target changes for periods before and after the

[19] The figures for the other four dates and for December 1988 are presented in the appendix.

FOMC's 1994 procedural change. We find that the response of the 3-month T-bill rate is nearly identical before and after this procedural change. The magnitude and significance of the response of longer-term rates, however, declines after this procedural change. One possible explanation for the smaller response of longer-term rates is that the Fed has been more transparent about its longer-run policy intentions. Under this interpretation, the market would have relatively firm expectations that the Fed will change the funds rate target at some point in the future, but may have less-firm expectations of exactly when that change will occur. If only the timing of the target changes were unexpected, shorter-term futures rates would respond more to announcements of a target change than would longer-term rates.

We note that the interpretation of the response of Treasury rates to unexpected changes in the funds rate target is complicated by the possibility that all forward-looking rates might respond to common information, such as information that alters the market's expectation of the term premium. For this reason, extreme care must be exercised in identifying unexpected changes in the funds rate target. To address this issue, we undertake a case-by-case analysis of occasions when market commentary indicted that the market was surprised by the Fed's action or inaction. This analysis suggests that, in most of those cases, market participants revised their expectations for the funds rate at least two months out in response to an unexpected target change. Moreover, there is some indication that the larger the unexpected target change, the more likely it is that the market will revise its expectation for the funds rate.

Our most important finding is that greater transparency appears to help. Not only is the market better able to anticipate funds rate target changes, but it appears that the market is able to anticipate such changes further in advance. This is important since changes in the funds rate target can have a significant effect on economic variables only by generating changes in longer-term interest rates. The Fed can only affect long-term rates by affecting market participants' expectations for the future funds rate. The further in advance the market can anticipate changes in the funds rate, other things the same, the larger will be the corresponding changes in longer-term rates. Moreover, in such an environment, market responses in anticipation of policy actions begin to stabilize the economy long before the policy actions themselves occur.

The interaction of economic policy and market expectations has been a core feature of macroeconomics for 30 years. In this paper we documented the substantial change in the predictability of monetary policy that occurred in 1994. The period since 1994 has also been one of remarkable economic stability. We believe that the greater transparency of monetary policy has contributed to this outcome.

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Appendix

Figure A1-A

Funds Futures for December 1994 FOMC Event

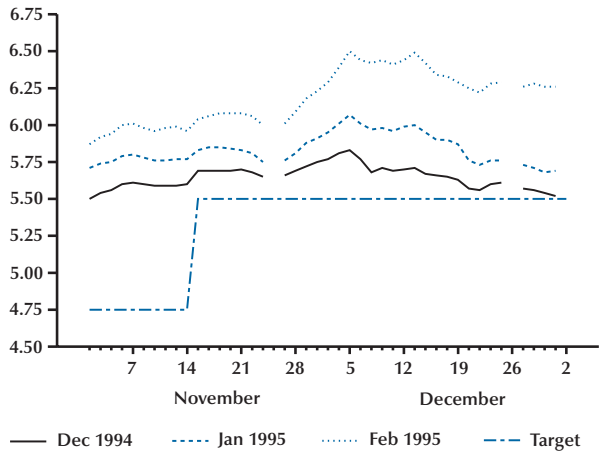


Figure A1-B

Funds Futures for May 1997 FOMC Event

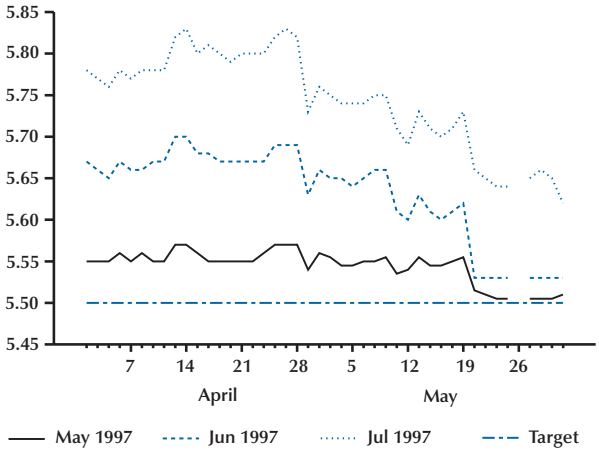


Figure A2-A

Funds Futures for August 1994 FOMC Event

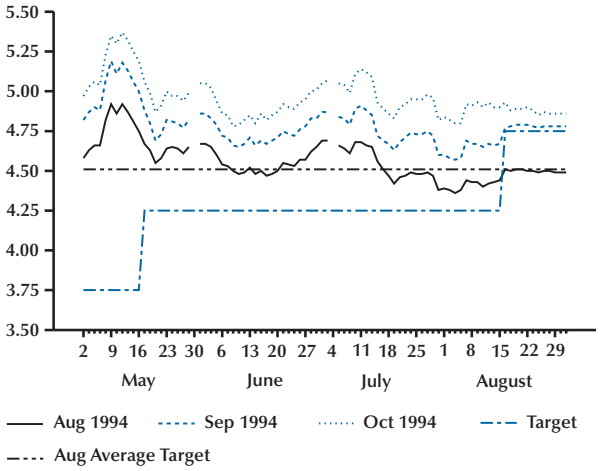


Figure A2-B

Funds Futures for November 1994 FOMC Event

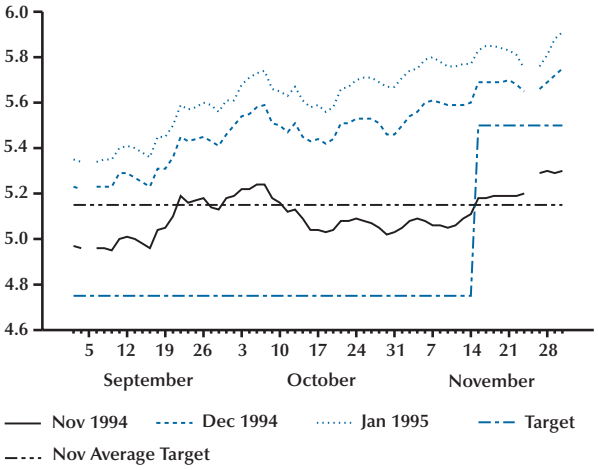


Figure A2-C

Funds Futures for July 1995 FOMC Event

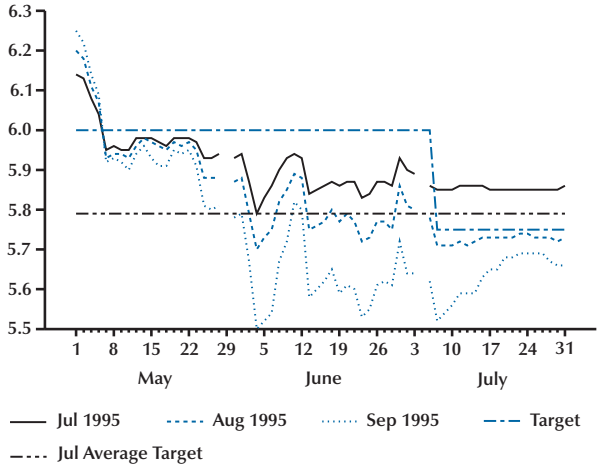


Figure A2-D

Funds Futures for December 1995 FOMC Event

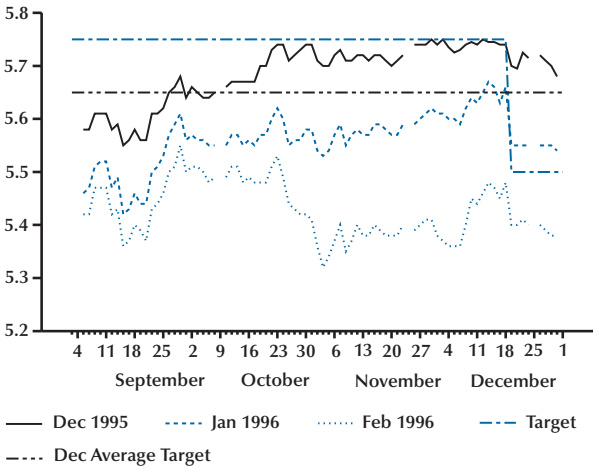


Figure A2-E

Funds Futures for January 1996 FOMC Event

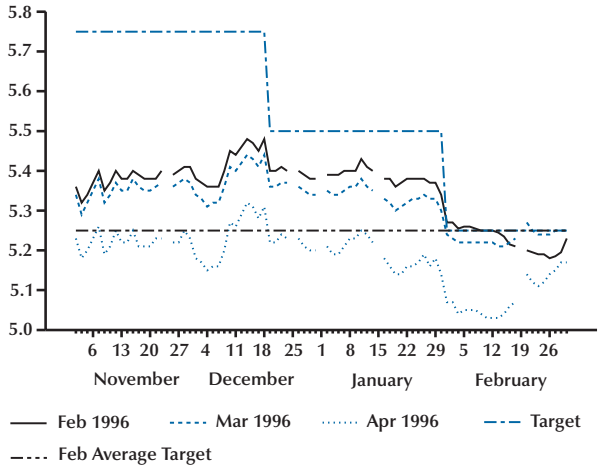


Figure A2-F

Funds Futures for October 1998 FOMC Event

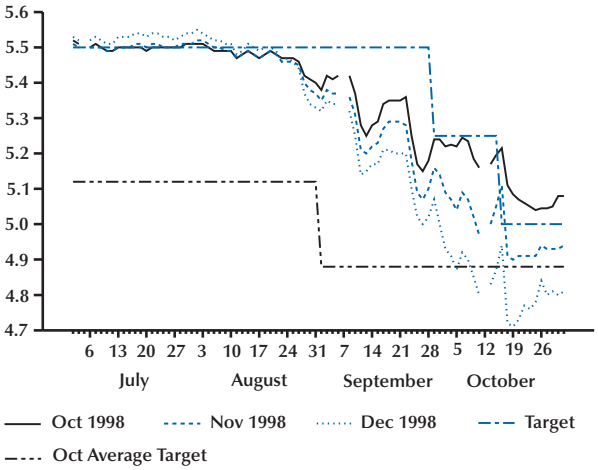


Figure A2-G

Funds Futures for November 1998 FOMC Event

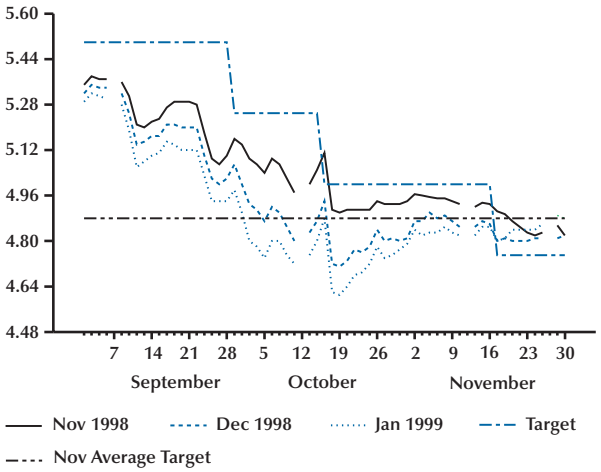


Figure A2-H

Funds Futures for November 1999 FOMC Event

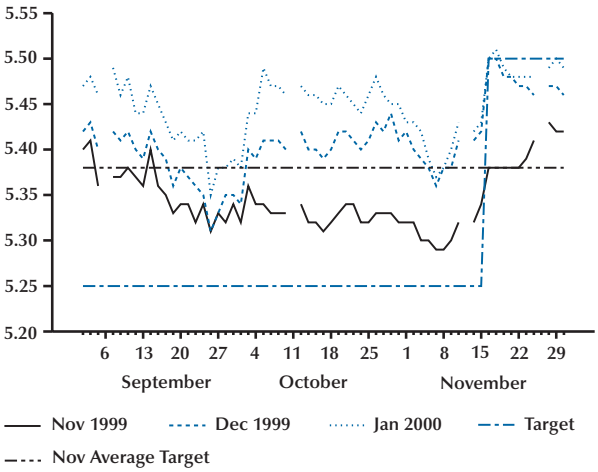


Figure A2-I

Funds Futures for January 2001 FOMC Event

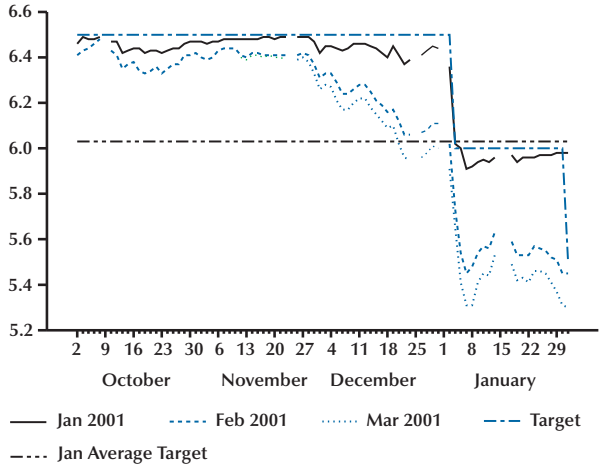


Figure A2-J

Funds Futures for April 2001 FOMC Event

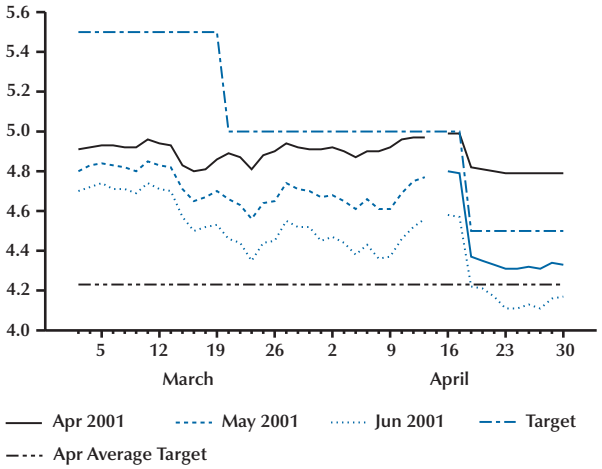


Figure A3-A

Funds Futures for February 1995 FOMC Event

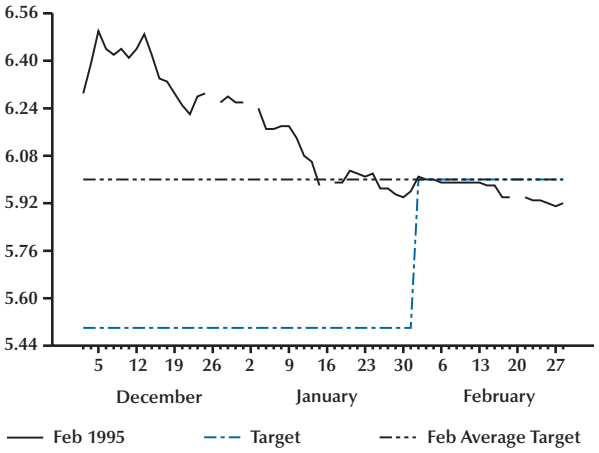


Figure A3-B

Funds Futures for March 1997 FOMC Event

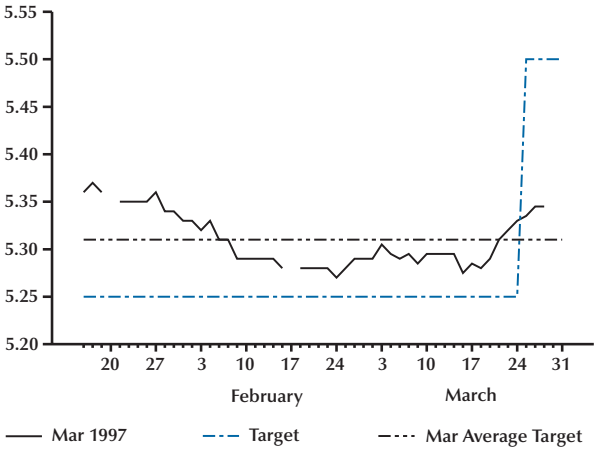


Figure A3-C

Funds Futures for September 1998 FOMC Event

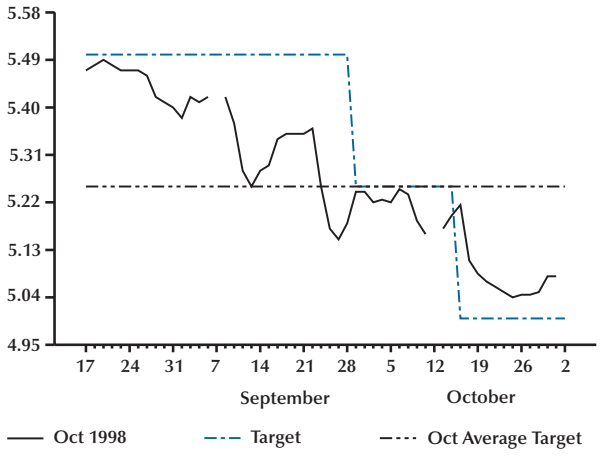


Figure A3-D

Funds Futures for February 2000 FOMC Event

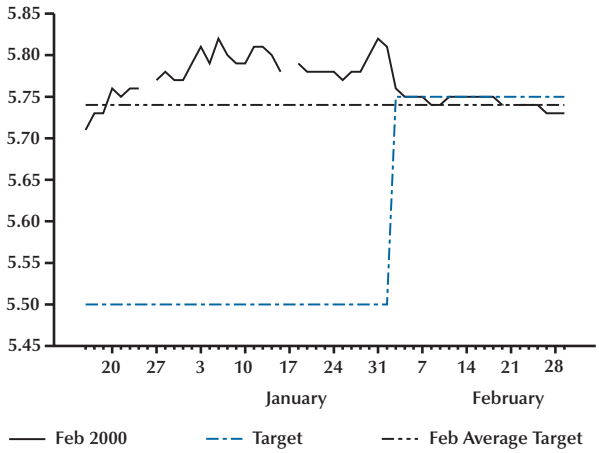


Figure A3-E

Funds Futures for May 2000 FOMC Event

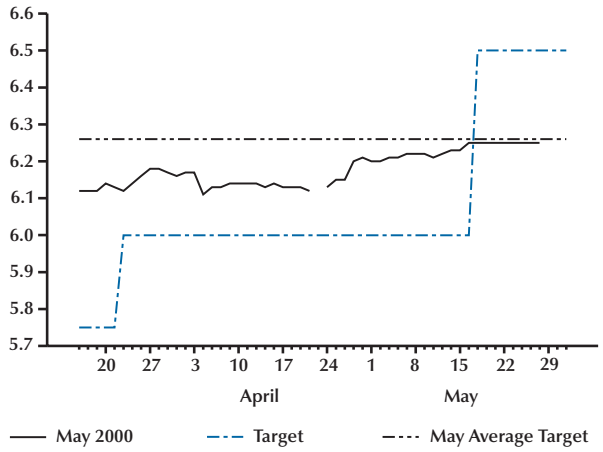


Figure A3-F

Funds Futures for January 2001 FOMC Event

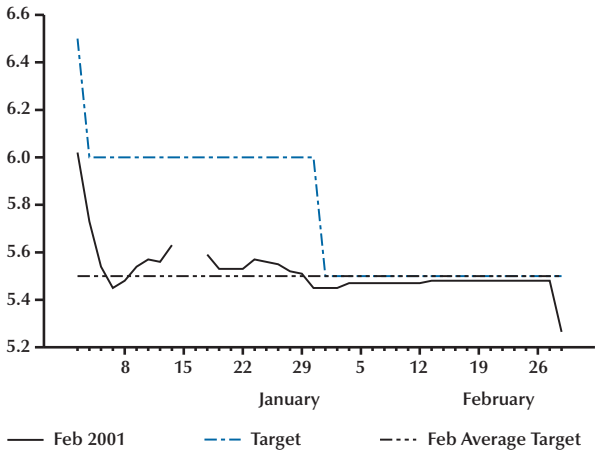


Figure A3-G

Funds Futures for May 2001 FOMC Event

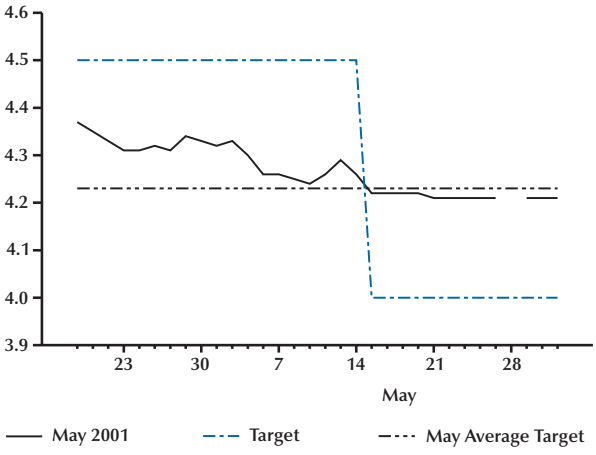


Figure A4-A

Funds Futures for December 1988 FOMC Event

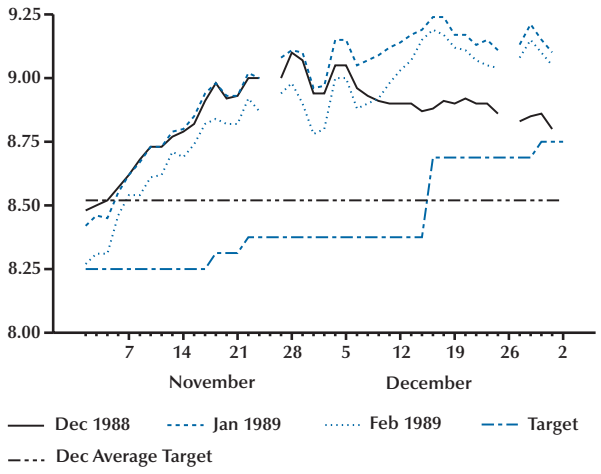


Figure A4-B

Funds Futures for February 1989 FOMC Event

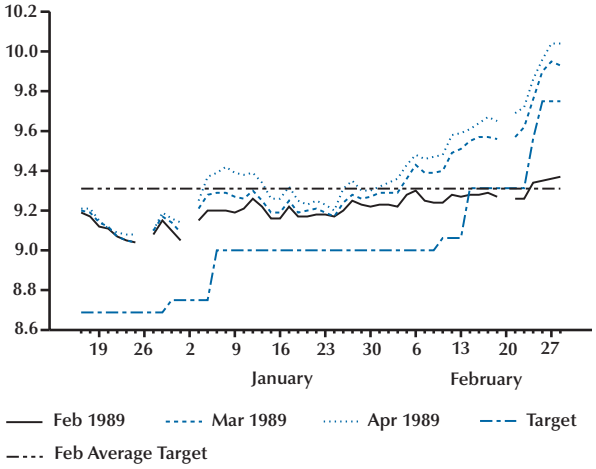


Figure A4-C

Funds Futures for June 1989 FOMC Event

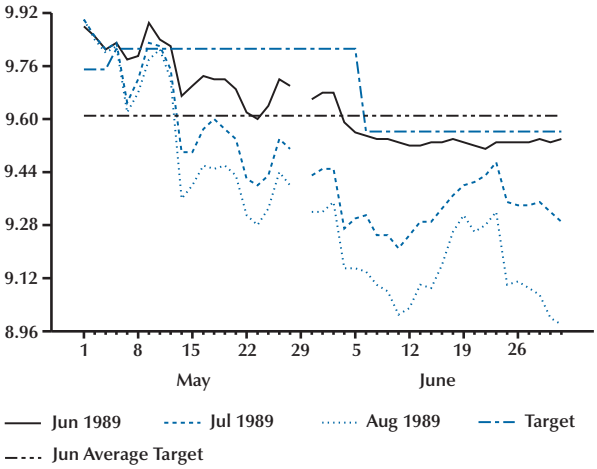


Figure A4-D

Funds Futures for October 1990 FOMC Event

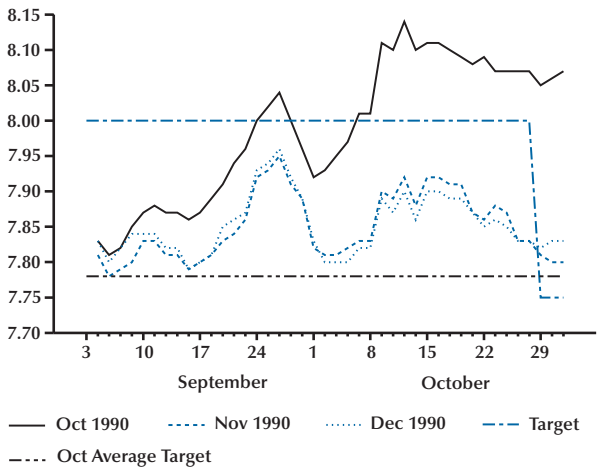
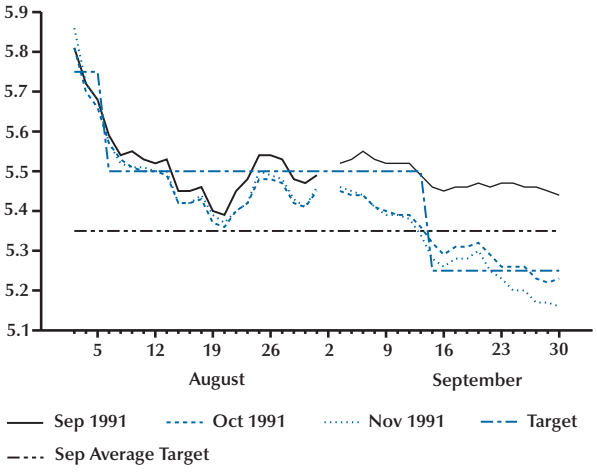


Figure A4-E

Funds Futures for September 1991 FOMC Event



Commentary

Mark W. Watson

This paper addresses three questions related to market anticipations of monetary policy actions. First, how can "anticipations" and "surprises" be measured? Second, has there been a change in the market's ability to anticipate monetary policy? Third, how far in advance does the market anticipate changes in the Federal Reserve's policy instrument?

These are important questions, and this paper makes four distinct contributions as it attempts to provide answers. Following earlier work by Poole and Rasche (2000) and Kuttner (2001), the paper uses the federal funds futures market to construct measures of anticipated and surprise movements in the target federal funds rate. The first contribution of the paper is a comparison of two versions of these measures. In February 1994, the Federal Open Market Committee (FOMC) began the practice of issuing a press release after each meeting that summarized their deliberations. The second contribution of this paper is an analysis of how this change in FOMC procedure affected the ability of the market to anticipate future changes in the federal funds rate. Regressions involving variables that measure "expectations" are prone to econometric problems that are technically similar to the classical problem of "errors-in-variables." The third contribution of this paper is an adjustment for this problem. Much of the paper's analysis is made possible by a new dataset that provides a qualitative summary of the market's expectations about changes in the target federal funds rate. The fourth contribution of the paper is the development of this dataset that was constructed by a careful analysis of reports that appeared in the *Wall Street Journal*.

I will begin this discussion by stepping outside the authors' analysis to address the general problem of measuring the forecastability of a time series and ask how futures prices might help with this task. I will then provide a brief and selective summary of the paper's main results. One of the important results in the paper is that the February 1994 change in FOMC procedure presaged an increase in the market's ability to anticipate changes in the target federal funds rate.

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HOW FORECASTABLE IS THE FEDERAL FUNDS RATE?

To begin, consider the decomposition of the change in the federal funds rate, ff,

$$ff_t = (ff_t - ff_{t/t-1}) + (ff_{t/t-1} - ff_{t/t-2}) + \cdots + (ff_{t/t-h+1} - ff_{t/t-h}) + ff_{t/t-h} \quad (0.1)$$

where $ff_{t/t-k} = E(fft \,|\, \text{information available at } t-k)$. The first term on the right-hand side of (0.1) represents the information about ff_t that is unknown at time $t-1$ and revealed at time t; the second term represents the information revealed at time $t-1$, etc. All of the terms on the right-hand side of this equation are mutually uncorrelated, and this implies that the variance of ff_t can be decomposed as

$$\text{var}(ff_t) = \sum_{k=0}^{h-1} \text{var}(ff_{t/t-k} - ff_{t/t-k-1}) + \text{var}(ff_{t/t-h}). \quad (0.2)$$

This decomposition of variance means that the fraction of the variability in ff_t associated with information revealed at time $t-k$ is

$$R_k^2 = \frac{\text{var}(ff_{t/t-k} - ff_{t/t-k-1})}{\text{var}(ff_t)}.$$

In many ways, values of R_k^2 provide an ideal summary of the ability of the market to anticipate changes in the federal funds rate. For example, $\sum_{k=i}^{\infty} R_k^2$ shows the fraction of the variability of ff_t associated with information revealed at $t-i$ or earlier.

Can R_k^2 be estimated using data from the futures market? In principle, yes. In practice, no. To see this, consider a futures contract with a payoff that is tied to the value of ff_t. Then, abstracting from changes in risk and discounting, changes in the price of the contract between periods $t-k-1$ and $t-k$ can be used to construct $f_{t/t-k} - ff_{t/t-k-1}$. The variance of these changes is the numerator of R_k^2, and the denominator is the variance of ff. Thus, these futures prices make it possible to estimate R_k^2.

In practice, federal funds rate futures contracts have payoffs that depend on the average value of the federal funds rate over a month, rather than the value on a particular day. This means that changes in futures prices can be used to compute averages of expected changes in the federal funds rates, such

as $m^{-1}\sum_{i=0}^{m-1}(ff_{t+i|t-k}-ff_{t+i|t-k-1})$. So, in general, the variance of changes in the federal funds rate futures price will depend on the variance of $ff_{t+i|t}-ff_{t+i|t-1}$ for all days in the month as well as the covariance between each of these terms. This makes it impossible to estimate R_k^2 from the futures data.

THE APPROACH USED BY POOLE, RASCHE, AND THORNTON

Complications like this mean that additional assumptions must be made if the federal funds futures market is to be used to summarize market anticipations. This paper uses assumptions made in earlier papers by Poole and Rasche (2000) and Kuttner (2001). The assumptions are similar, and here I will review Kuttner's version. The federal funds futures contract for the current month has a payoff that depends on the average federal funds rate in the current month. Thus, if there are 30 days in the month, the current date is denoted by t, and the month ends at date $t+k$, then

$$(0.3)\qquad FFF_t - FFF_{t-1} \approx \frac{1}{30}\sum_{i=0}^{k}(ff_{t+i/t} - ff_{t+i/t-1})$$

where FFF_t denotes the price of the futures contract and $\approx$ reflects the fact that changes in risk and discounting have been ignored. Now, consider a date when the federal funds rate changes unexpectedly (so that $ff_t-ff_{t|t-1}\neq 0$), and no other changes are expected during the month (so that $ff_{t+i|t}-ff_{t+i|t-1} = ff_t-ff_{t|t-1}$, for $i=1,\ldots,k$). For this date,

$$(0.4)\qquad ff_t - ff_{t/t-1} \approx \frac{30}{k+1}(FFF_t - FFF_{t-1}).$$

Thus, date t surprises in the federal funds rate can be measured by scaling up changes in the price of the federal funds futures.

Earlier researchers (Poole and Rasche, 2000, and Kuttner, 2001) used these estimates of surprise movements in the federal funds rate in regressions of the form

$$(0.5)\qquad i_t = \alpha + \beta(ff_t - ff_{t/t-1}) + \varepsilon_t$$

where i_t is a longer-term interest rate and $ff_t-ff_{t|t-1}$ is estimated by (0.4). These papers estimated (0.5) for dates when the approximations in (0.3) and (0.4) seemed reasonable a priori: that is, those dates when the target federal funds rate changed. This paper refines this earlier analysis by explicitly incorporating measurement error in (0.4). The authors estimate the magnitude of this measurement error using a variety of methods, all focusing on days when the target component of $ff_t-ff_{t|t-1}$ was zero, as determined from their reading of the business press. Reassuringly, they find that these measurement error corrections have little effect on the estimates of β in (0.5).

In addition, this paper compares estimates of (0.5) using the Poole and Rasche estimates of $ff_t-ff_{t|t-1}$ and the Kuttner estimates. They find little difference between the estimates, suggesting comparability of the Kuttner and Poole/Rasche measures.

DID FORECASTABILITY CHANGE IN 1984?

An important empirical conclusion in this paper is that the market was better able to anticipate changes in the target federal funds rates after February 1994. I offer two pieces of confirmatory empirical evidence.

First, consider the decomposition of the changes in the federal funds rate target, ff_t^*:

$$\Delta ff_t^* = a_t + u_t,$$

where a_t denotes the anticipated component and u_t is the unanticipated component. The fraction of the variability of the changes in ff_t^* that are unanticipated is $E(u_t^2)/E[(\Delta ff_t^*)^2]$, and the fraction anticipated is 1 minus this value. Using the Poole/Rasche (2000) measures of u_t, this fraction can be estimated from the data reported in the paper. For dates before February 1994, 80 percent of the variance of Δff_t^* was anticipated. For dates after February 1994, this fraction increases to 91 percent. Thus, in both periods, the market correctly anticipated the bulk of changes in the target rate, but there does appear to be a marked improvement in market expectations in the post-February 1994 sample period.

The second piece of empirical evidence is an estimate of how well long-term interest rates forecast the federal funds rate. Let

$$W_{t+90} = \frac{1}{90}\sum_{i=0}^{89} ff_{t+i}$$

denote the average value of the federal funds rate over the next 90 days, and let R_t^{90} denote the 90-day interest rate. From the expectations theory of the term structure, $R_t^{90}\approx W_{t+90|t}$. Consider the regression:

$$(0.6)\qquad W_{t+90} - ff_t = \alpha + \beta(R_t^{90} - ff_t) + \varepsilon_t$$

If changes in ff_t are not predictable, $\beta=0$ in (0.6) and

the regression R^2 is also zero. If changes in ff_t are predictable, then $\beta = 1$ and the regression R^2 is nonzero. More generally, the R^2 from (0.6), or its generalization containing other variables as well as the term spread, measures the predictability of change in the federal funds rate.

Table 1 shows the results from estimating (0.6) using monthly averages of federal funds rates and monthly 3-month Treasury bill rates over the two sample periods considered in this paper. The results are quite striking. Evidently, there is a marked increase in the predictability of federal funds rate changes, post 1994, at least at the 3-month forecast horizon.

Table 1

Predicting Changes in the Federal Funds Rate Using 3-Month Treasury Bills

Sample period	$\hat{\beta}$ (SE)	R^2
1987:01–1994:01	–0.02 (0.14)	0.00
1994:02–2001:06	0.97 (0.14)	0.61

NOTE: Estimates of (0.6) over the sample period are shown in the first column. Data are monthly. SE denotes the estimated heteroskedastic autocorrelation–robust standard error.

FINAL COMMENTS

In this paper, Poole, Rasche, and Thornton have further refined the use of federal funds futures prices for decomposing changes in the federal funds rate into anticipated and unanticipated components. They develop a new qualitative dataset that compliments the quantitative data in the futures prices. Their results suggest that changes in FOMC procedures adopted in February 1994 have improved the market's ability to anticipate changes in the target federal funds rate. My crude calculations, summarized above, are consistent with these conclusions. These results focus on very short-run forecasts (3 months in my analysis above).

A more important question involves the market's ability to forecast over longer horizons, particularly to form conditional forecasts: "If the path of inflation is ___ and the path of GDP growth is ___, then the path of the federal funds rate will be ___." Accurate long-run conditional forecasts follow from consistency of long-run Federal Reserve policy. Evaluating long-run conditional forecasts poses interesting and important questions, and I look forward to seeing extensions of this paper in that direction.

Does It Pay To Be Transparent? International Evidence from Central Bank Forecasts

Georgios Chortareas, David Stasavage, and Gabriel Sterne

I. INTRODUCTION

The past decade witnessed an increased interest in the institutional framework of monetary policy. The benefits of central bank independence have been demonstrated in much academic research and have become conventional wisdom among policymakers.[1] New questions have emerged, however, about the institutional characteristics of central banks and their effect on economic performance; recent analyses have attempted to identify optimal degrees of independence, accountability, and transparency in monetary policy.

Relative to the abundant literature on the effects of central bank independence, only limited research exists so far on the issues of transparency and accountability in monetary policy. Furthermore, empirical analyses have mostly focused on financial markets and used time-series data.[2] In this paper we examine how monetary policy transparency is associated with inflation and output in a cross-section of 87 countries. We use a particular concept of transparency that relates to the detail in which central banks publish economic forecasts (henceforth "transparency in forecasting"). We employ a new data set based on a survey conducted by Fry, Julius, Mahadeva, Roger, and Sterne (2000) (henceforth FJMRS). To our knowledge these are the only data covering transparency in monetary policy across such a wide cross-section of countries.

Our results show that a higher degree of transparency in monetary policy is associated with lower inflation. The relationship is robust to various econometric specifications and holds regardless of whether the domestic nominal anchor is based more on an inflation or a money target. In contrast, our results suggest that the publication of forecasts has no significant impact on inflation in countries that target the exchange rate. In addition, we do not find evidence to support the proposition that a high degree of transparency is associated with higher output volatility.

The rest of this paper is organized as follows. The next section reviews the relevant empirical and theoretical literature. Section III provides a discussion of our survey dataset. The econometric analysis and the discussion of our results are contained in Section IV, and Section V assesses the robustness of those results.

II. REVIEW OF THE LITERATURE

The currently expanding theoretical literature on central bank transparency identifies various channels through which increased transparency may affect economic policy outcomes. Not all of these move in the same direction. And neither is there a universally accepted definition of central bank transparency.[3] Various authors conceptualize transparency in different ways, focusing on preferences, models, knowledge about the shocks hitting the economy, the decisionmaking process, or the implementation of policy decisions.[4] The models by Faust and Svensson (2000, 2001), Jensen (2000), Geraats (2001a), and Tarkka and Mayes (1999) all assume private information about the central bank's objectives/intentions. Transparency is modeled as the degree of asymmetric information about control

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[1] See Blinder (2000).

[2] Some exceptions are the papers by Briault, Haldane, and King (1996) and Nolan and Schaling (1996). Their focus, however, is on accountability rather than on transparency, and these accountability measures involve only 14 countries.

[3] Blinder et al. (2001) assess why, how, and what central banks do and should talk about. Winkler (2000) discusses issues related to the definition of transparency.

[4] For example, see Geraats (2001a) for a classification.

errors (Faust and Svensson, 2001, and Jensen, 2000) or (anticipated) economic shocks reflected in the policy instrument (Cukierman, 2000a,b, and Tarkka and Mayes, 1999).

In this paper we focus on the detail in which central banks publish forecasts, since this variable is of common interest both in theoretical models of transparency and in related policy debates.[5] Furthermore, publication of forecasts may allow dissemination of information relating to the central bank's view of the world (economic models), stochastic shocks, or preferences.

For any form of central bank transparency to be relevant, some asymmetry of information in monetary policy must exist. Recent empirical work provides evidence suggesting central banks may possess superior information. Romer and Romer (2000), for example, show that if commercial forecasters had access to the Federal Reserve's inflation forecasts, they would generally find it optimal to adopt them, discarding their own forecasts. Peek, Rosengren, and Tootell (1998, 1999) also find that the Fed's forecasts benefit from an informational advantage over the public that assists the Fed in conducting monetary policy. Superior information here is a product of the Fed's supervisory function and includes information about non-publicly traded banks.

Increased central bank transparency may reduce uncertainty in financial markets. Studies employing various methodologies provide evidence that market participants react to the dissemination of macroeconomic information by the central bank. For example, Clare and Courtenay (2001) employ an event study methodology and use tick-by-tick exchange rate data from London International Financial Futures Exchange (LIFFE) futures contracts, finding that the publication of forecasts in the form of the *Inflation Report* has an information content for U.K. market participants. Kuttner and Posen (2000) examine how shifts in the Federal Reserve's and the Bank of Japan's degrees of transparency over time contributed to the reduction of exchange rate volatility.[6] Additional arguments in favor of transparency in monetary policy include the insulation of monetary policy from political pressures, increased accountability, facilitation of fiscal and monetary policy coordination, and improved internal organization of central bank analysis.[7]

In Faust and Svensson (2001), a high degree of transparency in monetary policy is, in general, welfare improving. Increased transparency reduces the inflation bias, inflation variability, and employment variability. Faust and Svensson (2001) use a modified Barro-Gordon model. The central bank's employment target is not announced and varies over time according to an idiosyncratic component. Fluctuations in this component of the employment target tempt the central bank to deviate from an announced inflation target. The central bank controls inflation imperfectly and the inflation outcome has two components: the central bank's intentions and a control error. The central bank decides upon the extent to which it will reveal its knowledge of the control error to the public. By revealing the control error, the central bank renders its intentions for inflation observable and thereby enables the public to infer the central bank's employment goal. Thus the degree of central bank transparency increases as the central bank reveals a greater proportion of the observable component of the control error.

Analytically, Faust and Svensson (2001) distinguish among three different regimes of transparency. In the first (least transparent) regime, neither the employment objective nor the intentions of the central bank are observable by the public. In the second regime, with a high degree of transparency, the inflation intentions of the central bank become observable. Increased transparency in inflation intentions results in lower inflation because it increases the sensitivity of a central bank's reputation to its actions, making it more costly for the central bank to pursue a high-inflation policy. The third regime is one the authors classify as "extreme" transparency where both the employment goal and the intentions of the central bank are observable. The central bank's actions no longer convey additional information about the inflation bias, and its reputation is no longer affected by its actions. An inflationary bias reemerges resulting in higher inflation, inflation volatility, and unemployment variability.[8]

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[5] See, for example, Buiter (1999) and Issing (1999) for a lively debate about transparency and accountability among central bankers.

[6] Other relevant studies include Dotsey (1987) and Haldane and Read (2000). Thornton (1999) provides evidence on whether the Fed controls the funds rate primarily through open market or "open mouth" operations.

[7] These views were expressed by Josef Tošovský, who was at that time Governor of the Czech National Bank. His views, and those of various other central bank governors, are contained in Mahadeva and Sterne (2000, pp. 186-205). For a discussion of policy-related arguments for transparency in monetary policy, see Blinder et al. (2001).

[8] This result is consistent with the results of the more general model of policymaking by Morris and Shin (2001).

Jensen (2000) adopts an informational structure similar to Faust and Svensson (2001), assuming that the output target is private information to the central bank and that the public's capacity to deduce it increases as the central bank publishes a greater percentage of the inflation control error. In contrast to Faust and Svensson (2001), who focus on the credibility effects of central bank actions in the future, Jensen (2000) uses a model with New Keynesian elements (staggered price-setting and monopolistic competition) and focuses on the marginal costs of inflation within the current period. More transparency increases the reputational costs of deviations from the inflation target and therefore increases its discipline and credibility.

The literature does not suggest that a high degree of transparency is unconditionally desirable. In Jensen's model, when central bank preferences are already public information, the credibility-enhancing effect of increased transparency becomes redundant. Furthermore, in the presence of a shock that requires counter-cyclical monetary policy, transparency becomes a straightjacket. Thus, the choice of the optimal degree of transparency is related to the trade-off between flexibility and credibility. A high degree of transparency is desirable for central banks with poor credibility but may be costly in terms of flexibility for high-credibility central banks.

Increased transparency may have the disadvantage of eliminating the central bank's strategic advantage, thereby reducing its capacity to stabilize the economy. "Cheap talk" and "optimal ambiguity" arguments are characteristic expressions of this view.[9] Other papers focus less on the reputational aspects of transparency and more on the consequences of the central bank releasing information about stochastic shocks. In Cukierman's (2000b) one-period model, the central bank's private information is about an upcoming shock. He uses a neoclassical transmission mechanism, relying on an expectations-augmented Phillips curve (i.e., a standard Barro-Gordon model) and a model along the most recent neo-Keynesian lines that focuses on the interest rate instrument. He examines the welfare implications of different degrees of transparency in each model. Under a regime of "limited" transparency, the central bank reveals its information about the upcoming shock after the public's inflation expectations have been set; conversely, under "full" transparency this information is released before the public forms its expectations.

Different degrees of transparency in the neoclassical version of the model merely affect the variability of inflation and not its average level. This is because the public becomes aware of the supply shock, and thus the central bank loses its informational advantage and cannot generate inflation surprises to stabilize the economy. Expected social welfare, however, is always higher under a limited transparency regime compared with the full transparency regime. This is because, under full transparency, unexpected inflation is always zero and therefore the central bank cannot affect employment. This result holds under assumptions of both perfect and imperfect (noisy) central bank forecasts. Under perfect central bank forecasts, however, only the variance of the policy outcomes is affected, whereas under noisy forecasts the average policy outcomes are affected as well.[10]

In the neo-Keynesian model of Cukierman (2000b), society is indifferent between the two regimes provided that interest rate variability does not enter its loss function. When the social loss function includes interest rate variability, however, the limited-transparency regime is superior to the full-transparency regime. Because the model incorporates a typical instrument rule, premature forecast publication requires more nominal interest rate variability in order to stabilize the ex ante real rate and through it the output gap and inflation.

Geraats (2001a) uses a two-period Barro-Gordon model with a real-interest-rate transmission mechanism and focuses explicitly on the publication of central bank forecasts. The central bank has private information about both demand and supply shocks and does not publish its inflation target. More transparency in the first period allows the private sector to observe the first period's demand and supply shocks and make inferences about the central bank's inflation target. More transparency therefore makes the central bank's reputation more sensitive to its actions, so an "opaque" monetary policy regime is characterized by higher inflation in the first period. This is because the non-publication of the central bank's forecasts implies a reputation loss. Given the

[9] For example, in the "cheap talk" model of Stein (1989), the central bank can generate inflation surprises. In the "optimal ambiguity" model of Cukierman and Meltzer (1986), imprecise control of the money supply allows the central bank to generate inflation surprises according to its time-varying preferences.

[10] Cukierman's (2000b) model does not include an explicit inflation bias, but our analysis shows that the results are similar when the model is extended to incorporate such a bias in the central bank's objective function.

uncertainty about whether the central banker is "weak" or "strong" in its aversion to inflation, the public tends to interpret the non-publication as an indication that the central bank is "weak." Transparency reduces the variability of inflation, but the effect on output is ambiguous. More precisely, under transparency, supply shocks lead to greater variability of output, whereas demand shocks lead to less. The reason is that under opacity, the central bank has less flexibility to adjust the interest rate in response to shocks. So under opacity, supply shocks lead to more variability in inflation and less in output; thus the demand shocks are no longer completely offset, leading to greater variability of both inflation and output.

Tarkka and Mayes (1999) suggest that publishing the central bank's forecasts leads to better macroeconomic performance because the released information reduces the private sector's uncertainty about the central bank's intentions. The authors use a Barro-Gordon model and assume that the central bank does not publish its inflation target.

Our assessment of the literature points toward appropriate measures of transparency for empirical tests, possible implications for the macroeconomy, and channels through which transparency may affect inflation:

- Transparency is generally conceptualized as the publication of central bank forecasts, since this allows the public to observe the control error.[11]
- The literature identifies a number of channels by which transparency affects the macroeconomy. These are conditional on model choice and specification (e.g., neoclassical versus neo-Keynesian models, presence of inflation bias) and assumptions such as the initial degree of credibility enjoyed by the central bank, the precise degree of transparency, and whether the models are specified over one or more periods.
- The effects of increased monetary policy transparency in the existing theoretical models are associated with variables such as average inflation, output, inflation volatility, output volatility, and interest rate volatility. Thus the hypotheses we test in this paper are, in general, consistent with the theoretical propositions of the recent literature.
- A common element in the majority of the models is that increasing transparency makes the central bank's reputation more sensitive to its actions and therefore reduces the incentive to pursue inflationary policies. Transparency has less impact on the sensitivity of reputation to the actions of the central bank when its preferences are already known. Regardless of the different implications of increased transparency about social welfare in the above models, more transparency never results in higher inflation outcomes.
- Another common element is that the improvement in inflation performance may be offset by a reduction in the capacity of the central bank to stabilize the economy by surprising the private sector with a policy-induced demand shock.

III. A NEW DATA SET ON CENTRAL BANKING INSTITUTIONS

In measuring transparency of central bank forecasts, we seek to establish the scope and coverage of macro-forecasts published by central banks. Data are taken from a survey of central banks contained in FJMRS.[12] They provide estimates of many transparency characteristics. We focus on central bank publication and explanation of macroeconomic forecasts, since this emphasis is closest to that of both theoretical and policy-oriented work on transparency in monetary policy.

The great majority of central banks in our sample publish some form of forward-looking analysis—79 percent of the 94 covered in the FJRMS survey.[13] Forward-looking analysis may, of course, take many forms, some of which may help to guide expectations more than others. For some central banks, the publication of a money target is in itself a form of forward-looking analysis, since such targets are often more benchmarks rather than rules, and other forecasts must underpin the target. Other central banks have attempted to guide inflation expectations by presenting forecasts of a number of variables in

[11] An exception in the recent theoretical literature is Cukierman (2000a), who focuses on the economic model and the operational objectives of the central bank rather than central bank forecasts and votes.

[12] The characteristics covered in the FJMRS survey include numerical measures of how policy decisions are explained and the quantity of current analysis, research, and speeches provided by the central bank. They also assess and provide scores for various aspects of accountability, independence, and target setting, each of which may contribute to transparency and clarity in the monetary framework.

[13] A total of 82 of these observations are included in our estimates. The other 12 are excluded because other data do not match up with them.

Table 1

Measure of Explanations of Forecasts and Forward-Looking Analysis: Questions and Distributions of Responses

Questions	Categories of answers, distribution of results	All	Industrial	Transitional	Developing
Form of publication of forecasts	Words and numbers	35	16	5	14
	Either words or numbers	25	8	6	11
	Unspecified	13	0	4	9
	None	21	4	7	10
Forward-looking analysis in standard bulletins and reports	More than annually	39	18	7	14
	At least annually	24	4	4	16
	Unspecified	10	2	4	4
	Otherwise	21	4	7	10
Discussion of past forecast errors	Yes	21	8	3	10
	Sometimes	9	7	2	0
	No	64	13	17	34
Risks to forecast published	Words and numbers	9	7	2	0
	Either words or numbers	23	9	4	10
	None	62	12	16	34

considerable detail including, for example, a discussion of risks.

The questions in the survey ask not only whether the central bank provides forward-looking analysis. They also consider the quality, scope, and frequency of forecasts and the extent to which forecast errors are monitored and publicly discussed. The exact wording of the questions, along with the motivation behind them, is provided below, with the distribution of the results for each question shown in Table 1. The questions are:

- *What is the form of publication of forecasts? Is it in words only, or is it also presented formally in terms of numbers?*[14]

  Motivation: The "bottom line" of a forecast is usually presented in a numerical or graphical format, which may help to influence expectations and discipline policy, since the forecast may then be directly compared with a target, and subsequently outcomes may be compared with the forecast. The analysis underpinning the forecast may, however, be more important than the precise number, since the accuracy of numerical forecasts may sometimes be attributable to luck as well as judgment. The questionnaire distinguishes between those central banks that publish forecasts: (i) using both words and numbers, (ii) using either words or numbers, and (iii) using neither.

- *With what frequency does the central bank publish forward-looking analysis in standard bulletins and reports?*

  Motivation: Published annual targets for money and inflation may help to guide expectations, but they only do so over a particular horizon. Forecasts published more frequently will guide/anchor expectations and may discipline policy over different forecast horizons.

- *Are risks to the forecast published; if so, in what form?*

  Motivation: A number of central banks use their forecast as a vehicle for highlighting the relative likelihood of various outcomes, rather than to focus on a particular number. The argument for publishing risks to a forecast is that a forecast that rests on a single number for each time period may be accurate for spurious reasons. An assessment of risks can convey a more accurate representation of the forecasters' subjective assessment of monetary conditions. As with the first question, the quality of risk assessment is judged

[14] Graphs are treated as identical to numbers in this analysis.

according to whether both numbers and words are used.

- *Is there a discussion of past forecast error; if so, is this a standard feature of discussion?*

  Motivation: Attempts to build credibility may rest on becoming more open about the capacity of the central bank (and other institutions) to forecast accurately. An open assessment of forecast errors may also reinforce the quality of future forecasts.

Data Reliability

The FJMRS survey data are the most comprehensive description available of central bank efforts to explain policy. The questions are worded objectively and cover a number of aspects of forecasting whose publication could enhance transparency to varying degrees, yet there are a number of reasons that might suggest caution in interpreting and using the data. We assess the implications of each in turn.

First, there could be a problem of sample selection bias to the extent that only the "best performers" respond. We are confident that the FJRMS survey is largely immune to this problem because of the very high response rate. Of 114 questionnaires, 94 were completed, and the survey covers over 95 percent of world gross domestic product (GDP). Furthermore, as the discussion of forecasts was only one facet of a broad survey, it is less likely that central banks were deterred by this particular part of the questionnaire.

Second, there could be problems with the subjective nature of the responses. For example, the distinction between publishing regular targets and forecasts may become blurred in some cases. Some respondents may have interpreted publishing an intermediate money target as providing forward-looking analysis. Such a target, after all, must be based upon output and inflation projections. Other countries, however, interpreted the publication of an intermediate target as distinct from publishing a forecast. This potential subjectivity bias may not be serious, however, since the questionnaire asked about the nature of publication, its frequency, and the discussion of risks and forecast errors.

A third problem is that it may be relatively easy to change some transparency characteristics. Some of the transparency measures in the survey have been implemented only recently, and so they may not have had an impact on inflation in the sample. If the impact of these measures represents a significant change in central bank behavior, the effect may also take some time to influence inflation expectations. We consider this problem in the discussion of the robustness of our empirical results.

IV. EMPIRICAL METHODS AND RESULTS

As noted above, theoretical work on transparency has generated a number of different propositions about the effect of publishing central bank forecasts. In order to evaluate these alternative models, in this section we provide empirical tests of the effect of transparency on inflation and on the volatility of output, using a cross-section of 87 countries over the period 1995-99. Our results show that there is a statistically significant negative correlation between transparency and inflation and, in particular, in countries with flexible exchange rate regimes. At the same time, there is no evidence of a cost of transparency in terms of increased output volatility.

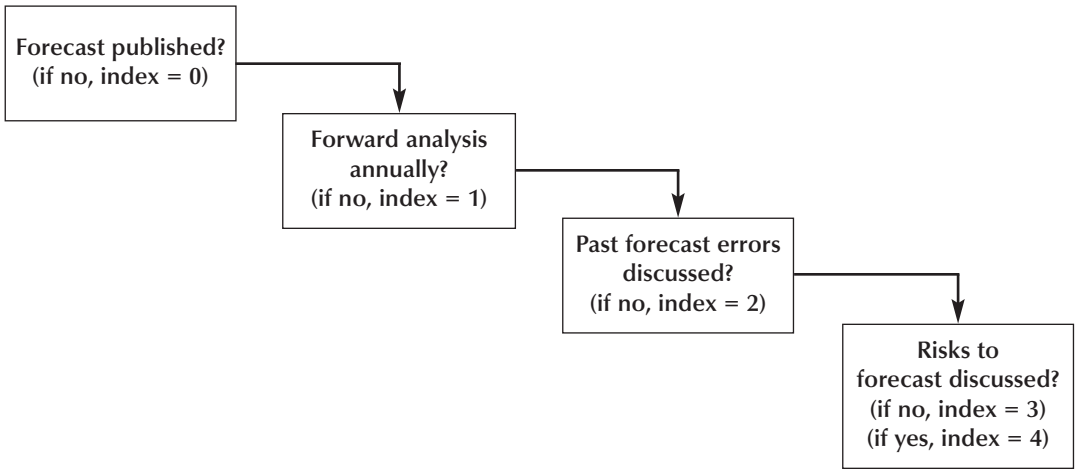
Constructing an Index for Transparency of Forecasts

The FJMRS data set provides four separate indicators that can be used to assess the detail in which a central bank publishes its inflation forecasts. These include the frequency with which forecasts are published and whether past forecast errors and risks to the forecast are discussed in publications. These indicators are highly correlated, implying that any regression that included each would exhibit multicollinearity. This factor argues in favor of aggregating the four to produce a composite measure of transparency.

Rather than creating an aggregate measure by simply taking the average of the different transparency measures in the FJMRS data set, we considered to what extent the FJMRS indicators can be arranged to form a Guttman scale. Its major advantage is that, unlike an average of several variables, a Guttman scale constructed from several indicators does not result in a loss of information through aggregation. A Guttman scale is constructed by arranging binary variables in a sequence such that a positive value for one indicator implies a positive value for all previous variables in the sequence. To construct a Guttman scale for transparency, we have ordered our variables according to the decision tree in Figure 1. Although a few of the central banks in our sample do not fit this pattern (for example, they discuss risks to their forecast but not past forecast

Figure 1

A Guttman Scale of Transparency in Forecasting



errors), the vast majority did. A common criterion for judging whether data can be ordered in a Guttman scale is if the "coefficient of reproducibility," defined as the number of errors/total responses, is less than 0.10. ("Errors" are cases where ordering according to a Guttman scale results in a false prediction for a response.) Our transparency data set easily satisfies this criterion, with a ratio of errors to total responses of 0.08.[15]

The advantage of Guttman scaling is that, based on the aggregate index, one can determine exactly how a central bank scores on each of the four separate sub-indicators. So, for example, a score of 2 on our transparency index implies that a central bank publishes forecasts and that it does so on at least an annual basis, but it does not discuss either past forecast errors or risks to the current forecast.[16] In contrast, if we took the simple average of the four indicators, then a score of 2 could imply a positive response on any two of the four sub-indicators. Furthermore, we later show that our results are robust to the use of either a Guttman scale or the simple average of our four sub-indicators of transparency in forecasting. The distribution of the Guttman scores is as follows: Of the 82 countries, 25 have a Guttman score of 0; 8 have a score of 1; 24 have a score of 2; 6 have a score of 3; and 19 have a score of 4.

Transparency and Inflation

As a first step toward investigating the effect of transparency in forecasting in monetary policy, we examined whether our index is negatively correlated with average inflation across our 87-country sample. Because the FJMRS data set examined transparency at one specific point in time (1998), we are limited to tests that consider only cross-country variation in inflation, rather than variation over time. Given that many reforms to increase central bank transparency are quite recent, we also chose to use a brief period for calculating average inflation (1995-99). This is based on consumer price index (CPI) data from the International Monetary Fund's *International Financial Statistics*. As discussed later, our results are nonetheless robust to using different time periods and to running regressions based on data from individual years.

Table 2 presents pairwise correlations between levels of transparency and average inflation. We use both our overall index and individual measures from the FJMRS data set. There is a significant negative correlation between all of these indicators and both the level and the variability of inflation, and this correlation is significant for the Guttman index in both cases.

As a next step, we examined whether this relationship holds when controlling for other deter-

[15] Alternative orderings, such as scaling in the following order of (i) forecasting, (ii) forward analysis, (iii) risks to forecast, (iv) past forecast errors, generate virtually identical results for the 82-observation sample that we use in our regression.

[16] This highlights the importance of having the overall data set closely approximate a perfect Guttman scale, in order to be able to make this inference.

Table 2

Transparency and Inflation: Pairwise Correlations

	Log inflation
Guttman scale of transparency	–0.37 ($p < 0.01$)
Publication?	–0.29 ($p = 0.01$)
Forward analysis at least annually?	–0.15 ($p = 0.15$)
Past forecast errors discussed?	–0.21 ($p = 0.05$)
Risks to forecast considered?	–0.28 ($p = 0.01$)
Number of observations	87

minants of average inflation.[17] To do this we followed existing cross-country empirical literature on inflation including Campillo and Miron (1996), Lane (1997), Bleaney (1999), Romer (1993), and Ghosh, Gulde, and Ostry (1995). First, we included the log of real GDP per capita, based on the possibility that lower-income countries may rely more heavily on the inflation tax to finance government expenditures. Second, we included a measure of openness,[18] following Romer (1993) and Lane (1997) who argue that incentives for policymakers to generate "surprise" inflation are weaker in more open economies. We also included a measure of political instability as a control variable, based on the prediction from a number of different political economy models that a high frequency of government turnover may shorten the time horizons of politicians, prompting them to adopt more inflationary macroeconomic policies.[19] Finally, we added a dummy variable to control for a country's exchange rate regime (fixed = 1).[20] This follows the theoretical arguments that emphasize how pegging can serve as a commitment device. It also follows empirical findings of Ghosh, Gulde, and Ostry (1995), Bleaney (1999), and others who show that there is a clear negative correlation between exchange rate pegs and average inflation.

Table 3 reports the results of four cross-country regressions. Regression (1) includes each of our control variables in addition to our Guttman scale for transparency in forecasting. The coefficient on the scale is negative and highly significant. Our second regression adds an interaction term, which allows the effect of transparency to vary between countries with fixed exchange rates and those with flexible exchange rate regimes. This tests our hypotheses about transparency in forecasting with greater precision because arguments in favor of publishing inflation forecasts apply, above all, to economies with floating exchange rates where the monetary authorities have greater control over the domestic money supply. In small open economies with a fully credible fixed exchange rate regime and with full convertibility, publishing forecasts should have no effect on average inflation since the central bank has little or no control over domestic interest rates or the money supply. Following Canavan and Tommasi (1997) and Herrendorf (1999), exchange rate pegs can be seen as an alternative strategy for establishing transparency, since they provide the public with an easily observable indicator over which the government has direct control.

The results of regression (2) in Table 3 correspond to those predicted in theory. In countries with floating exchange rates, transparency in forecasting is negatively correlated with average inflation. The coefficient on our transparency index is highly significant and becomes more negative when compared with the result from regression (1).[21] The significance is accounted for by a high-point estimate of the effect of transparency in inflation coupled with relatively wide error bands. In a country with a floating exchange rate that began with an inflation rate of 12 percent per annum, we estimate that a decision by the central bank to begin publishing regular inflation forecasts (a move on the index from 0 to 2) would lead to a reduction in inflation of between 1.8 percent and 7 percent per annum (the 95 percent confidence interval). In contrast, in countries with fixed exchange rates, transparency in forecasting has less effect on inflation. According to our estimates, the effect of a similar increase in transparency in forecasting in a fixed exchange rate country would be much smaller (reducing inflation from 12 percent to 11.8 percent per annum).

We also investigated whether the effect of transparency in forecasting on inflation might depend

[17] We restrict our attention to average inflation here because existing empirical work focuses on this variable.

[18] We define openness as $(x + m)$/GDP, where x and m stand for exports and imports, respectively.

[19] Drawn from a database created by Beck et al. (1999), this variable measures the percentage of key decisionmakers (executive, legislative majority[ies], coalition members) that change in a given year.

[20] Based on the classifications in the IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions*.

[21] The results are very simple from a regression that excludes countries with pegged exchange rates.

Table 3

Transparency in Forecasting and Average Inflation

Dependent variable: log inflation	(1)	(2)	(3)
Log GDP per capita	–0.47*** (0.07)	–0.45*** (0.07)	–0.50*** (0.066)
Openness	–0.001 (0.002)	–0.001 (0.002)	–0.002 (0.002)
Political instability	1.13* (0.63)	0.97 (0.64)	1.07* (0.63)
Exchange rate peg (peg = 1)	–0.47** (0.23)	–0.95** (0.43)	–0.74* (0.40)
Transparency in forecasting index	–0.16** (0.07)	–0.26*** (0.09)	
Peg × transparency		0.25* (0.13)	0.01 (0.10)
Inflation target × transparency			–0.15* (0.08)
Money target × transparency			–0.24** (0.01)
Constant	6.04*** (0.54)	6.11*** (0.51)	6.40*** (0.55)
R^2	0.52	0.54	0.52
N	82	82	82

NOTE: Heteroskedastic-consistent standard errors are in parentheses; ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively.

on whether countries are inflation targeters or whether they target monetary aggregates. A number of authors have defined transparency as a key ingredient of inflation targeting (e.g., Mishkin, 2000), while some have gone further by arguing that transparency is a prerequisite to inflation targeting (Masson, Savastano, and Sharma, 1997). The latter argument would suggest that transparency should have a greater impact on the credibility of monetary policy when adopted in conjunction with the use of an inflation target. In regression (3) in Table 3, we include two multiplicative dummy variables representing transparency in countries whose frameworks are based on inflation targets and money targets. We first construct two variables, *inflation target* and *money target*, each of which is a binary variable compiled from several different indicators in the FJMRS data set.[22] These two variables are then multiplied by the Guttman scale such that the inflation (money) target multiplicative dummy is equal to the value of the Guttman scale when the country's framework is based more upon an inflation (money) target and is equal to zero otherwise. The results of regression (3) suggest that the effect of transparency on inflation may be stronger for money-targeting frameworks, but tests reveal that the difference between the coefficients is insignificant. In unreported results, we find that when the binary dummy variables, inflation target and money target, are included separately, neither is significant.

Our estimates of the effects of our control variables on inflation are consistent with previous studies. Income per capita is negatively correlated with inflation, while political instability tends to be associated with higher inflation. As in previous studies, there is a very large and very significant negative correlation between exchange rate pegs and inflation. One finding that may appear surprising is the result that greater openness of an economy to trade is not associated with lower inflation. Earlier studies by both Romer (1993) and Lane (1997) using data covering the 1970s and 1980s found evidence of a negative openness-inflation correlation. More recently Bleaney (1999) has reproduced earlier findings with regard to the 1970s and 1980s, while also concluding that there is no significant correlation between openness and inflation in data from the 1990s. Given that our data cover the period 1995-99, our results are consistent with those obtained by Bleaney. We also investigated whether these results

[22] The questions ask central banks (i) to classify their regime, (ii) to report if an explicit target was published for each variable, (iii) to rank objectives in practice, and (iv) to indicate which variable prevails in policy conflicts. Each country was allocated a score for each of the following: exchange rate, money and inflation focus, and discretion. The maximum of these scores was classified as the "targeted" variable. This definition is broader than that used in other papers (e.g., Mishkin and Schmidt-Hebbel, 2000).

Table 4

Transparency and Output Volatility: Pairwise Correlations

	Standard deviation annual GDP growth (p value)	Standard deviation quarterly GDP growth (p value)
Guttman scale of transparency	–0.08 (0.47)	–0.29 (0.13)
Publication?	0.06 (0.59)	–0.10 (0.60)
Forward analysis at least annually?	0.02 (0.86)	–0.25 (0.19)
Past forecast errors discussed?	–0.22 (0.06)	–0.20 (0.29)
Risks to forecast considered?	0.09 (0.43)	0.16 (0.40)
Number of observations	76	29

Table 5

Transparency and Output Volatility: Controlling for Terms of Trade Variability

Dependent variable	Standard deviation annual GDP growth	Standard deviation quarterly GDP growth
Guttman scale of transparency	–0.03 (0.12)	–0.005 (0.004)
Standard deviation terms of trade shocks	0.53*** (0.14)	0.23 (0.29)
Number of observations	71	28

NOTE: Heteroskedastic-consistent standard errors are in parentheses; ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively.

with regard to openness were attributable to outliers with very high levels of openness, but our results rejected this possibility.

Transparency and Output Volatility

In addition to making predictions about the effect of transparency on average inflation, models of transparency in monetary policy also produce comparative statistics about volatility of output.[23] As noted, one's prediction here depends heavily on underlying assumptions. Our empirical investigation of the effect of transparency on output volatility is limited by the lack of obvious controls to be used in estimating cross-country differences in output volatility. To construct measures of output volatility (based on the standard deviation of GDP growth), annual data were available for our entire sample (1993-99), while quarterly GDP data were available for 30 of our sample countries (also 1993-99).

Table 4 reports the results of pairwise correlations, using both the Guttman scale for transparency and the individual indicators from the FJMRS data set. There are several extreme outliers in our output volatility data, and in order to obtain more robust results we have excluded these countries from the correlations reported in the table.[24] The results show that the correlation between transparency and output volatility is often negative, especially in the sample using quarterly data, but in only one case is a correlation significant at conventional levels. While this evidence certainly does not suffice to demonstrate that publishing inflation forecasts reduces output volatility, it does appear to be fairly strong prima facie evidence against claims that

[23] We also tested for the effects of transparency on the volatility of inflation, and our tentative results showed no significant positive or negative impact.

[24] In the sample based on annual data, Kuwait and the Kyrgyz Republic were outliers in terms of having very high standard deviations of GDP growth, while in the quarterly data Turkey was the only severe outlier. We defined a "severe" outlier, x, using the following formula where "pctile" refers to the percentiles of the entire sample: $x < 25\text{pctile} - 3(75\text{pctile} - 25\text{pctile})$ or $x > 75\text{pctile} + 3(75\text{pctile} - 25\text{pctile})$.

increasing transparency increases output volatility. Results obtained before outliers were excluded were also consistent with this finding.[25]

We also estimated several ordinary least squares (OLS) regressions of output volatility on the Guttman scale of transparency, controlling for the variance of terms of trade shocks.[26] The results, reported in Table 5, show no significant effect of increased transparency on output volatility.

V. INTERPRETING THE ROBUSTNESS OF OUR RESULTS

The effort required for a central bank to publish detailed forecasts may not appear to be particularly arduous relative to the benefits of securing lower inflation. Why, then, do many more central banks not introduce detailed forecasts?[27] We base our detailed discussion of the robustness of our results on five complementary explanations of this empirical conundrum:

- The result (that greater transparency in forecasting leads to lower inflation) is valid and could be exploited by more central banks than at present, but some central banks have not yet completed the transition to greater transparency.
- The result is valid overall but may not be true of all frameworks.
- The result is valid, but there may be offsetting costs to transparency, which deter some central banks from introducing it.
- The results may be overstated or invalid because of endogeneity and reverse causality.
- There may be other statistical biases.

Econometric techniques are necessary but insufficient for judging the robustness of our results. In this section we also include a detailed discussion of how such tests relate to the theory and practice of monetary frameworks.

A Transition to Greater Global Transparency in Monetary Policy?

One possible reason why only a relatively small number of central banks publish detailed forecasts may be that policymakers have not yet fully acted upon the evidence that transparency can contribute to lower inflation. The theoretical and empirical evidence on the effects of transparency is relatively new. Goodfriend's (1986) landmark paper was among the first to discuss the costs and benefits of secrecy in monetary policy, in the context of the Merrill vs. FOMC case.[28] His paper was framed by questions relating to how central banks might respond to increasing evidence of the importance of expectations in economic decisionmaking. The theoretical literature began to increase rapidly only at the end of the 1990s, and our paper is among the first to provide cross-country empirical evidence using macroeconomic data. Similarly, the practical precedents of frameworks in which published forecasts contributed significantly in building credibility have emerged only in the 1990s.[29]

Framework designers have not always been quick to adjust their frameworks quickly in response to new framework innovations,[30] yet recent developments in global framework design suggest that central banks are on a transition path toward much higher average levels of transparency. Even since FJMRS constructed their data, several countries have markedly increased the information about their forecasts.[31] And the rapid global proliferation of explicit money and inflation targets in the 1990s is, according to Mahadeva and Sterne (2001), part of a global trend whereby disinflating countries use targets more as a forecasting device than as a policy rule.

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[25] Before exclusion of outliers, all correlations were negative and seven of ten were significant at conventional levels.

[26] The variable was based on an indicator from the World Bank's *World Development Indicators*. We then calculated this effect as a share of GDP and took the standard deviation of this indicator over the period 1992-97.

[27] In the FJMRS survey, only three central banks (Norway, Sweden, and the United Kingdom) satisfy every criterion by which the authors judged the detail in which central banks explain forecasts.

[28] One of the Fed's arguments for resisting greater transparency, that it was difficult in the early 1980s to provide information evenly to all market participants, has been eroded over time by advances in information technology.

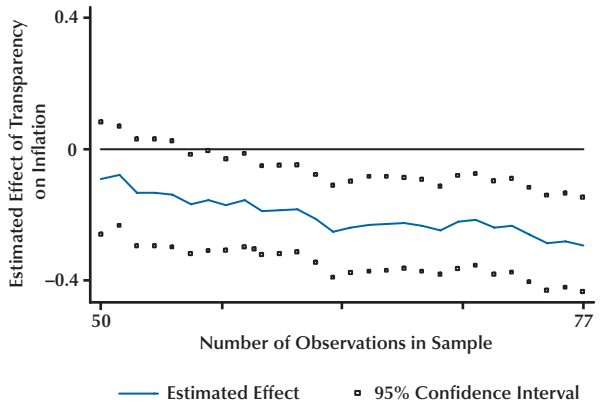
[29] The discussion of central bank governors in Mahadeva and Sterne (2000, pp. 182-205) illustrates that inflation-targeting countries have made transparency a key aspect of their framework. The Bundesbank has, according to Posen (2000), a long history of explaining its policies well, yet its independence is more widely perceived as contributing more strongly to its credibility.

[30] For example, if regimes are classified according to money targeting, exchange rate targeting, inflation targeting, and discretion, then only three countries (Australia, the United Kingdom, and Uruguay) have changed their regime as much as four times since the breakdown of the Bretton Woods agreement.

[31] Brazil, Chile, South Africa, and Thailand each now publish fan charts for inflation and provide explicit discussion of risks to inflation forecasts in regular inflation reports.

Figure 2

Results of Recursive Estimation



Transparency May Have Significantly Different Effects on Inflation Across Frameworks

Our discussion suggests that more explanation of policy does not significantly reduce inflation under all circumstances. Moreover, our point estimates of the overall effect, though large, were surrounded by relatively wide error bands, suggesting that there are a number of frameworks that are exceptions to the overall result. The governance structure of the central bank may affect the willingness of the central bank to publish forecasts. In some central banks, senior policymakers are responsible for the published forecast; in others, the central bank's staff are the sole authors.[32] Such differential arrangements may affect the perceptions of policymakers and the public alike regarding the closeness of the link between published forecasts and policy decisions, and this in turn may affect the transmission channels between transparency and inflation outcomes. To the extent that transparency operates by enhancing credibility, as is predicted by a number of the models we have discussed, the effect of transparency on inflation may be smaller when credibility has been secured by actions rather than words. This applies to exchange rate targeters (see results noted previously) and may also apply to countries with low inflation.[33]

Given that our sample includes countries both with very low and very high average rates of inflation, we examine the extent to which our results are stable when we exclude high-inflation countries from the sample. As a first step, we used a standard procedure to determine whether the coefficient on the Guttman scale was influenced by outliers. This resulted in the exclusion of five observations, after which the coefficient on the Guttman scale remained significant.[34] We then used a recursive estimation procedure to examine how our results changed as we progressively excluded high-inflation observations from the remaining sample. This was an iterative procedure which involved the following: (i) estimating regression (2) in Table 3 using a sample of the 50 countries with the lowest average rates of inflation, (ii) adding the observation with the next highest rate of inflation, and (iii) reestimating the regression and then repeating the process until we reached maximum sample size. Figure 2 plots the estimated coefficient on the Guttman scale, together with bounds for the 95 percent confidence interval according to sample size. The coefficient becomes progressively more negative as we include high-inflation countries in the sample, suggesting that the estimated anti-inflationary effect of publishing a forecast in our Table 3 regressions may be somewhat inflated by the inclusion of high-inflation countries.

Costs to Publishing Forecasts

There may be political and economic costs associated with a central bank publishing forecasts, and these may offset the benefits of potential reductions in inflation. To the extent that fiscal policy may in some circumstances be the root of high inflation, detailed forecasts are likely to pinpoint the source of the problem and could, in some cases, lead to tensions between the central bank and the government. Transparency may, in such circumstances, also be proxying for a degree of central bank inde-

[32] Kohn (2001) and Svensson (2001) include discussions on ownership of the forecast in their respective reports.

[33] A related issue is the optimal degree of transparency. It is conceivable that there exist circumstances when increased transparency might lead to a deterioration in welfare or an increase in inflation. Telling the public about a likely financial or exchange rate crisis might precipitate the crisis. And many central banks have developed well-resourced press offices to manage the clarity of published information.

[34] The countries excluded were Bahrain, Indonesia, Mauritius, Turkey, and Russia. We tested for outliers based on the *dfbeta* statistic, which measures the impact of an individual observation on a specific coefficient. Following standard practice, we excluded observations for which the absolute value of the *dfbeta* statistic was greater than

$$(2/\sqrt{n}),$$

where n is the number of observations. The coefficient on the Guttman scale was –0.29 (0.08), $p < 0.01$, after five outliers were eliminated (based on regression (2)).

pendence that may be very difficult to measure in conventional surveys.[35]

There may also be economic costs to introducing transparency that prevent central banks from publishing forecasts. The discussion of theoretical literature pointed to circumstances in which greater transparency may be associated with higher volatility in inflation and output. Where there is a risk of a banking or exchange rate crisis, for example, it is questionable whether or not a central bank should highlight such an issue by publishing forecasts. Cross-country evidence presented in Chortareas, Stasavage, and Sterne (2002) indicates that increased transparency may reduce the costs of disinflation in a sample of mainly industrialized economies.

Endogeneity and Reverse Causality?

There is a possibility that the results may be affected by reverse causality whereby low inflation may lead to greater transparency as well as being caused by it. Similarly there may exist endogeneity caused by cross-country differences in institutional circumstances, or macroeconomic conditions may imply systematic variation in transparency and inflation. In this section we seek to address these issues that have potentially serious implications for bias in our results.

Could it be the case that low inflation dissolves a central bank's preference for secrecy? Geraats (2001a) models the effect of transparency on the utility of both strong and weak central banks. Strong central banks are defined as having lower (unpublished) inflation targets than weak ones. She considers two alternative scenarios that shed light on the issue of endogeneity. In the first, transparency is exogenous, being imposed by the public. Weak central banks prefer secrecy since it affords them an opportunity to conduct stabilization policies with a lower probability of their preferences for relatively high inflation being revealed. In the case of transparency being an endogenous choice of the central bank, however, weak central banks also choose greater transparency. They overcome an inclination toward secrecy because they appreciate that secrecy will itself be interpreted by rational agents as a sign of weakness.[36]

We attempt to assess empirically the extent of any endogeneity. First, we can demonstrate that although transparency is positively correlated with other measurable characteristics of a country's economic, legal, and political environment, our results remain robust even when we control for the fact that transparency might be endogenous to these other factors. The second column in Table 6 shows simple correlation coefficients between our Guttman scale of transparency and other variables to which it might arguably be endogenous. These include measures of development (per capita GDP, OECD membership), other features of monetary policy (a focus on inflation objectives, legal central bank independence, quality of central bank analysis[37]), and measures for the political environment (democracy, political instability, political polarization, type of legal system[38]). As one might expect, transparency is positively correlated with a number of these variables, but in no case is the correlation high enough to suggest that transparency is perfectly correlated with another variable. Two of these variables, per capita GDP and political instability, are already included in our Table 3 regressions. As a next step, we reestimated regression (2) from Table 3 while adding one of the variables that may affect transparency. We repeated this procedure for each variable. In every single case, the coefficient on the Guttman scale remains negative, significant, and of roughly the same magnitude as in the original regression. The Guttman scale coefficient also remained significant when we included all variables in Table 6 simultaneously.

Although we can demonstrate that our transparency index is not merely proxying for levels of income or the level of democracy, it remains possible that our index may, to some extent, be influenced by some other political or economic variable x which may be difficult to measure directly. It may be possible to investigate this indirectly, though. If this unmeasurable variable x involves some broad change in the economic or political conditions that

[35] Fry (1998) questions the extent to which survey measures are capable of fully capturing central bank independence.

[36] Geraats qualifies this channel in her paper and provides possible reasons why, in spite of her results under endogenous choice of transparency, not all central banks are transparent. Furthermore, in Geraats (2001b) the author shows that the desirability of transparency depends critically on the institutional framework. In this model, when the central bank has limited independence, less transparency reduces the government's information about the economy, which discourages it from overriding the central bank.

[37] The FJMRS study collected data on the extent to which central banks conduct detailed analysis of inflation expectations (based on market information) and on the sophistication of the models used to generate forecasts.

[38] The type of legal system is a dummy variable distinguishing whether countries have a common legal system. Data are taken from La Porta et al. (1998).

Table 6

Correlation of Transparency to Economic, Political, and Legal Variables

	Correlation with Guttman	Coefficient on Guttman after inclusion†	Number of observations
Democracy	0.23	–0.34 (0.10)	64
GDP per capita	0.34	–0.26 (0.09)	82
OECD member	0.39	–0.21 (0.09)	82
Inflation target	0.17	–0.26 (0.10)	82
Central bank independence (FRJMS)	0.32	–0.28 (0.10)	82
Central bank independence (Cukierman‡)	–0.10	–0.39 (0.12)	47
Type of legal system	0.15	–0.26 (0.10)	82
Quality of CB analysis	0.44	–0.32 (0.09)	82
Political instability	0.07	–0.26 (0.09)	82
Political polarization	0.02	–0.24 (0.09)	82

NOTE: "Democracy" from the Polity III data set; "inflation target," "central bank independence," and "quality of analysis" from the FJMRS data set; "political instability" and "polarization" from Beck et al. (1999). Heteroskedastic-consistent standard errors are in parentheses; ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively.

†Each coefficient may be compared to –0.26, the result from regression (3) in Table 3.

‡Cukierman's central bank independence measure for 1980-89. A number of smaller countries in Cukierman's data set were not included in the FJMRS survey.

Table 7

Endogeneity of Transparency to Broader Policy Measures

	Correlation with Guttman	Coefficient on Guttman after inclusion	Number of observations
Fiscal surplus	0.30	–0.25 (0.11)	59
Foreign currency bond rating	0.37	–0.20 (0.08)	58

NOTE: "Foreign currency bond rating" from Standard & Poor's, January 2000; "fiscal surplus" from *International Financial Statistics*. Heteroskedastic-consistent standard errors are in parentheses; ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively.

leads to both increased transparency and lower average inflation, then we might expect it to lead also to improvements in other policy outcomes that are exogenous to inflation. For example, in many countries dramatic turnarounds in economic policy often involve both reductions in inflation and improvements in a government's fiscal balance, to the extent that fiscal balance can be seen as being exogenous to inflation. Likewise, a policy turnaround is also likely to lead to an improvement in the rating on a government's foreign currency bonds, which should be independent of domestic inflation. This suggests using the fiscal balance and the rating on foreign currency–denominated bonds in order to proxy for x. We can then perform the same test that we performed for variables such as "democracy." Table 7 shows the results, while also showing the simple correlation of each variable with the Guttman scale. The results strongly suggest that our original results with respect to transparency and inflation cannot be attributed entirely to broader policy improvements.

We also considered directly the possibility of reverse causality, whereby the negative correlation between transparency and inflation could reflect the fact that central banks are more likely to publish

Table 8

Endogeneity of Transparency to Past Inflation and Output Outcomes

	Correlation with Guttman	Coefficient on Guttman after inclusion
Past deviation of output from desirable	–0.16	–0.24 (0.10)**
Past output volatility	–0.26	–0.23 (0.09)***
Past deviation of inflation from desirable	–0.42	–0.16 (0.10)*
Past inflation volatility	–0.43	–0.20 (0.11)*

NOTE: "Past deviation of output from desirable" is average absolute deviation from 2 percent real GDP growth over 1990-94. "Past output volatility" is the mean deviation of real GDP growth with respect to the average level of GDP growth. "Past deviation of inflation from desirable" is average absolute deviation from 2.5 percent inflation over 1990-94. "Past inflation volatility" is the log of the mean deviation of inflation 1990-94 with respect to the average level of inflation for the same period. Heteroskedastic-consistent standard errors are in parentheses; ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively.

forecasts when they have greater control over macroeconomic outcomes. If this assessment is accurate, one would expect central banks to decide whether to make their forecast public based on the level and the volatility of past inflation (and potentially output). A bias would be introduced in our results, then, to the extent that lagged inflation or lagged inflation volatility is correlated with the current level of inflation.

For each of our sample countries using the five years preceding our sample period (1990-94), we calculated the mean absolute deviation of inflation and output from their desirable levels during this same period (2 percent inflation and 2.5 percent annual output growth). We also calculated the mean absolute deviation of inflation and output from their average level for the period, in order to measure volatility. As the endogeneity critique would suggest, our Guttman scale for transparency is in fact negatively correlated with lagged inflation outcomes over the 1990-94 period (see Table 8). We then included each of these four measures as control variables in regressions using the specification from regression (3) in Table 8. As can be seen in Table 8, the coefficient on the Guttman scale is essentially unchanged when we control for both lagged output and lagged output volatility. However, when we control for lagged inflation and lagged inflation volatility, the coefficient on the Guttman scale is less negative and somewhat less significant in each case ($p = 0.10$ and $p = 0.07$). The reduction in the significance of the coefficient after the inclusion of lagged inflation is to some extent inevitable. Lagged inflation is itself likely to have been caused partly by lagged transparency, measures of which are not at our disposal. So although we acknowledge that it is difficult to be certain that there is not some endogeneity between transparency and inflation, we are reassured that the association is clearly detectable even when we control for the effect of the average rate or volatility in past output and inflation.

Other Robustness Issues

We also considered several other robustness issues, including whether or not our results are stable when we consider subsamples of low-inflation countries, whether changes in the time period affect the results, and whether modifications in the Guttman scale lead to significantly different inferences.

In addition to investigating outliers, we also determined the extent to which our results are robust with regard to modification of the time period considered. When we performed regressions based on inflation data for individual years between 1995 and 1999, the coefficient on our transparency index was always negative and generally statistically significant at conventional levels.[39]

We also examined the possibility that the Guttman scale might not be the most appropriate technique for examining the relationship between average inflation and the transparency indicators collected as part of the FJMRS survey. We compared the results of our regressions using a Guttman scale with two alternative specifications. The first alternative was to take the simple average of the four

[39] Coefficients and standard errors for each successive year were –0.29 (0.10) for 1995, –0.15 (0.17) for 1996, –0.30 (0.09) for 1997, –0.28 (0.21) for 1998, and –0.41 (0.20) for 1999.

indicators. To test which of the two specifications (Guttman vs. average) provided more explanatory power, we used a simple non-nested test developed by Davidson and MacKinnon (1981); the test results supported using the Guttman scale.[40]

The second alternative to the existing Guttman scale involved creating a matrix of dummy variables, each of which takes a value of 1 for a particular range of values of the Guttman scale. This method allows the estimated effect of each step on the Guttman scale to vary, whereas introducing the Guttman scale as a single variable constrains the estimated effect of each successive step upward on the Guttman scale to be constant. Our sample countries can be divided into three groups of roughly equal size for this purpose. First, there are 25 countries that do not publish any form of inflation forecast (Guttman = 0). Second, there are 32 countries that publish a basic forecast that, in most cases, includes forward analysis on at least an annual basis (Guttman = 1 to 2). Finally, there is a third group of 25 countries that publish an inflation forecast including a discussion of previous forecast errors and, in most cases, a discussion of risks to the forecast (Guttman = 3 to 4).

We repeated regression (2) from Table 3, while substituting two dummy variables for the Guttman scale: one for countries with Guttman values of 1 and 2, and the other for countries with Guttman values of 3 and 4. Both dummy variables had the expected negative sign, and the dummy for Guttman values of 3 and 4 was both more negative and more statistically significant than the dummy for Guttman values of 1 and 2.[41] These results suggest that while there may be significant gains from publishing a basic inflation forecast, the marginal gain in terms of inflation performance from publishing a more detailed forecast may be even larger. It should be noted, though, that because the coefficient on the dummy for Guttman values of 1 and 2 was not highly significant, using a standard F test, we were unable to reject the null hypothesis that the coefficients on the two dummies were equal.

A final potential robustness issue involves the measurement of our dependent variable. While much of the cross-country literature on determinants estimates a semi-log model which minimizes the effect of high-inflation outliers, Bleaney (1999) argues that using log inflation as a dependent variable results in too much weight being given to countries with very low inflation. As an alternative, he suggests estimating an equation where the dependent variable is $(\pi_i)/(1 + \pi_i)$, where π_i is inflation in the ith country. All of our results from Table 3 remain robust when we use transformed inflation instead of log inflation as our dependent variable. As a further alternative, we also repeated our Table 3 regressions using a Box-Cox model, and the results of this estimation were nearly identical to our original semi-log specification.

Our Bottom Line on Robustness

We have subjected our results to numerous econometric tests, and they remain reassuringly robust. But how far have we gone in explaining the apparent empirical conundrum we highlighted at the start of the section—that few central banks publish forecasts in full detail in spite of the evidence that such acts would facilitate lower inflation? Although we have controlled for a number of additional variables in this section, it remains possible that the negative correlation we observe between transparency and inflation is biased by our inability to control for unobserved country effects.

To be absolutely confident that our results are subject to zero econometric bias, we would need more data. To eliminate the possibility of reverse causality affecting our results, for example, we would need to distinguish those central banks that were publishing forecasts merely to rubber-stamp their reputation, and those that were reluctant to publish because inflation was high. Such causality analysis would benefit from a time series or panel data on transparency, yet so far these data are unavailable. We feel comforted, however, that we know of no example of a framework in which policymakers have reduced transparency in response to an increase in inflation. Furthermore, to the extent that transparency locks in low-inflation policies even if it is introduced when inflation is already low, then

[40] The J test involves estimating each specification and saving the fitted values as a first step. Then, in the second step the fitted values from each specification are included as an additional explanatory variable in the alternative specification. The t statistic on the coefficient for the fitted values can then be used as a test of the null hypothesis that the alternative specification *does not* add any explanatory power. Using this test we rejected the null hypothesis that the Guttman specification did not add explanatory power to the "average" specification. In contrast, we could not reject the null hypothesis that the "average" specification does not add explanatory power to the Guttman specification.

[41] The coefficient (and standard error) for the dummy Guttman values of 1 and 2 was –0.48 (0.38). The coefficient for the dummy Guttman values of 3 and 4 was both larger and highly statistically significant: –0.98 (0.37), $p < 0.01$.

the issue of reverse causality becomes less important, since transparency may be effective in reducing and maintaining low inflation.

Of greater practical relevance could be the possibility that some central banks have attempted to improve macroeconomic policy by simultaneously altering policy preferences, transparency, and other aspects of the institutional framework, which could be argued to be the case in some inflation-targeting countries.[42] Cukierman (2000c) develops a model where there is a possibility of a policymaker being dependable or weak, yet inflation control errors are sufficiently large to offer weak policymakers a possible cloak of disguise. Dependable policymakers like to raise the probability of being revealed as such, whereas opportunistic policymakers like to reduce the probability of being revealed as weak. An interpretation of his results is that a decision to become transparent and a decision to become dependable may be observationally inseparable. Even with good time-series data, it would be difficult to identify the precise empirical role of transparency in such circumstances, yet our conclusion that publishing forecasts can lead to lower inflation is unaffected by this sort of endogeneity.

Overall, we acknowledge that in spite of the battery of tests we employ, we cannot be sure that our tests using cross-section data eliminate all possible biases. Yet our existing tests have gone far enough to make us confident that we have identified empirically an established theoretical channel for attaining and maintaining low inflation. Furthermore, there are important global policy implications: many central banks around the world could secure improved credibility and lower inflation by publishing their forecasts in greater detail.

VI. CONCLUSION

There are a number of aspects to central bank transparency, yet recent theoretical models and much of the policy debate focus on the role of the publication of central bank forecasts. The existing literature provides mixed suggestions and evidence on the welfare effects of monetary policy transparency. It is virtually unanimous, however, about the main proposition tested in this paper: greater transparency in monetary policy leads to lower inflation. Furthermore, one of the most important channels identified by the theoretical literature is entirely consistent with the practical experiences of the numerous central banks that have chosen to explain policy more thoroughly: transparency makes a central bank's credibility more sensitive to its actions.

This paper is the first to consider detailed cross-country evidence for a wide range of countries covering the effects of central bank transparency on monetary policy outcomes. We construct an index of central bank transparency based on forecast publications by central banks. The main empirical result is that greater transparency in publishing forecasts is associated with lower inflation. We acknowledge that it is difficult to be certain that there is not some endogeneity between transparency and inflation. We are, however, reassured that the result is robust to a comprehensive set of econometric specifications and robustness checks, and the association between transparency and inflation is detectable even when we control for the effect of the average inflation rate or volatility in past output and inflation.

Our results suggest that transparency contributes to lower inflation whether or not policy is based more on an inflation-targeting or money-targeting anchor for policy. In countries that target the exchange rate, the publication of forecasts does not appear to have a significant impact on inflation. Finally, we do not find evidence supporting the proposition that a high degree of transparency is associated with higher output volatility.

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[42] See Schaecter, Stone, and Zelmer (2000).

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Commentary

Adam S. Posen

In the span of 15 years, central bank transparency has gone from being highly controversial to motherhood and apple pie (or knighthood and fish and chips to the Bank of England–based authors of this paper). It is now an accepted broad goal to which all central banks pay at least lip service. Yet, like many other broad concepts in macroeconomic policy, such as "fiscal discipline" or "price stability," what central bank transparency actually means remains rather open to debate. Chortareas, Stasavage, and Sterne make a valiant attempt to test whether one particular aspect of transparency—the release of economic forecasts by central banks to the public—confers the benefits that some theories predict it should.

Recent monetary theory has had difficulties in generating much in the way of operational hypotheses about transparency for empirical examination. The bulk of today's theoretical models applied to central bank transparency—including those in the formal analysis of inflation targeting—cast the issue as whether or not a representative agent of the public can discern the central bank's "type" (wet or dry; that is, soft or hard on inflation) and therefore whether it is more or less "credible."[1] This is simply the wrong question to frame, especially in the developed economies: no one really has any doubts about the commitment of any current central banks to low inflation, and any reasons for doubt in this area would quickly become self-evident.[2] Even in the developing economies (which make up the bulk of the authors' sample), discerning runaway fiscal positions, overt political pressures upon central bank governors, or economic world views at odds with today's (perhaps questionable but evident) consensus on a vertical long-run Phillips curve is rather easy. Moreover, the all-or-nothing trigger strategy in these models implies that, once a central bank type is revealed, all is determined. This unrealistically reduces the conversation between central banks and the private sector to a simple long-lasting thumbs up or thumbs down. For purposes of even applied research, the failure of the predictions of these widely used models raises further questions[3] about much of the theoretical time-inconsistency framework that has been the workhorse of monetary economics in the last 20 years.[4]

The authors, presumably in pursuit of rigor and microfoundations, go to great pains to survey the extant literature in order to claim a source for their two testable hypotheses: that greater transparency reduces average inflation and increases output volatility. Yet, the fact that these hypotheses can easily be generated by a host of differing models and say nothing specific about which (measurable) aspect of transparency is at issue only underscores how irrelevant these microfoundations are. The two real issues are, instead, as follows: (i) to come up with hypotheses that are specific to transparency as distinct from just one more set of circular statements indicating that more credible central banks have better inflation performance and (ii) to derive reproducible measures of transparency that differentiate among the various types of information that may be disclosed by central banks. Unfortunately, the authors stick with the broad hypotheses and arbitrarily focus on a particular aspect of transparency, idiosyncratically measured. This puts them somewhat at odds with those few rigorous empirical investigations of central bank transparency that have already been done. Does it pay to be transparent? Yes, but not in the way the authors suggest.

SUMMARY OF THE ARGUMENT

The authors' plan of attack is deceptively simple. They go through the current theoretical literature on central bank transparency (primarily the works of Cukierman, Faust and Svensson, Geraats, and Jensen). They acknowledge the relative lack of clear consensus on operational predictions:

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[1] The seminal article starting this approach is Cukierman and Meltzer (1986). See Faust and Svensson (2000a) and Geraats (2001), among others, for examples of these models.

[2] Despite the constant invocation of the word "credibility," it remains unclear that this concept does any meaningful work, except as a circular validation of successful central banks' success. See Posen (1998).

[3] Broader problems with this framework, such as the observation that removal of the inflation premium proved rather easy once central banks chose to remove it, have been noted previously by Blinder (1998), McCallum (1997), and others.

[4] The founding papers being Kydland and Prescott (1977), Calvo (1978), and Barro and Gordon (1983), with the aforementioned Cukierman and Meltzer (1986) setting up a new subfield in this area. In the spirit of transparency, I should acknowledge my own reliance on such models in, for example, Kuttner and Posen (1999), despite earlier published misgivings.

> The currently expanding theoretical literature on central bank transparency identifies various channels through which increased transparency may affect economic policy outcomes. Not all of these move in the same direction. And neither is there a universally accepted definition of central bank transparency. Various authors conceptualize transparency in different ways…

They then abruptly decide in their investigations to "focus on the detail in which central banks publish forecasts…," suggesting that this is of wide interest without any particular justification for its saliency over preferences, targets, models, decisionmaking processes, or other aspects of central bank transparency. Fair enough, were they to make this an empirically driven exploration of simply what difference forecast disclosures make.

But the authors then underline the arbitrariness of their focus by spending several pages discussing the inconsistent theoretical models, most of which are concerned with the revelation of central bank preferences (over inflation versus output goals and for the target level of inflation). At the conclusion of the paper's first section, the authors assert that "transparency is generally conceptualized as the publication of central bank forecasts, since this allows the public to observe the control error." This claim is incorrect in two senses. First, in terms of the theory, the public is only able to discern the control error, given the forecast, if they are also informed of the model of the economy, of the nature of any revealed shocks (and/or the central bank's perception of those shocks), and most importantly of the central bank's true preferences. The forecast simply is not enough to reveal what the authors claim it does. Second, in terms of the empirical investigations, it is extremely difficult to say what specifically should be the impact of forecast releases on observable macroeconomic outcomes without considering what other information releases or institutional frameworks the central bank in question exercises.

In any event, the authors then identify two general hypotheses about the effects of transparency for testing: (i) that increasing transparency reduces the incentive to inflationary policies, never resulting in higher inflation outcomes and (ii) that improvement in inflation performance may be offset by a reduction in the capacity of the central bank to stabilize the economy. The authors then pull in "a new data set on central banking institutions," created from a survey of central banks conducted (under the leadership of one of the authors) by the Centre for Central Banking Studies of the Bank of England. The results on the subset of questions on "…the quality, scope, and frequency of forecasts and the extent to which forecast errors are monitored and publicly discussed" are to be used as the measure of the independent variable of transparency. It should be kept clear that they are testing joint hypotheses—their offered hypotheses plus the idea that forecast releases are a sufficient measure of transparency plus the idea that the results of their measure accurately portray forecasts—and not just the hypotheses about transparency per se.

In fact, this is critical, since the availability of this survey data determines the scope of the authors' investigations. The authors proceed to conduct a cross-sectional analysis of the effects of this measure of forecast disclosure on the level of inflation and of the volatility of output, in a sample of 87 countries over the period 1995-99. The four aspects of forecast disclosure are amalgamated into a four-point Guttman scale, a new twist on the standard additive indices for such measures. They find a significant negative correlation between their measure of forecast transparency and average inflation, even when controlling for such institutional factors as fixed exchange rate pegs, political instability, and central bank independence. They find no such significant correlation between the disclosure of forecasts and average output volatility. Finally, the authors take on a large number of what they consider robustness checks to their results, but they rephrase those as the question, since "the effort required for a central bank to publish detailed forecasts may not appear to be particularly arduous relative to the benefits of securing lower inflation…Why, then, do many more central banks not introduce forecasts?" They end up raising a number of questions about the possibility of reverse causality, to which I will return.

SOME FRIGHTENING FOOTNOTES ON THE RESULTS

Leaving aside for the moment the questions of whether the dependent and independent variables are properly defined, consider the authors' results on their own terms. Is the significant negative correlation between this measure of forecast disclosure and the average level of inflation (and the absence of any such correlation with output volatility) well established? Given the authors' commendable clarity

with which they conduct their investigations, there are a number of details which unfortunately raise some doubts. These have to do for the most part with the construction of the forecast disclosure index and with the nature of the sample determined by the availability of this index.

A particular concern is the absence of discussion of subsamples beyond Table 1, where the distribution of responses across industrial, transitional, and developing economies' central banks is displayed. As shown in Table 1, however, there is a strong correlation between level of development and positive response to the survey regarding forecast disclosure: 56 percent of industrial countries publish forecasts with words and numbers versus less than 25 percent of transitional and less than 33 percent of developing countries; 25 percent of industrial countries publish "words and numbers" risks to the forecast, while only 9 percent of transitional and no developing countries do. While the authors later include per capita gross domestic product (GDP) as a control variable, this is likely insufficient to account for such differences. In fact, in their robustness checks, as displayed in the authors' Figure 2, the authors note that "[t]he coefficient becomes progressively more negative as we include high-inflation countries in the sample, suggesting that the estimated anti-inflationary effect of publishing a forecast in our Table 3 regressions may be somewhat inflated by the inclusion of high-inflation countries." This is more than somewhat inflated—as the authors move from 50 observations to 63 (in their total sample of 94), the estimated coefficient drops below the lower bound of significance on the point estimate at 50, while at 50 it was not significantly different from zero. Considering that industrial economies make up only 28 observations of their full sample, this hardly is convincing of subsample stability. This problem is exacerbated when one considers that, by dummying out the pegged exchange rate countries in their Table 3, they are disproportionately taking out (European) developed countries from their sample.

A second set of concerns has to do with embedding these results in the other aspects of central bank structure. In short, for us to believe in these results about the effects of forecast disclosure, we have to believe that other aspects of central bank transparency, independence, exchange rate regimes, and the like are appropriately held constant. While the authors make some attempt to do so, notably by including the fixed exchange rate yes/no classification from the International Monetary Fund's (IMF) lists in their Table 3 regressions, these are insufficient. The authors' controls for inflation or money [sic] targets in Table 3 are based on central banks' self-reporting from the same central bank survey (see their footnote 22). As there is great dispute over who should call themselves "inflation targeters" (including those who are "implicit targeters") and similar dispute over "monetary targeters" (with many who assume this label having proven their tendency to ignore their stated monetary targets while making policy decisions), this measure should be replaced with a standardized, independently observable means of verifying targeter status.

Moreover, given the narrowness of the authors' "focus" on forecast disclosure, it is difficult in the time period they consider (the late 1990s) to disentangle high scores on this measure from the adoption of inflation targeting writ large. The authors themselves state in footnotes 30 and 31 that there is some coincidence of the two and that their reporting of self-assessed measures of targeter status leads to some strange results (e.g., that only three countries have changed their regimes four or more times since Bretton Woods, which points up a very awkward definition of regime). In their controls for central bank independence, they use a very noisy measure made up of five elements even though the literature has long since established that only one aspect of central bank transparency has predictive power for the industrial economies (restrictions on direct central bank purchases of government debt) and a different single aspect has power for developing economies (turnover of central bank governors).[5]

There are also some plain strange results which are disclosed in the authors' discussion, but not taken sufficiently seriously. In footnote 23, they point out that, while they get their expected results for a negative correlation between forecast disclosure and inflation level, they find no link between their measure and inflation volatility, despite the long-standing correlation of inflation's volatility and level. Given that the relationship between inflation volatility and level increases with the level of inflation, this may be another indicator that their desired correlation is being driven unduly by the low-inflation countries. In footnote 27, the authors note that only 3 of their 87 countries get a top score on their four-point Gutman index of forecast disclosure; but footnote 41 shows that all the major variation across

[5] Berger, de Haan, and Eijffinger (2001) and Eijffinger and de Haan (1996).

countries is in the jump between scores 3 and 4—in other words, it is only whether the risks to forecast are discussed that matters, and this should have been done as a simple dummy. But, definitionally, this is the aspect of the authors' forecast disclosure that has most to do with preferences, least to do with forecast narrowly defined, and probably least dependable as gathered in a self-description. This re-raises the questions about the authors' definition of the independent variable as a measure of transparency.

Finally, the authors' Table 8, meant as a robustness check using lagged inflation and volatility to test for reverse causation between low inflation and forecast disclosure, shows that the greater the past inflation and output deviations (from "desirable," presumably high and low, respectively) and the greater the past volatility of each, the less disclosure of forecasts.[6] Given that this runs opposite to the theoretical models (e.g., those of Faust and Svensson) that the authors invoke to justify their investigations suggesting that central banks with less credibility will need to disclose more, this re-raises questions about the authors' definition of the dependent variables of interest as average inflation and average output volatility. It also suggests, as the authors acknowledge, "that it is difficult to be certain there is not some endogeneity between transparency [as defined by their forecast disclosure measure] and inflation…"

WHAT DEFINITION OF TRANSPARENCY IS RELEVANT?

Returning to the design of the authors' investigation, we have to reconsider the explanatory variable. As discussed in Posen (1999), we can use the control theory view of monetary policy to come up with the aspects of central bank behavior that can be revealed by transparency. Essentially, the central bank has preferences over macroeconomic outcomes, an intermediate target linked to a model of the economy, and a forecast of that economy based on shocks revealed to date. If the issue is to determine the central bank's preferences on the relative weight of inflation versus output goals or for a longer-term target for inflation, the public and markets need two of these three plus the outcome in the economy in order to determine the remaining one. A forecast alone, even combined with economic results, does not necessarily reveal preferences, without a clear revelation of the central bank's model. Yet, in the real world, central banks never have one exact model that is relied upon consistently, especially when there are multiple monetary policy decisionmakers (voters on a committee) and changing economic structures; and, in the real world, the public and even markets are unable to discern such models and reason backwards from them and from forecasts and shocks to determine central bank preferences, even if it is possible theoretically.

Ultimately, central bank transparency is about the broad communication of general preferences by the central bank. When the public trusts in the preferences of the central bank, its inflation expectations will respond differently to shocks than when trust is less (King, 1997; Kuttner and Posen, 1999). In this regard, it is important to have a forecast definition that is not just the revelation of numbers, but a mechanism for a structured conversation with the public that conveys the central bank's evaluation of shocks and reinforces the longer-term goals. Posen (2000) sets out this framework and identifies it as the source of the Bundesbank's success. This would imply that the independent variable to measure is the institutional framework committing the central bank to regularly report on its activities and explain its performance against its stated goals (Kuttner and Posen, 2001, give one way of operationalizing such a measure for empirical work).

Interestingly, this is consistent with the fact noted in the previous section that the bulk of variation and explanatory power in the authors' measure has to do with whether or not (in their survey) central banks discuss risks to the forecast. Thus, it is not the forecast specifically or the implication of reasoning backwards to a model (to "discern control errors" as the authors have it) that counts. It is the provision of context for economic decisionmakers. This underlines the difficulties the authors have in "controlling" for the broader institutional structures of inflation targeting, central bank independence, and exchange rate pegs in their investigations.

Given that the authors have only a cross-section of central bank self-definitions, because of their commitment to use survey data from a specific one-time survey, they cannot distinguish whether the disclosure of forecasts is the result of a prior or contemporaneous adoption of inflation targeting

[6] Another problem with this examination of endogeneity is that all countries' desirable real growth level is presumed to be 2 percent, and the desirable inflation level is presumed to be 2.5 percent, which is rather inappropriate for a sample that includes numerous developing and transitional economies.

or of something called (but not necessarily indicative of) central bank independence. Their use of the IMF's definition of exchange rate pegs is particularly misleading in this set-up: it is impossible to tell whether inflation forecasts do not offer "transparency benefits" when pegs are in place (i) because of a lack of discretion or (ii) because inflation is irrelevant to the goal of the central bank (especially because, as is now well-known, many floaters seem like fixers). Ultimately, the authors' use of their idiosyncratic measure of forecast disclosure as a measure of transparency, and their reliance on the one-time observation of it, renders their definition of the explanatory variable irrelevant.

WHAT EXPECTED IMPACT OF TRANSPARENCY IS REASONABLE TO TEST?

Whatever the measure of transparency, the authors have another hurdle in deciding which variables should be affected by it. As mentioned, they test two—average inflation level and average output volatility—finding support for a negative correlation between transparency and the first and no correlation with the second. But are these the right variables to test? It is not clear that average macroeconomic outcomes, particularly of real variables, are the right dependent variables for investigations of transparency. The obvious problem, particularly on the real side, is the inability to control for a sufficient range of factors, including the degree of structural change induced (or not) by changes in monetary regime, a la Lucas.

More importantly, though, is the question of what one thinks central bank transparency is for. Even if the central bank has a greater commitment to low inflation, or can be held to one because of increased transparency (which seems to be the authors' vision), dependent upon the shocks that the bank faces, it can choose to let inflation rise temporarily. For example, after the second oil shock in 1979, the Bundesbank allowed its "unavoidable rate of price increase" to climb from 2 percent to over 4 percent in 1980 and then transparently brought it down year-by-year to 1986 (see Laubach and Posen, 1998). This may well have been the optimal response to a supply shock for a (nearly) inflation-targeting central bank (see Bernanke et al., 1999, Chap. 4). What made the Bundesbank's policy a success was that this optimal easing did not result in pass-through of a second round of inflation increases, or even a particularly costly disinflation.

Kuttner and Posen (1999, 2001a,b) argue that this means the real issue of central bank transparency is therefore the reaction of inflation expectations and (long-bond) markets conditional on central bank action. The implication is that the macroeconomic variables likely to be affected most directly by transparency are inflation persistence, not inflation level, and the ratio of inflation and output volatility, not the level of output volatility. Following King's (1997) articulation of the optimal state-contingent rule strategy for an inflation-targeting central bank, increased transparency should remove Svensson's (1997) stabilization bias, reducing inflation persistence, and should free the central bank to be more aggressive about stabilizing output. From this point of view, the authors' focus on inflation level as the dependent variable is misguided, even if one accepts that the point of transparency is to make the central bank more sensitive about its reputation.

THE CELL PHONE–LIKE USES OF CENTRAL BANK TRANSPARENCY[7]

What are the hypotheses that might be tested about central bank transparency, and what are the appropriate measures that might be utilized instead of the ones in the authors' paper? Think of the relationship between a central bank and the attentive public as analogous to the relationship between a married couple. Good communication is key if the relationship is to cope well with the bumps and bruises of everyday life. While familiarity removes the need for too much explicitness in communication, changing surroundings and personal needs over time make it dangerous to take too much previous understanding for granted. Presumably, the relationship is for the long-term and day-to-day misunderstandings do not imperil the relationship, but they can make it less pleasant or mutually beneficial.

My wife already has a (subjective) estimate of how considerate a husband I am, that is, my "type" on a scale of wet to dry. While she may update it if I were to do something extraordinarily bad or good more than once, she is unlikely to do so as a result of our quotidian existence. In fact, small variations in the day-to-day signals she gets from me are likely to be ignored, while any big changes will be easily noticed, whatever the day-to-day signals. Communication between us, therefore, is not about her judging my type or my commitment—instead, it is about the smaller, practical issues of coordination.

[7] This section is drawn and adapted from Posen (2002).

This fall, in response to the more worrisome world in which we find ourselves, my wife had me get a cell phone. This cell phone increases the transparency with which I live my life: I can be reached at any time we are apart, and similarly I can reach her; in an emergency (God forbid), I can make a call; and, most concretely, we can use it to update each other on our schedules, such as who is likely to get home first from work. I can be more or less considerate about updating her by using the cell phone (probably well within one standard deviation of how considerate I was prior to having this transparency mechanism). Yet, her primary concern is to know where I am for practical reasons and not to have a means of monitoring my commitment to her well-being.

Being a bit more explicit, there are six conceivable channels through which my use of the cell phone could affect her:

- She could be more relaxed in general if updates via cell phone about my comings and goings reduce her worry.
- She could find life a little easier if this device makes it simpler for us to adjust our schedules.
- She could find that, after all, she really does not care about what I say on the cell phone, just that I am no less prompt or responsive than I was before.
- She could herself become more cognizant of my activities and use this to demand greater responsiveness, perhaps interfering with my normal habits.
- She could become annoyed if I were to say that I would call at a specified time and am late in doing so.
- Or, she could be more (rather than less) worried if she came to count on my calls and events beyond my control, even innocuous ones, prevented me from calling.

It is ultimately an empirical matter which of these various, occasionally contradictory, but all theoretically plausible, effects will turn out to be of practical import to the day-to-day functioning of our relationship. To repeat, none of this, however, should change her basic estimate of what type of husband I am and therefore of my level of commitment.

Now, consider the analogous situation of a central bank communicating with its public (including financial markets) as part of an ongoing relationship based on a fundamental assumption of trust and good will. The addition of various recent measures of transparency to monetary policymaking—announced inflation targets, disclosure of votes, timely publication of minutes, explicit forecasts, and so on—in hopes of showing sensitivity to markets and the public's concerns are the equivalent of my acquisition and use of the cell phone in response to my wife's concerns. Being a bit more explicit, there are six conceivable channels through which central banks' enhanced transparency could influence the public's and markets' reaction to monetary policy (see Table 1):

- The public could be *reassured* in general if updates via regular releases about policy decisions reduce worry about what is going on in the short-term.
- The public, and particularly markets, could find it a little easier to plan their actions if transparency about the *details* of the economy makes the world more predictable.
- The public could find that, after all, what central banks say is *irrelevant*, so long as the central banks are no less responsive to shocks than before.
- The public, and particularly markets, could become more cognizant of central bank activities and use this to demand greater responsiveness *contingent* on specific targets, perhaps interfering with central banks' normal habits.
- The public could become *annoyed*, adding political pressures, if central banks were to announce a specific target or forecast, and fail to meet it.
- Or, the public could be more (rather than less) worried in general if it demanded adherence to announced targets, *diverting* central banks from responding optimally to shocks.

As Table 1 summarizes, each of these six practical views of central bank transparency (reassuring, detailed, irrelevant, contingent, annoying, and diverting) focuses on a specific set of information releases, with a specific hypothesis for the impact of those releases upon expectations and central bank behavior and for the mechanism by which this impact is transmitted. None of these hypotheses can be ruled out a priori on theoretical grounds, and these multiple options show the diversity of implications possible from (and proposed in) the current literature on central bank transparency. All are subject to empirical examination, and some work has already been completed. On the reassuring

Table 1

Practical Views of Central Bank Transparency

View of transparency	Information released	Hypothesized impact	Cause of impact	Testable impact	Result
Reassuring	Regime, speeches	Greater flexibility	Greater trust	Inflation persistence	Supported by evidence
Detailed	Forecasts, models	Greater disclosure	Greater predictability	Market response	Supported by evidence
Irrelevant	Whatever	None	Only actions matter	Inflation level	Exact opposite—lower inflation
Contingent	Mandate, votes	Stronger reputation	Greater credibility	Inflation volatility	Unsupported by evidence
Annoying	Minutes, targets	Greater confusion	Increased politicization	Effect of target misses	Unsupported by evidence
Diverting	Targets, goals	Less discretion	Increased oversight	Output volatility	Unsupported by evidence

view, as discussed in the preceding section, Kuttner and Posen (1999, 2001a,b) have offered evidence that the announcement of explicit inflation targets is associated with a decline in inflation persistence and no rise in output volatility; this tends to contradict the diverting view, which is the mirror image with opposite predictions. On the details view, Daniel Thornton has done a series of papers (including Poole, Rasche, Thornton, 2002, for this conference) indicating the benefits of disclosure for the U.S. Treasuries market.[8] The authors of "Does It Pay To Be Transparent?" can find in these papers some evidence that their answer of yes is correct, even though the authors' own method of assessing the contingent view is unconvincing.

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Does Inflation Targeting Matter?

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I. INTRODUCTION

Since it was first introduced by New Zealand and Chile in 1990, Canada in 1991, and the United Kingdom in 1992, inflation targeting (IT) has received a lot of attention in the public and academic debate over the design of monetary policy regimes. In part, this attention reflects the growing number of countries that have adopted an IT regime over the past decade. Schaechter, Stone, and Zelmer (2000) count 13 countries with IT experience as of February 2000: Australia, Brazil, Canada, Chile, the Czech Republic, Finland, Israel, New Zealand, Poland, South Africa, Spain, Sweden, and the United Kingdom. Corbo, Landerretche Moreno, and Schmidt-Hebbel (2001) add Korea and Thailand to this list. Most recently, Hungary and Switzerland have introduced inflation targets. Since the Bundesbank declared a normative target inflation rate as the principal goal of its monetary policy, Mishkin and Posen (1997), following von Hagen (1995), classify Germany as an early case of IT, although the German inflation objective was formulated for the medium run, while the short-run focus of the Bundesbank's monetary strategy was on the annual monetary target.

As early as 1994, an academic conference reviewed the experience with IT (Leiderman and Svensson, 1995). A number of more recent studies summarize the experience gained with IT over the past decade (Bernanke et al., 1999; Corbo, Landerretche Moreno, and Schmidt-Hebbel, 2001). These papers focus on a variety of questions related to the choice of monetary regimes, including the improvement in inflation performance, in monetary policy credibility, and in the sacrifice ratio, i.e., the cost of lowering inflation.

The debate over IT exposes a couple of odd characteristics. One is that, despite a lot of effort, empirical studies on IT have consistently failed to show convincingly that IT has been an important factor in speeding up disinflation, achieving lower inflation rates, lowering the cost of disinflation, or raising the credibility of the central bank's commitment to low inflation. An important challenge for IT supporters comes from the observation that the environment of the 1990s, when IT was first undertaken, was generally benign, implying that the particular strategy of IT may have done little to improve monetary policy outcomes over what any reasonable strategy could have achieved (Cecchetti and Ehrmann, 2000). We will review this literature in more detail in Section II.

The other oddity is that, despite the lack of empirical evidence supporting the advantages of IT, its proponents consistently argue that the failure to adopt it jeopardizes the ability of a central bank to deliver price stability. For example, Bernanke et al., after presenting pages upon pages of rather inconclusive evidence regarding the superiority of IT, nevertheless submit a plea for the Fed to adopt IT in the end, arguing that this is critical to secure price stability in the United States in the post-Greenspan era. Similarly, Alesina et al. (2001), in a discussion of the European Central Bank's (ECB) monetary policy, boldly claim that the ECB could improve its policy by adopting a version of IT, although they neither present supporting evidence for this claim nor even indicate where such evidence might be found. It is understandable that some academics find IT intellectually attractive for the outright declaration of central bank intentions and the increase in accountability implied by the announcement of an inflation target. Yet, others remain skeptical: Both the ECB (2001) and the Fed (Gramlich, 2001) have argued that they do not regard IT as an appropriate monetary policy framework.

In this paper, we contribute to the assessment of IT in several ways. After reviewing earlier studies of IT experiences, we examine the changes of short-term interest rates and of consumer price inflation and output gaps at different frequencies, as well as show that IT has reduced short-term variability in central bank interest rates and in headline inflation. We interpret this as evidence that IT has induced central banks to pay less attention to short-run news and noise and adopt a steadier course of monetary

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policy. Next, we study central bank behavior and ask whether IT has resulted in a change in central bank reactions to key monetary policy variables. We estimate Taylor rules to describe central bank policies and find that these rules indeed indicate changes in the reaction of IT central banks to output and inflation. Furthermore, we find that this fact distinguishes them from a group of other central banks that we use as a benchmark. This difference suggests that IT has affected central bank behavior.

Third, we take an event-study approach to compare the performance of IT and non-IT central banks under two similar, exogenous shocks, namely, the oil price hikes of 1978 and 1998. We find that IT countries realized a credibility gain in the second episode compared with the first, allowing them to keep interest rates lower and face these shocks with a much less contractionary monetary policy. Our paper thus suggests that IT has indeed changed central bank behavior and that this policy yields benefits under those circumstances that central banks have historically found difficult to cope with. But comparing IT and non-IT central banks shows that the former have conformed to the standards of monetary policy set by the Bundesbank, the Fed, and the Swiss National Bank in the late 1970s and 1980s. Thus, we cannot confirm the superiority of IT over other monetary policy strategies geared at price stability.

II. BENEFITS OF INFLATION TARGETING: WHAT ARE THEY?

The literature on the design of monetary policy under IT and experiences with the new regimes has expanded rapidly in the past six years, partly reflecting the growing number of countries adopting such a regime. Most of the studies presented in the literature look at the time-series behavior of inflation, output, unemployment, and interest rates to see whether the new regime affected the dynamic interaction of these variables.

Early studies by Ammer and Freeman (1995) and Freeman and Willis (1995) present vector autoregression (VAR) models for real gross domestic product (GDP), price levels, and interest rates. Ammer and Freeman compare inflation forecasts generated from their VARs with actual outcomes in New Zealand, Canada, and the United Kingdom and with actual time series. They find that inflation fell by more than was predicted by the models in the early 1990s, an indication of the effect of the new regime. The evidence regarding the cost of disinflation is more mixed. Real GDP fell and recovered in New Zealand and the United Kingdom, but fell and remained low in Canada. Freeman and Willis (1995) note that long-term interest rates fell in the three IT countries in the early 1990s, an indication of improving monetary policy credibility. However, long-term rates came back a few years later. This occurrence could indicate that the credibility effect of IT did not last long, although Freeman and Willis ascribe most of the resurgence in long-term rates to a rise in interest rates worldwide.

Mishkin and Posen (1997) present careful accounts of the IT experiences in New Zealand, Canada, and the United Kingdom and estimate VARs of core inflation, GDP growth, and short-term central bank rates for the same countries. They point out that the disinflation had actually been almost completed in New Zealand, Canada, and the United Kingdom before the introduction of IT. This suggests that IT might have served to lock in the gains from disinflation rather than to facilitate disinflation. Mishkin and Posen then ask whether IT helped these countries to keep inflation rates down following the initial disinflation. Comparing dynamic simulations with actual outcomes, they find that inflation and interest rates remained below their counterfactuals after the introduction of IT, while output did not. In particular, actual inflation did not rise with the upswing in the business cycle, as it would have prior to IT. One shortcoming of these results is the absence of confidence bands in their dynamic forecasts, which implies that their positive conclusion relies on visual inspection alone. Laubach and Posen (1997) find further evidence supporting these results by analyzing interest rates and consumer expectations. Kahn and Parrish (1998) observe a number of inflation blips in New Zealand and Canada during the 1990s, suggesting that the central banks did not necessarily achieve better control through IT.

Debelle (1997) looks at a larger sample of IT countries, including the former three plus Sweden, Finland, Spain, and Australia. He notes the decline in inflation rates and long-term bond rates achieved in these countries but points out that unemployment increased in the same countries during the disinflation, indicating that the latter did not come without cost. Furthermore, Debelle points out that other countries achieved similar reductions in inflation rates during the first half of the 1990s, making it difficult to conclude that the disinflation is a success of the IT regime. Siklos (1999) argues that the intro-

duction of IT should change the persistence of inflation rates, as central banks no longer tolerate lasting movements of the actual rate outside the target range. Using univariate time-series techniques and quarterly inflation data, he finds that first-order autocorrelation of inflation rates has declined significantly after the introduction of IT in Australia, Canada, and Sweden, but not so in Finland, New Zealand, Spain, and the United Kingdom.[1]

Other empirical studies have focused more on the behavior of central banks before and after the introduction of IT. Kahn and Parrish (1998) note that the volatility of official central bank interest rates (both nominal and real) has declined substantially after the introduction of IT. They argue that this could reflect a change in monetary policy away from activist policies, but it might also be due simply to a more stable economic environment in the 1990s. The fact that interest rate volatility decreased in the United States, too, lends some support to the second interpretation over the first. Kahn and Parrish also estimate monetary policy reaction functions for New Zealand, Canada, Sweden, and the United Kingdom relating current official rates to their own lags as well as lagged inflation, unemployment, and exchange rates. They find significant structural breaks in these functions for New Zealand and the United Kingdom. In the case of New Zealand, this break is associated with a stronger reaction of the official rate to lagged inflation and unemployment and a weaker reaction to lagged exchange rates. In the U.K. case, the break mainly reflects the loss of significance of the exchange rate in the reaction function. In neither case is it obvious that the changes in the reaction function are consistent with a shift to inflation as the primary goal of monetary policy after the adoption of IT.

Kuttner and Posen (1999) interpret the introduction of IT as a change in the central bank "type," i.e., a shift in the parameters of the central bank's preference functions, toward a stronger commitment to price stability and less discretionary policy. According to their model, such a shift should imply a decline in inflation persistence. The response of short-term interest rates to inflation shocks could increase or decrease, however, depending on the central bank type prior to IT. Kuttner and Posen estimate VARs for inflation, unemployment, and short- and long-term interest rates to test the impact of IT. Their results are rather ambiguous. For Canada and the United Kingdom, they find no change in the persistence of inflation after the introduction of IT, nor a change in the central bank reaction functions. For New Zealand, they do find a reduction in the persistence of inflation, but also a stronger reaction to unemployment with no change in the reaction to inflation in the central bank's reaction function.

Cecchetti and Ehrmann (2000) look at a sample of 23 countries, both developed and less developed, 9 of which have central banks pursuing inflation targets. A first observation from their data is that inflation rates generally came down in the 1990s compared with the 1980s independent of the geographical region of the country, their pursuit of inflation targets, or whether they were striving to enter the European Monetary Union at the end of the decade. This indicates that the 1990s were a period friendly to increased price stability. Cecchetti and Ehrmann then ask whether this improvement in price stability reflects a change in central bank aversion to inflation and whether this is particular to inflation targeters or not. They find that their measure of inflation aversion indeed rises between the mid-1980s and the 1990s among IT central banks. Unfortunately, their methodology provides no standard errors for testing whether these changes are statistically significant. A similar observation of rising inflation aversion holds for other central banks, too. Furthermore, inflation aversion of the IT central banks rises to no more than the levels of non-IT central banks. Thus, rather than being a product of the IT regime, the rise in inflation aversion may just reflect the general culture among central bankers in a decade that provided an environment conducive to price stability and, therefore, an opportunity to move away from the inflationary policies of the 1970s and 1980s.

Corbo, Landerretche Moreno, and Schmidt-Hebbel (2001) build on this study and show that inflation aversion increased during the 1990s among IT countries that do not belong to the group of industrialized economies, most notably Israel and Chile. Among industrialized countries, inflation targeters do not show an increase in inflation aversion. The same authors also suggest that IT central banks lowered the dynamic reactions to current inflation and output gap shocks. They also find that inflation persistence has declined substantially among IT countries since the introduction of the new regime. According to their results, inflation persistence was much higher in IT countries than in others before

[1] Siklos finds that the first-order autocorrelation lost statistical significance after the introduction of IT in Finland, Spain, and the United Kingdom, but this result may be due to the relatively short sample he has in quarterly data.

the introduction of IT, i.e., the new regime has produced more similar inflation dynamics.

A central feature of IT regimes is the publication of inflation forecasts and surrounding analysis to explain the central bank's assessment of monetary conditions and its monetary policy actions to the public. IT has thus contributed to improving the transparency of central bank policy. This is the focus of Chortareas, Stasavage, and Sterne (2000), who develop a measure of monetary policy transparency and use it to compare monetary policy performance across countries. These authors construct a panel data set for 87 countries and show that transparency has a significant negative impact on average inflation rates over time. This corroborates the impression that inflation targeters were able to bring and hold inflation down in the 1990s; at the same time, their results also show that IT is but one way of achieving that.

III. INFLATION TARGETING: NEW TIME-SERIES EVIDENCE

In this section, we present new empirical evidence on the performance of IT central banks. Following the comparative approach of previous papers, we consider a group of IT countries (viz., Australia, Canada, Chile, New Zealand, Sweden, and the United Kingdom) and a group of non-IT countries (Germany, Switzerland, and the United States). Our reference group thus contains two countries that used monetary aggregates as their intermediate targets of monetary policy in the past, Germany and Switzerland. We are primarily interested in this question: Did central bank behavior change under inflation targeting and, if so, how?

We use monthly as well as quarterly data spanning the period from September 1978 to March 2001. For Germany, we end the sample in December 1998 to account for the start of the European Monetary Union. The sample period is divided into two subperiods in order to test whether IT made any noticeable difference. The first sample runs up to June 1992, and the second sample starts in January 1993. We leave out the second half of 1992 to eliminate the interest rate effects of the crisis of the European Monetary System. The choice of subperiods is somewhat arbitrary, as some IT countries such as Chile and New Zealand had already adopted the new policy regime in 1990, whereas countries such as Sweden and the United Kingdom only started in 1993. Since we do not focus on any single country but are looking for cross-country evidence, we found this choice preferable as it allows us to use the same subperiods for all countries considered.[2]

Volatility of Interest Rates, Inflation, and Output Gaps

We begin this section by studying the volatility of consumer price (CPI) inflation, short-term interest rates, and output gaps. The interest rates are overnight money rates; exceptions are Chile and New Zealand where, due to data availability, we use 3-month interest rates. Since output gaps calculated from GDP are not available at a monthly frequency, we generally use the index of industrial production; exceptions are Australia, New Zealand, and Switzerland, where monthly data on industrial production are not available. For Australia and New Zealand the output gap is calculated from quarterly GDP data; for Switzerland, monthly GDP data are used. The output gap is defined as the percentage difference between the actual index value and a trend derived by applying a Hodrick-Prescott (HP) filter.

Panel A of Table 1 shows average annual inflation rates together with the standard deviation of annualized monthly, annual, and biannual relative changes in the CPI for the two sample periods. These standard deviations provide a simple measure for the volatility of inflation at different frequencies. We first note the well-known fact that the level of inflation has been reduced everywhere. In the pre-IT period, the IT countries were less determined to squeeze out the inflation inherited from the 1970s and hence were troubled by much higher average inflation than the non-IT countries. Thus, the adoption of IT can be regarded as the consequence of this poor performance. With regard to the level of inflation, the new policy regime has been successful. Average inflation in IT countries has come down to the level observed for non-IT countries—Chile being an exception. Note that average inflation in the post-IT sample matches the medium-run target rates for Germany (1.9 percent) and the United Kingdom (2.6 percent), while it undercuts the 2 percent target rates of Canada and Sweden by half a percentage point. Similar to average inflation, the volatility of inflation has fallen in IT as well as non-IT countries. Again, similar to average inflation, the volatility of inflation in IT countries has converged from relatively

[2] The main data source is the International Financial Statistics (IFS), supplemented by data for Australia and New Zealand from the Organization for Economic Cooperation and Development (OECD).

Table 1

Volatility of Inflation, Interest Rates, and Output Gaps

A. Volatility of inflation

	1978:09–1992:06				1993:01–2001:03			
		Standard deviation of				Standard deviation of		
	Average inflation	1 month	12 months	24 months	Average inflation	1 month	12 months	24 months
Industrial countries	5.9		3.0		2.0		0.5	
Australia	7.3		2.8	2.3	2.5		1.9	1.4
Canada	5.9	4.8	3.1	1.5	1.5	3.0	1.1	0.8
Chile	20.1	22.1	8.1	6.1	6.3	5.4	2.8	2.4
New Zealand	9.8		5.8	5.1	1.8		1.3	0.9
Sweden	7.5	7.9	3.1	2.7	1.5	4.2	1.1	0.8
UK	7.4	8.0	4.4	3.8	2.6	4.5	0.7	0.4
Germany	3.1	4.1	2.0	1.9	1.9	2.8	0.6	0.5
Switzerland	3.7	6.8	1.9	1.8	1.1	3.3	0.6	0.5
US	5.5	4.3	3.4	3.0	2.6	2.2	0.6	0.5

B. Volatility of interest rates

	1978:09–1992:06			1993:01–2001:03		
		Standard deviation of			Standard deviation of	
	Average interest rate	1 month	12 months	Average interest rate	1 month	12 months
Australia	13.4	11.4	3.6	5.8	2.4	1.3
Canada	11.1	20.3	3.6	4.9	4.6	1.7
Chile	31.8	124.0	19.0	12.9	53.7	5.7
New Zealand	15.4	14.8	6.7	7.2	5.3	2.4
Sweden	11.5	13.6	2.7	5.8	2.6	1.6
UK	11.9	10.1	3.0	6.0	3.0	1.2
Germany	6.7	4.7	2.1	4.5	1.8	0.9
Switzerland	3.7	14.1	2.0	2.5	3.9	1.1
US	9.4	10.2	3.1	5.1	1.9	1.0

C. Volatility of output gaps

	1978:09-1992:06		1993:01-2001:03	
	Standard deviation of		Standard deviation of	
	3 months	12 months	3 months	12 months
Australia	4.7	2.4	2.7	1.2
Canada	9.0	4.7	4.7	2.1
Chile	43.1	9.5	34.5	7.3
New Zealand	14.7	4.5	4.1	1.9
Sweden	10.3	3.3	11.2	3.4
UK	7.7	3.2	3.2	1.2
Germany	7.3	2.4	6.9	3.0
Switzerland	2.0	1.6	1.2	0.9
US	6.0	3.3	3.2	1.4

NOTE: Entries are in percent. For New Zealand, the sample starts in 1982:03; for Germany, it ends in 1998:12; for Switzerland, it starts in 1980:01.

Table 2

Monthly Taylor Rules

	Constant	Gap_{t-1}	π_{t-1}	i_{t-1}	R^2	STD	Long-run response to inflation
A. 1978:09–1992:06							
Canada	1.99**	0.16**	0.24**	0.62**	0.78	1.77	0.75
Chile	7.19**	0.05	–0.01	0.77**	0.60	9.68	
Sweden	1.49**	0.01	0.07*	0.82**	0.78	1.07	0.41
UK	1.47**	0.05	0.08**	0.83**	0.89	0.79	0.45
Germany	0.26**	0.04*	0.06*	0.94**	0.97	0.38	0.96
Switzerland	0.00	–0.01	0.08*	0.92**	0.81	1.15	0.99
US	0.45*	0.05	0.08*	0.90**	0.93	0.90	0.77
B. 1993:01–2001:03							
Canada	0.64**	0.10**	–0.12*	0.90**	0.91	0.44	
Chile	3.41**	0.04	0.50**	0.45**	0.44	3.79	0.90
Sweden	0.22*	0.03**	0.08**	0.93**	0.99	0.23	1.10
UK	0.47*	0.03	0.10*	0.88**	0.89	0.24	0.81
Germany	0.11*	0.02*	0.09*	0.92**	0.99	0.12	1.12
Switzerland	0.12*	–0.00	0.06	0.91**	0.95	0.31	0.66
US	0.34**	0.09**	–0.10	0.94**	0.98	0.14	

NOTE: *Gap* is the output gap, π the annual rate of inflation, *i* the nominal interest rate, R^2 the adjusted R-squared value, STD the standard deviation of the residuals. For Germany, the sample ends in 1998:12; for Switzerland, it ends in 2000:09. * and ** indicate significance at the 5 and 1 percent confidence levels, respectively.

high levels to the levels observed in the non-IT countries of the reference group. This result suggests that the IT countries have joined our non-IT group in their determination to stabilize inflation over the medium run and to gain credibility in this way. But note that, with the exception of the United Kingdom, the volatility of inflation at the 12- and 24-month frequencies still remains above the level observed for our reference group of non-IT countries.

Panel B of Table 1 provides similar information for short-term interest rates. Given the improved inflation performance in all countries, it is no surprise that between the sample periods the average levels of interest rates have fallen. The table shows that the volatility of short-term interest rates has decreased, too. Similar to what one observes for the volatility of inflation, the volatility of overnight rates in IT countries converges to the lower level observed in our non-IT countries, though it remains higher for IT than for non-IT countries in the post-IT period. The United Kingdom again is the exception.

Finally, consider panel C of Table 1, which shows the volatility of the output gaps. They, too, have fallen generally between the sample periods in all countries. Notable exceptions are Germany and Sweden, where the volatility at the 12-month frequency has increased in the post-IT sample.

Taylor Rules

The inspection of the data suggests that the behavior of central banks has changed between the sample periods. To study this in more detail, we estimate dynamic Taylor rules by combining the Taylor equation with the assumption of interest-rate smoothing. We do this for both monthly and quarterly data. Overnight money market rates serve as the dependent variable. The explanatory variables are the inflation rate and the output gap, apart from the lagged overnight rate.

Evidence from Monthly Taylor Rules. A first set of estimates uses monthly data. Based on a

specification search relying on the Akaike information criterion (AIC), we include both inflation and the output gap with one lag in all equations. Table 2 has the results for the two sample periods. The first thing to note is that the standard deviations of the residuals (or standard errors) are considerably lower in the post-IT period for all countries. A standard likelihood-ratio test indicates that the differences are statistically significant.

The table shows that, judged by R^2 values, the estimated Taylor rules fit the data well for all countries except Chile. This result holds for both groups of countries and confirms findings reported in earlier literature. The estimated coefficients generally have the correct signs. Exceptions are the Swiss response to output in both sample periods, the Chilean response to inflation in the pre-IT period, and the United States and the Canadian responses to inflation in the post-IT period. Only in the Canadian case, however, is the coefficient significantly different from zero. Overall, the Taylor rules appear to be reasonable descriptions of central bank behavior. Table 2 shows the long-run responses of the interest rates to inflation together with the estimated coefficients.

According to this table, Canada is the only country in the IT group where the interest rate responded significantly to the output gap in the first sample period. Reactions to the output gap are not significantly different from zero in the other three countries. The reaction to lagged inflation was significantly positive in Canada, Sweden, and the United Kingdom during that period, and not significantly different from zero in Chile. The short-run reaction to inflation was more than three times larger in Canada than in Sweden and the United Kingdom. The greater persistence of the interest rate in the latter two countries, however, implied that the differences in the long-run responses are less pronounced.

These patterns have changed somewhat in the post-IT period. Sweden and Canada now show significant reactions to the output gap. The estimates for the United Kingdom, Sweden, and Chile indicate significant, positive reactions to lagged inflation, while the estimate for Canada shows a negative sign. Compared with the first period, the long-run responses to inflation almost doubled for the United Kingdom and more than doubled for Sweden. Chile's long-run reaction to inflation is now similar to that of the United Kingdom and Sweden. The persistence in interest rates increased somewhat in the United Kingdom, Sweden, and Canada, but dropped in Chile. Overall, the substantial increase in the long-run response to inflation is the strongest indicator of a change in central bank behavior that we take from these estimates.

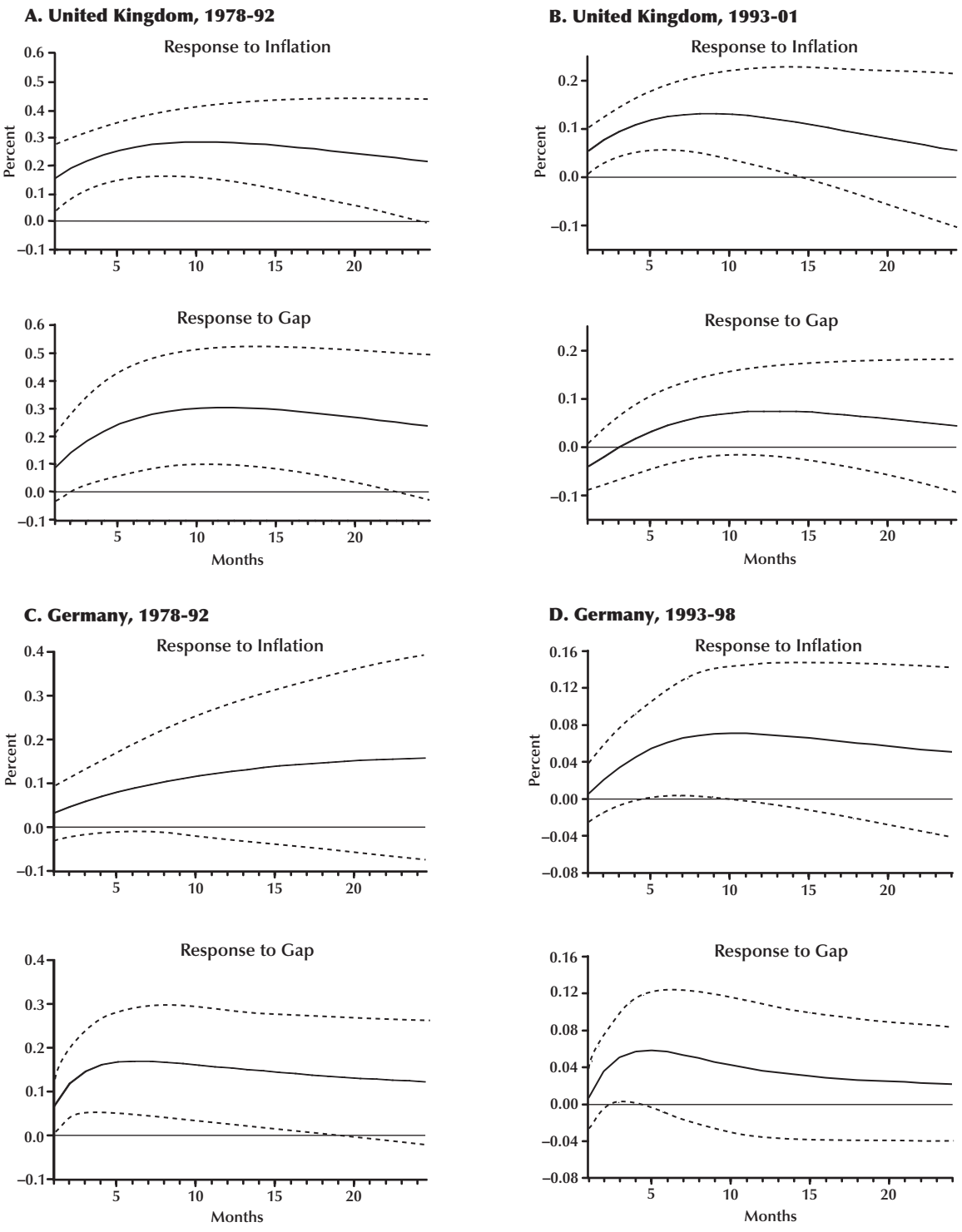
Consider, then, the non-IT countries. In the first subsample, the estimate for Germany shows positive and significant reactions of the overnight rate to both the output gap and inflation. For neither Switzerland nor the United States do we find a significant reaction of short-term rates to the output gap, but their reactions to lagged inflation are in line with Germany's. The results remain similar for Germany and Switzerland in the post-IT sample, although the Swiss reaction to inflation loses statistical significance. The U.S. reaction to inflation even changes sign and loses significance, while its reaction to the output gap is larger and significant.

Comparing IT and non-IT countries in the pre-IT sample, we see the starkest differences in their long-run reactions to inflation, which are uniformly much lower among the countries that later adopted IT than in Germany and Switzerland. This changed in the post-IT period, as the long-run reactions to inflation have increased by more in IT countries than in Germany. The suggestive result then is that the move to IT marks a convergence in central bank behavior of the first group to the Bundesbank and the Swiss National Bank, the two banks that showed the strongest determination to keep inflation down in the 1970s and 1980s. This finding corroborates the results reported by Cecchetti and Ehrmann (2000) and Corbo, Landerretche Moreno, and Schmidt-Hebbel discussed above. Finally, the estimates support the conjecture that under the IT regime central banks give less weight to stabilizing the business cycle. With the exception of Sweden, the reaction of IT countries to the output gap is lower in the post-IT period than before, though still stronger than in Germany.

We pursue this analysis further by embedding our Taylor rules into three-dimensional VARs for short-term inflation, the output gap, and the interest rate. All estimates employ a constant and only one lag. Based on the Cholesky decomposition, we can use the VARs to study the impulse responses of the overnight rates. Figure 1 shows results for the United Kingdom and Germany. For both countries and both sample periods we observe significantly positive responses of central bank interest rates to innovations in inflation and output gaps. This replicates the information from our estimates of Taylor rules. Beyond that qualitative result, Figure 1, in panels A

Figure 1

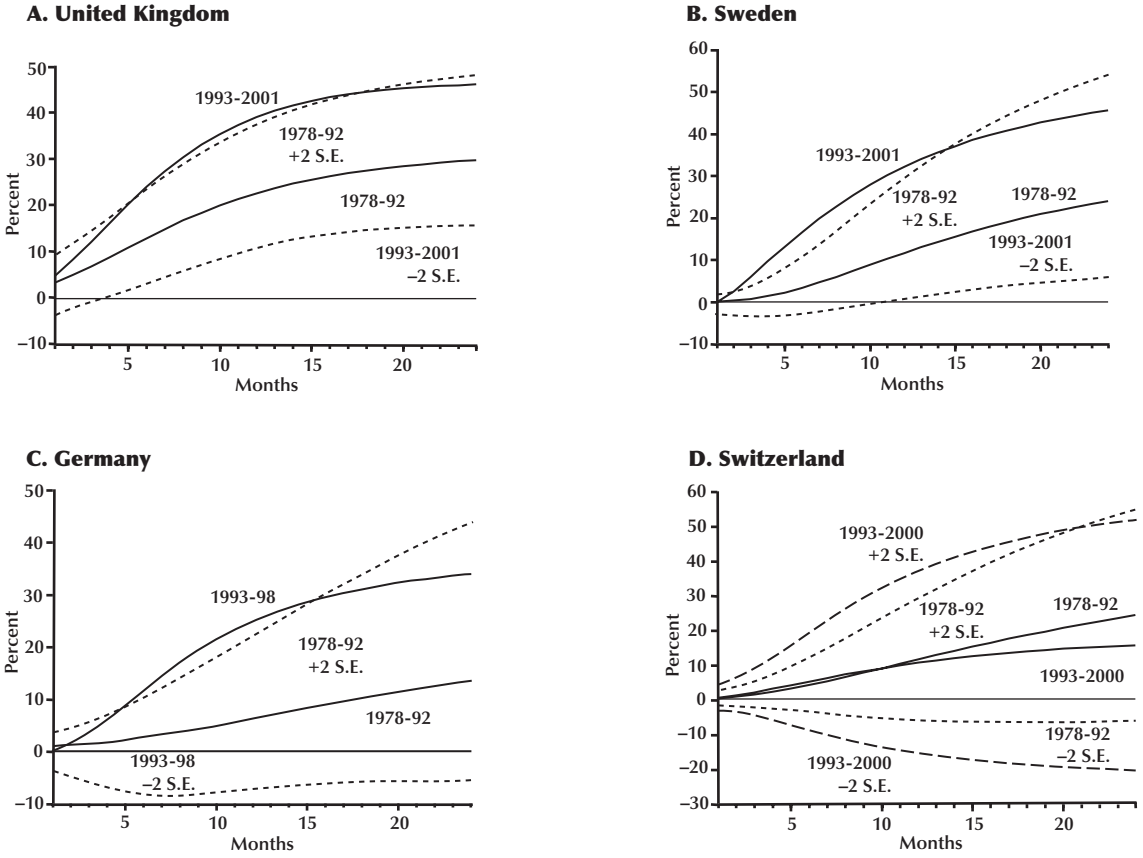
Response of the Overnight Rate



NOTE: Responses were calculated to Cholesky one standard deviation innovations ± standard errors.

Figure 2

Contribution of Inflation Shocks to the Overnight Rate Variance



and B, shows for the United Kingdom that the post-IT impulse response to a one-standard-deviation shock to the inflation rate is considerably smaller in magnitude than the pre-IT impulse response. The former never exceeds 0.12, while the latter goes above 0.2 after six months. Thus, while the long-run response to inflation has increased strongly (as shown in Table 2), the impulse response functions suggest that the short-run response to inflation shocks has become less aggressive. The impulse response functions for Germany (Figure 1, C and D) convey the same impression. In the post-IT sample, the impulse response never exceeds 0.08, but it does climb above 0.1 in the pre-IT sample. Also, these two panels in the figure show similar reductions in the impulse responses to output-gap shocks. Thus, the estimates suggest that both IT and non-IT central banks moved to a less activist monetary policy in the 1990s.

Consider next the contributions that the innovations in the inflation rate at various lags made to the variance of the overnight rates. This is an indicator of the degree to which monetary policy actions were directed at counteracting inflation shocks. The question is whether the relative importance of these shocks to interest rate policy has risen in the post-IT period. Figure 2 shows the results for two IT countries, the United Kingdom and Sweden, and for two non-IT countries, Germany and Switzerland. We cannot apply this comparison to Canada, Chile, and the United States because the monthly VAR estimates for these countries suggest a counterintuitive, negative response of the overnight rate to inflation in at least one of the sample periods.

Each of the panels in Figure 2 provides the percentage of the variance of the interest rate due to innovations in the inflation rate for both sample periods. For the United Kingdom, Figure 2A shows a strong increase in the relative importance of

inflation shocks as a source of interest rate variance in the post-IT period. At lag 12, their contribution to the variance of the overnight rate reaches 40 percent, compared with less than 25 percent in the pre-IT period. Note that the 1993-2001 line lies outside the confidence interval around the 1978-92 line for lags 5 to 18. The picture thus suggests that U.K. monetary policy has become more strongly determined to fight inflation under the IT regime. Similar findings emerge from Figure 2B for Sweden. At the annual lag, the contribution of inflation shocks to the variance of the Swedish money market rate rose from 10 percent in the pre-IT period to 35 percent in the post-IT period. It is noteworthy that a similar result holds for Germany. There, too, the contribution of inflation shocks to the variance of the overnight rate was higher in the post-IT period. Figure 2C shows that, at lag 12, inflation shocks contributed less than 10 percent to the variance of Germany's money market rate before 1992, but 25 percent thereafter. Again, the data convey the impression of a convergence in central bank behavior that coincides with the introduction of inflation targeting in the IT countries. An exception is Switzerland, where the estimated contribution of inflation shocks to the variance of money market rates appears to have been quite small in both periods. But note that the underlying estimate for the post-IT period is poor, which might reflect the fact that Swiss monetary policy to a larger extent is directed at controlling the exchange rate.

Evidence from Quarterly Taylor Rules. We now turn to quarterly estimates of Taylor rules, which allow us to consider a broader group of countries. Thus, we can include Australia and New Zealand as two additional inflation targeters. For these countries the output gap is estimated from real GDP and an HP filter. Inflation continues to be measured in terms of the CPI. Switching from a higher to a lower frequency may change the dynamics of the Taylor estimate. Using the AIC again, we find that the contemporaneous output gap and the contemporaneous inflation rate fit better than the first lags in most Taylor models. Exceptions are Canada and Switzerland in the first sample and Canada, Sweden, Germany, and Switzerland in the second sample. In these cases, the first lag of the output gap gave better estimation results. Table 3 provides the results.

As before, the estimates look reasonable and fit the data well, with the exception of Chile and Switzerland. If we disregard the latter, all signs are as expected except the output gap response of the United Kingdom in the post-IT sample, as well as the Canadian inflation response in that period; but these coefficients are not statistically different from zero. Note that the quarterly estimates provide a significant positive reaction to inflation for the United States in the post-IT sample, in contrast to the estimate based on monthly data.

As in the case of monthly Taylor rules, the quarterly estimates suggest that the behavior of central banks has changed between the sample periods. Among the inflation targeters, Canada is the only country where the output response of interest rates increased between the first and the second sample. A similar observation for Sweden (made from monthly data) has vanished. Among the non-IT countries, it is again in the United States where the reaction to the output gap is stronger in the second sample period. The short-run reaction to inflation is larger in the second period for the IT countries except Canada and New Zealand. More importantly, the long-run response to inflation increases for all IT countries. In the United Kingdom, Sweden, and Australia, it is more than twice as large as in the first sample period. These changes in long-run inflation responses are in line with the estimates from monthly Taylor rules for the United Kingdom, Sweden, and Chile. Turning to the non-IT countries, we find that the long-run response to inflation goes up in Germany and decreases slightly in the United States. Overall, the estimates from quarterly data confirm the impression from monthly data: The adoption of IT has produced a convergence of central bank behavior to that of the Bundesbank in the 1980s and 1990s.

A notable feature of our estimates is that the estimated long-run response of short-term interest rates to inflation is below unity in all cases except for Germany, Sweden, and the United Kingdom in the post-IT period. This contrasts with the familiar claim of the literature on Taylor rules that the response of interest rate policy to inflation should exceed unity in order to guarantee that monetary policy is able to stabilize inflation. The fact that we do not find this for most countries, including the United States, is puzzling.

One reason for this finding may be that earlier studies have commonly used GDP deflators instead of CPIs for computing the rate of inflation. In the appendix, we show that the long-run response coefficient of the federal funds rate to U.S. inflation is about 1.5 if the GDP deflator is used but 1.0 or less if the GDP deflator is replaced by the CPI. From a

Table 3

Quarterly Taylor Rules

	Constant	Gap_t	Gap_{t-1}	π_{t-1}	i_{t-1}	R^2	STD	Long-run response to inflation
A. 1978:Q3–1992:Q2								
Australia	–25.4*	0.27*		0.03	0.84**	0.78	1.39	0.21
Canada	2.97**		0.16**	0.38**	0.52**	0.68	1.68	0.78
Chile	9.06**	0.23		0.26	0.54**	0.32	11.48	0.57
New Zealand	–17.85	0.22*		0.35**	0.56**	0.86	1.64	0.79
Sweden	1.81*	0.13*		0.11	0.76**	0.72	1.50	0.49
UK	3.22**	0.09		0.22**	0.59**	0.79	1.06	0.54
Germany	0.75**	0.16**		0.18*	0.81**	0.95	0.53	0.91
Switzerland	0.27		–0.03	0.01	0.96**	0.85	0.94	0.35
US	0.74	0.15*		0.16*	0.81**	0.85	1.20	0.87
B. 1993:Q1–2001:Q1								
Australia	–19.8*	0.21*		0.08	0.85**	0.89	0.33	0.55
Canada	1.99**		0.26**	–0.20	0.64**	0.69	0.59	
Chile	6.33**	0.03		0.96**		0.41	3.18	0.96
New Zealand	1.68*	0.10		0.28	0.68**	0.70	0.83	0.88
Sweden	0.84**		0.10**	0.35**	0.74**	0.95	0.45	1.32
UK	1.71**	–0.11		0.59**	0.46**	0.81	0.30	1.09
Germany	0.22*		0.07**	0.22*	0.83**	0.99	0.16	1.28
Switzerland	0.30*		0.27**	0.09	0.84**	0.94	0.31	0.58
US	0.78**	0.28**		0.18*	0.76**	0.95	0.21	0.74

NOTE: *Gap* is the output gap, π the annual rate of inflation, *i* the nominal interest rate, R^2 the adjusted R-squared value, STD the standard deviation of the residuals. For Germany, the sample ends in 1998:Q4; for Switzerland, it ends in 1980:Q1. * and ** indicate significance at the 5 and 1 percent confidence levels, respectively.

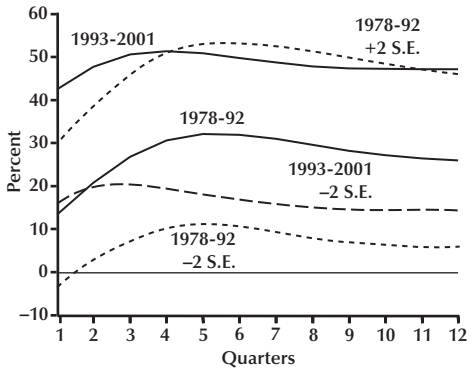
purely statistical point of view, the difference can be traced to the markedly higher variance of the CPI. But the question remains: Which price index is the more appropriate one? If central banks, in practice, care more about inflation derived from CPIs than from GDP deflators, our estimates suggest that central bank interest rates do not respond sufficiently to inflation in most countries even in the post-IT period.

To check the contribution of inflation shocks to the variance of interest rates, we again estimate three-dimensional VARs for the inflation rate, the output gap, and the interest rate. All estimates employ a constant and only one lag. Note that the quarterly Taylor estimates show contemporaneous reactions to inflation for all countries and to the output gap for some countries. This implies that the interest rate equations of the VARs differ from the estimated Taylor equations. In Figure 3, we plot the contribution of inflation shocks to the variance of money market rates for all countries, except Canada, Chile, and Switzerland, and for both sample periods. For the United Kingdom, Sweden, and Germany, the estimates with quarterly data replicate the results from monthly data (see Figure 2, A through C). For the other countries, the results are more mixed. In the cases of New Zealand and the United States, we find a smaller contribution of inflation shocks to the variance of money market rates in the post-IT period. For Australia, finally, the contribution of the inflation shocks increases, but only slightly so. In sum, we find that the quarterly data support the

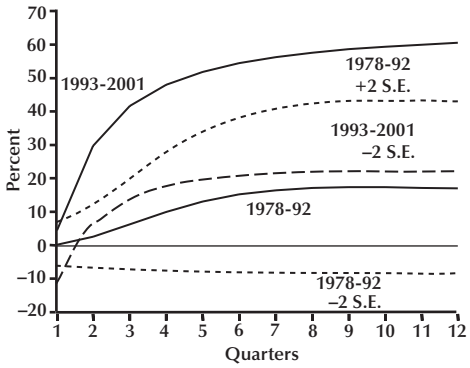
Figure 3

Contribution of Inflation Shocks

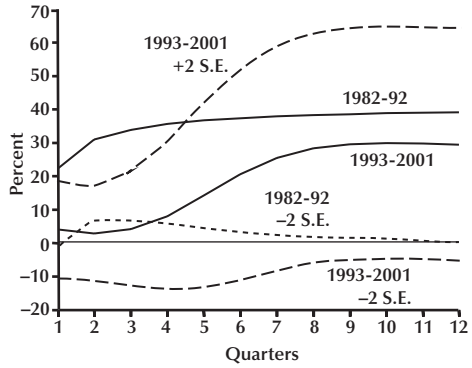
A. United Kingdom: Contribution to Overnight Rate Variance



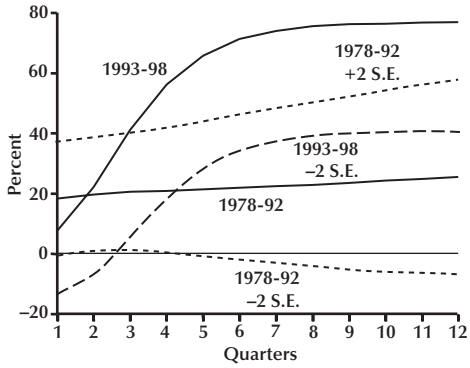
B. Sweden: Contribution to Overnight Rate Variance



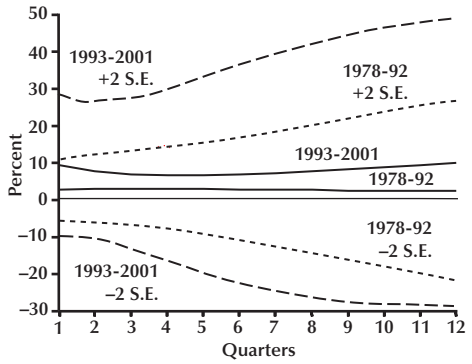
C. New Zealand: Contribution to Variance of 3-Month Bank Bill Rate



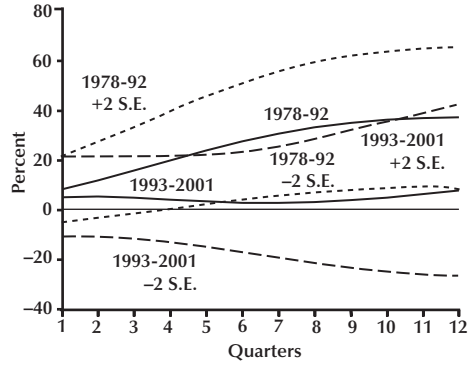
D. Germany: Contribution to Overnight Rate Variance



E. Australia: Contribution to Overnight Rate Variance



F. United States: Contribution to Variance of Federal Funds Rate



results derived from monthly data for the IT countries Sweden and the United Kingdom and for the non-IT country Germany, while the results for the other countries remain mixed.

IV. INFLATION TARGETING: AN EVENT STUDY

An important shortcoming of the analysis presented in the previous section and of similar work in the literature is the assumption that the economic environment of monetary policy remains basically unchanged in the period under consideration. In particular, it is a maintained, though usually only implicit, hypothesis that monetary policy was exposed to the same type of shocks in different periods, so that any observed changes in central bank performance or in the level and dynamics of interest rates and inflation rates can be attributed to changes in the monetary regime. Regression analysis of central bank reaction functions or inflation dynamics of course allow for exogenous shocks of different magnitude in different periods of time. Nevertheless, the analysis necessarily assumes that all exogenous shocks are drawn from the same distribution and that monetary policymakers interpreted their environment in this way. This is obviously a very strong assumption and one that is hard to verify. But if we cannot be sure that monetary policy responses as described by empirical reaction functions are truly reactions to shocks from the same distribution, the analysis loses much of its strength.

In this section, we look at the issue in a different way. We do not ask how the average response of central banks to many shocks, as described by regression analysis, changed before and after the adoption of IT. Rather, we compare central bank performance and monetary policy outcomes in two historical episodes in which monetary policy was faced with very similar, exogenous shocks. By ensuring that the nature and the size of the shock are truly similar, we can be more confident that we compare monetary policy under truly comparable circumstances, yet with one important difference, namely, the adoption of IT by some central banks in one of the episodes considered.

The kind of experiment we pursue here demands that the shocks we look at be truly exogenous to monetary policy in the countries considered; that is, we should look at shocks originating outside these countries. With this in mind, we choose two periods of rising crude oil prices. From the point of view of the central banks in our analysis, episodes of rising oil prices present the dilemma of a negative supply shock. Rising oil prices lead to a slowdown of economic growth and rising inflation. Monetary policy can attempt to hold unemployment down, but only at the cost of even higher inflation rates. This is the experience of the "stagflations" most industrialized countries first encountered following the oil price shock of 1973. While markets may not have fully understood the macroeconomic consequences of rising crude oil prices immediately after the first oil price shock, it is plausible to assume that they did subsequently.

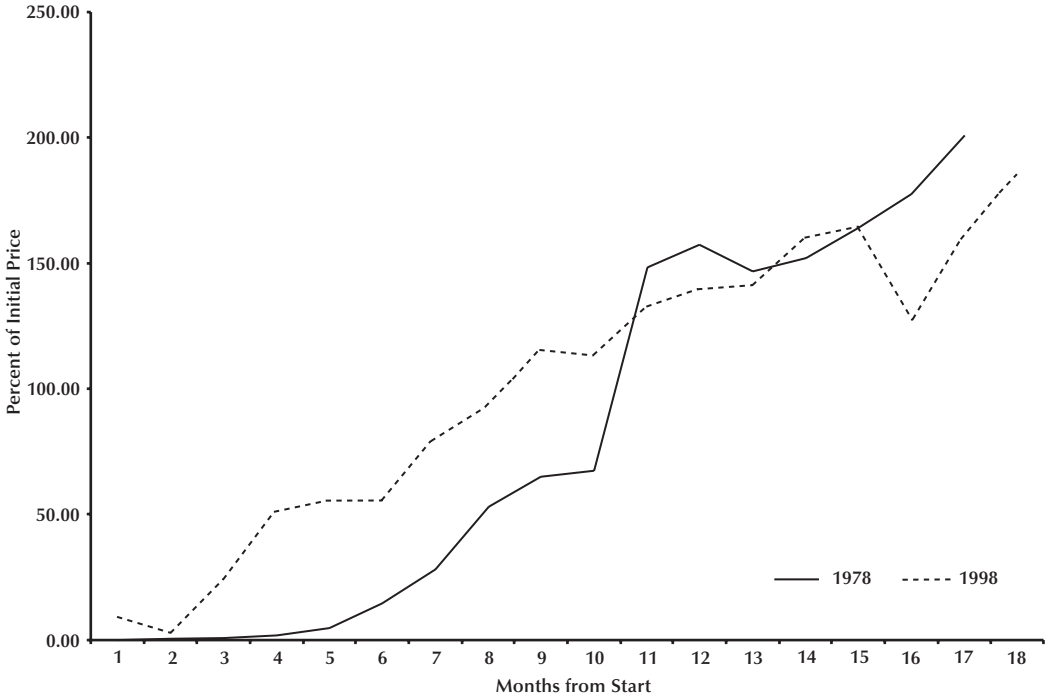
The two episodes we look at are the periods of rising crude oil prices starting in July 1978 and in December 1998. During the first episode, the price per barrel of crude oil increased from $13.15 to $39.57 (U.S.), a total increase of 201 percent. The peak was reached in November 1979. During the second episode, the price increased from $10.41 per barrel to $29.62, for a total of 185 percent reached in June 2000. After a temporary drop to $27.93 per barrel in July 2000, the oil price rose again to $32.68 in September. The price hikes are thus similar in magnitude, although oil prices rose faster initially in the second episode. Figure 4A illustrates the similarity of the price developments in the two periods.

We are interested in exploring the differences in the monetary policy responses to these two oil price hikes. This would be much easier if we could safely assume that the economies we look at are the same in terms of aggregate demand and supply performance in both episodes. However, the oil price hikes of the 1970s induced important substitutions away from the use of oil as a source of energy in the industrialized world. In many countries, tax policies have amplified these substitution processes. This is indicated by the concept of "energy intensity," which relates annual energy consumption to annual economic activity. According to the OECD (2001), energy intensity of European industries improved by an average 1.5 percent annually in the European Union countries during the 1990s, driven by gains made particularly in Germany and Sweden. Energy intensity improved by an annual average rate of 1.9 percent in the North American Free Trade Agreement (NAFTA) region during the 1980s; it was flat in 1990-93, but improved again thereafter. These gains were realized mainly by the United States and Canada. The improvements in energy intensity suggest that the economies became less vulnerable to oil price shocks, and the inflationary consequences of the second episode we consider should be less dramatic as a result. However, the data also suggest

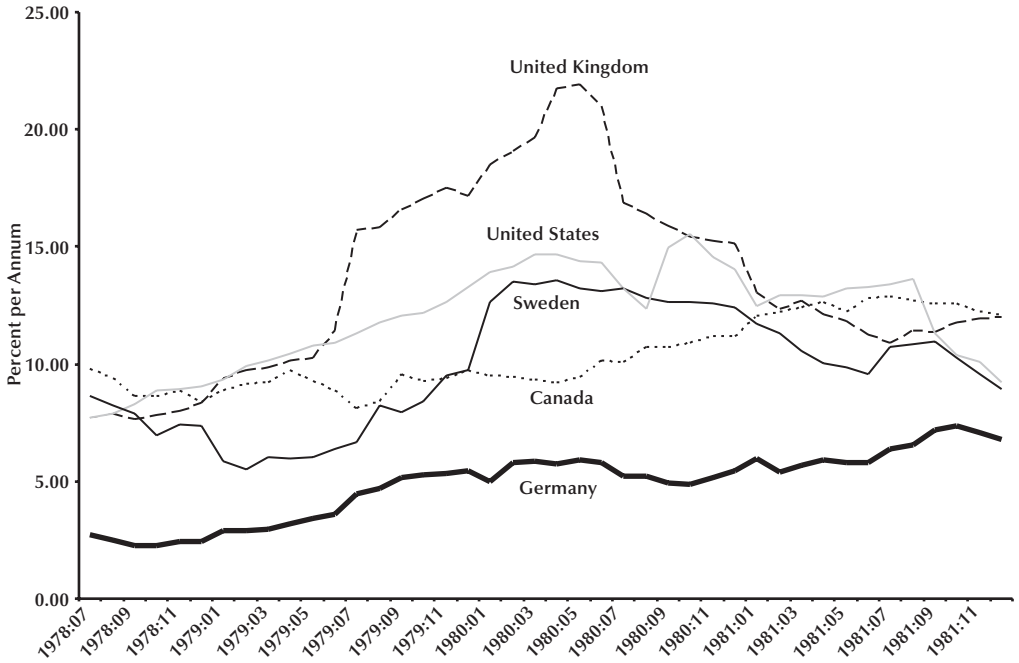
Figure 4

Oil Prices

A. Two Oil Price Hikes



B. First Oil Price Shock: Inflation



that improvements in energy intensity are not special to IT or non-IT countries. Therefore, using non-IT countries as a benchmark, we can control for the effects of these substitution processes.

The Method of Double Differences

We wish to evaluate the effect of a change in monetary regime, the adoption of IT, on a number of monetary indicators of a country. The main problem with such an assessment is that the monetary policy regime may not be the only relevant variable that changed between the two periods we compare. A change in energy intensity is just one example of other relevant developments that might have occurred. A widespread change in public perceptions about the role and the goals of monetary policy is another example.

A standard method for dealing with this kind of evaluation in a public policy context is the "method of double differences." Consider a variable of interest, y, and assume that this variable is a function of an exogenous variable, x, and a vector of other, exogenous variables, z, as well as a policy regime. We are interested in how the response of y to a change in the exogenous variable x is affected by a change in the policy regime. We have observations of y for a group of countries $i = 1,...,N$ that underwent a regime change and a group of countries $j = 1,...,M$ where no regime shift occurred. In both groups of countries, the indicator is affected by the same exogenous variables, and we hypothesize that the effects of variables z are approximately the same for all countries.

Consider two time intervals during which we observe the indicator y. The starting point of the first period is $t1$ and the end point is $t2$; the starting and the end points of the second period are $t3$ and $t4$, respectively. Let $D1_i = y_{i,t2} - y_{i,t1}$ be the change in indicator y over the first period for country i, and define $D1_j$, $D2_i$, and $D2_j$ analogously for the second group of countries and the second time period. If no changes in variables z occurred, the difference $D1_i - D2_i$ would tell us how the reaction of y to x changed as a result of the shift in the policy regime. Because variables z can change, however, we must compare this change with the same difference for countries in which no regime shift occurred. Thus, the double difference

$$DD = \frac{1}{N}\sum_{i=1}^{N}(D1_i - D2_i) - \frac{1}{M}\sum_{j=1}^{M}(D1_j - D2_j)$$

gives us a proxy for the impact of the change in policy regime on the response of y to x.

Comparing the 1978 and the 1998 Oil Price Hikes: Empirical Results

We use this method to compare the monetary policy reactions and consequences of the 1978 and 1998 oil price hikes. Specifically, we look at three indicators. The first is the annual CPI inflation rate, our basic indicator of monetary policy outcomes. The second is the change in long-term government bond rates. We take this as a measure of monetary policy credibility, as a large increase in nominal long-term rates indicates rising inflation expectations. The third is the change in short-term money market rates. The increase in short-term rates following an oil price hike indicates the extent of monetary tightening that the central banks perceived to be necessary to control inflation after that rise in oil prices. We use data from six IT countries—Australia, Canada, Chile, New Zealand, Sweden, and the United Kingdom—and four non-IT countries—Denmark, Germany, Switzerland, and the United States. Note that the second episode of rising oil prices spans the beginning of the European Monetary Union on January 1, 1999, which implies a shift of responsibility for monetary policy from the Bundesbank to the European Central Bank (which does not pursue IT). Thus, the case of Germany remains a valid observation in the control group. All data except Sweden's long-term bond rates, Chile's short-term and long-term interest rates, and New Zealand's inflation rates, which were provided by the respective central banks, are taken from the International Monetary Fund's IFS. We use monthly series wherever possible.

The use of the double differences method requires us to choose the dates at which we measure an indicator to calculate its total change during an episode of rising oil prices. The simplest choice would be to take the value of the indicator at the start and at the end of the oil price hike. This, however, could lead to serious measurement bias. Consider CPI inflation. A first point is that changes in oil prices take some time to be passed through to consumer prices. Thus, the CPI inflation rate at the start of the oil price hike is unlikely to be affected by the hike. A second point is that CPI inflation at the start of a period of rising oil prices is affected by economic policies and developments preceding the oil price hike. Taking a too-early measurement of CPI inflation thus runs the risk of using data tainted by the effects of policies predating the episode of interest. Finally, there is likely to be some variation across countries in the appropriate dates

for measuring the effect of the oil price hike on inflation, as the pass-through and preceding policies will be different across countries. In the case of long-term rates and short-term rates, there is also likely to be some cross-country variation in the time that it took markets to realize that a prolonged oil price hike was happening and in the time that it took central banks to realize this and to decide to take action against the incipient inflationary consequences of those rising oil prices.

In view of these difficulties, we use a common rule for picking observations for all countries and data series rather than the same dates for all countries. For each indicator series, we look for the first valley after the beginning of the episode of rising oil prices, i.e., the lowest realization followed by a string of increases. We then look for the next highest realization followed by a string of declining values for the same series, i.e., the next peak in the time series. We use the difference between the latter and the former to calculate the differences $D1_i$ and $D1_j$ and apply the same procedure for the second episode.

Consider Figure 4B, which shows the inflation rates of Germany, Canada, the United Kingdom, the United States, and Sweden for illustration. The German inflation rate stood at 2.70 percent in July 1978, the starting month of the oil price hike. It fell to 2.24 percent in November 1978, which we use as the valley in this episode. Between November 1978 and May 1980, the inflation rate increased to a maximum of 5.94 percent. Thus, $D1$ is 3.70 percent for Germany. The Swedish inflation rate stood at 8.63 percent in July 1978 and fell to 5.53 percent in February 1979. We use this value as the valley of this episode. Swedish inflation then rose to 13.58 percent in April 1980, resulting in a difference ($D1$) of 8.05 percent in this episode. Note that, after several months of lower inflation rates, Swedish inflation eventually peaked at 15.57 percent in October 1980. We do not use that value as the peak to calculate $D1$, however, as the new increase in inflation might have been due to other influences. If anything, this biases our procedure in the conservative direction. Using similar considerations, we chose September 1978, July 1978, and December 1978 as the valleys for the United Kingdom, the United States, and Canada in this episode, and May 1980, March 1980, and July 1981 as the respective peaks. While the procedure admittedly requires some judgement in some cases, we try to err on the conservative side. In Table 4, we indicate the length of time between the valley and the peak for each indicator considered and each episode.

Table 4A shows our results for inflation rates. The average increase in inflation rates over the first episode amounted to 8.35 percent, considerably more than the 5.37 percent average for the non-IT countries. In the second episode of rising oil prices, the average increase in inflation is 2.99 percent for IT countries. Thus, the average difference in the inflation impact between the two episodes is $D1-D2 = 5.36$ percent. This indicates that the inflation performance of IT countries facing oil price hikes has improved substantially. But note that these gains are distributed quite unevenly. Canada and Australia realized only relatively small improvements, while New Zealand and the United Kingdom enjoyed large ones. The average increase in inflation in the second episode is 1.97 percent among non-IT countries. Thus, $D1-D2 = 3.41$ percent, indicating that the non-IT countries realized improvements in their inflation performance, too. As a result, the double difference is $DD = 5.36 - 3.41 = 1.95$.

The result thus shows that the IT countries were able to achieve greater improvement in their inflation performance than the non-IT countries. We can conclude, therefore, that the introduction of the new monetary regime helped these countries to improve their inflation performance. However, a conventional t test shows that the difference to the non-IT countries is not statistically different from zero. This is due primarily to the relatively small improvements in inflation performance observed in Canada and Australia.

Now consider the evidence for inflation expectations contained in long-term bond rates (see Table 4B). The average increase in long-term interest rates among the IT group was 5.78 percent. Chile stands out in this group with the largest increase. On average, among the non-IT countries, long-term rates went up by 3.27 percent during the first episode of rising oil prices. The difference between the two groups suggests that non-IT countries enjoyed better monetary policy credibility. In the second episode, the average increase in long-term bond rates was 2.17 percent, signaling a large improvement in credibility. In fact, the average increase in long-term bond rates among the IT countries was only marginally higher than the average increase among the non-IT countries (1.83 percent). The non-IT countries thus experienced an improvement in monetary policy credibility, too, though a more modest one. As a result, the average double difference, *DD,* amounts

Table 4

Double Differences

	Low	High	*D*1	Time	Low	High	*D*2	Time	*D*1–*D*2	*DD*
A. CPI inflation rates*										
Australia	5.68	11.46	5.78	15	0.42	4.46	4.02	14	1.76	–1.65
Canada	8.43	12.87	4.44	32	0.55	3.03	2.48	13	1.96	–1.45
Chile	29.68	39.22	9.54	11	2.31	4.69	2.38	14	7.16	3.75
New Zealand	10.30	18.40	8.10	15	–0.5	4.00	4.50	15	3.60	0.19
Sweden	5.53	13.58	8.05	14	–1.12	1.33	2.35	12	5.68	2.27
UK	7.76	21.94	14.18	32	1.10	3.31	2.21	13	11.97	8.56
Switzerland	0.4	5.16	4.76	13	–0.10	1.94	2.04	13	2.72	
Denmark	6.73	12.80	6.07	9	1.71	3.15	1.44	13	4.63	
Germany	2.24	5.94	3.70	22	0.19	2.47	2.28	19	1.42	
US	7.72	14.68	6.96	20	1.61	3.76	2.10	15	4.86	
B. Long-term government bond yields†										
Australia	8.80	16.50	7.70	33	5.01	7.16	2.15	13	5.55	4.11
Canada	9.66	13.45	3.79	11	5.08	6.38	1.30	11	2.49	1.05
Chile	54.47	67.27	12.80	9	11.62	16.77	5.15	2	7.65	6.21
New Zealand	9.99	13.57	3.58	15	5.27	7.28	2.01	13	1.57	0.13
Sweden	9.99	13.78	3.79	31	4.02	5.92	1.90	10	1.89	0.45
UK	11.68	14.70	3.02	26	4.40	4.94	0.54	9	2.48	1.04
Switzerland	3.03	5.10	2.07	27	2.53	4.19	1.66	13	0.41	
Germany	5.90	9.40	3.40	20	3.53	5.35	1.82	13	1.58	
US	8.41	12.75	4.34	9	4.65	6.66	2.01	13	2.33	
C. Short-term money market rates										
Australia	6.88	17.05	10.17	38	4.72	6.24	1.52	12	8.65	4.27
Canada	6.61	19.36	12.75	16	4.59	5.75	1.16	13	11.59	7.21
Chile	45.59	73.13	27.54	6	5.54	13.62	8.08	5	19.46	15.08
New Zealand	10.00	16.32	6.32	16	4.30	6.88	2.58	16	3.74	–0.64
Sweden	5.40	16.99	11.59	25	3.00	4.10	1.10	17	10.49	6.11
UK	8.25	17.38	9.13	21	4.56	6.00	1.44	11	7.69	3.31
Switzerland	0.03	4.90	4.67	15	0.76	3.50	2.74	16	1.93	
Denmark	10.08	16.69	6.61	3	3.07	5.78	2.71	10	3.90	
Germany	2.67	9.02	6.35	13	2.42	4.98	2.56	17	3.79	
US	7.81	17.61	9.80	21	4.63	6.54	1.91	19	7.89	

NOTE: Time means number of months between low and high.
*Estimates are based on monthly data except those for Australia and New Zealand, which are based on quarterly data.
†Data for Denmark were not available.

to 2.17. Using a t test indicates that this average is significantly different from zero. Thus, we conclude that the introduction of IT has produced significant gains in terms of the credibility of the monetary authorities' commitment to price stability.

Finally, we turn to short-term interest rates (see Table 4C). During the first episode of rising oil prices, central banks in the IT group raised short-term rates, on average, by 12.92 percent. Eliminating Chile from this group, where the increase was much larger than in the other countries, still leaves an average increase in short-term rates in this group of 9.99 percent. In contrast, the average increase among the non-IT group was 6.86 percent in the first episode. In the second episode, IT and non-IT central banks resembled each other much more in the way they tightened monetary policy. Here, the average increase among IT central banks is 2.65 percent, while the average increase among non-IT central banks is 2.48 percent. The difference in the interest rate responses between the first and the second period is thus substantially larger for the IT central banks. The average double difference, $DD = 5.89$, is statistically different from zero as indicated by a t test. This result does not change qualitatively if we remove Chile and the United Kingdom from the IT group. Thus, the data suggest that both types of central banks could get through the second episode of rising oil prices with substantially reduced interest rate hikes compared with the first episode. However, IT central banks managed to reduce their response to the increase in oil prices significantly more than non-IT central banks, which reflects the comparatively poor performance of the IT central banks during the first episode.

Pulling these results together, we find that central banks generally managed to cope with the 1998 oil price hike with substantially less inflation than with the price hike starting in 1978. This may be the result of improved energy intensity and a generally greater commitment to price stability on the parts of all central banks. While both groups of central banks enjoyed improvements in credibility, as indicated by the smaller increases in long-term inflation rates, these gains were larger in the case of IT central banks. The observation that the IT central banks had experienced much larger increases in long-term rates during the first episode than non-IT central banks suggests that the introduction of IT allowed them to achieve the same level of credibility as the central banks in our control group. Finally, we note that better inflation performance and improved credibility required less action in terms of driving up short-term rates from all central banks in the second episode compared with the first episode. Here, again, the IT central banks' improvement is significantly larger, and the data suggest that inflation targeting has resulted in an assimilation of central bank responses to those of the central banks in the control group. Altogether, these findings suggest that the new monetary policy regime has affected central bank behavior and credibility more than it has changed inflation outcomes, which have improved for both groups.

V. INTERPRETATION AND CONCLUSIONS

In the early 1990s, a number of countries that had been troubled by high inflation since the 1970s adopted inflation targeting as a strategy to bring inflation down to the low levels experienced by Germany and Switzerland. Since then, the new regime has been praised in the literature as a superior concept for monetary policy. In this paper, we have looked at different types of evidence in order to validate this claim. For six IT countries and three non-IT countries and for two sample periods—a pre-IT period (1978-92) and a post-IT period (1993-2001)—we have investigated (i) the stability record by examining the volatility of inflation, output gaps, and central banks' interest rates; (ii) the reaction of central banks' interest rate policies to inflation shocks by estimating Taylor rules and unrestricted VARs; and (iii) the policy reactions to large supply shocks by comparing the central banks' reactions to the huge oil price hikes of 1978-79 and 1998-99.

Taken together, the evidence confirms the claim that IT matters. Adopting this policy has permitted IT countries to reduce inflation to low levels and to curb the volatility of inflation and interest rates; in so doing, these banks have been able to approach the stability achieved by the Bundesbank. Thus, IT has helped the former high-inflation countries to achieve a degree of credibility similar to that of the Bundesbank and the Swiss National Bank. Of all IT countries it is the United Kingdom that has performed best even though its target rate of inflation is higher than the inflation targets of most other countries.

While IT has proven an effective strategy for monetary policy, our evidence does not support the claim that it is superior to strategies that focus on monetary aggregates, such as the Bundesbank's

approach to monetary targeting between 1974 and 1998, nor even to the Fed's strategy in the 1980s and 1990s, which focused neither on monetary nor on inflation targets. It is interesting to note in this context that one of the staunchest supporters of inflation targeting, Svensson (2001), has recently endorsed a more moderate "flexible inflation targeting" in which the inflation target serves as a yardstick for the conduct of monetary policy in the medium run. Abstracting from technicalities, the main idea of "flexible IT" does not differ much from the Bundesbank's former monetary policy concept, in which the inflation objective serves to anchor medium-run inflation expectations while short-run operations are guided by an intermediate monetary target.

Reviews of that strategy have long shown that monetary targeting must not be misinterpreted as a rigid rule. Instead, it is well known that the Bundesbank often tolerated deviations of actual money growth from target if doing so seemed compatible with the goal of low inflation rates. For the Bundesbank, monetary targeting fulfilled two important functions (von Hagen, 1999). It served to structure internal monetary policy debates within the Bundesbank and forced monetary policymakers to take into account the inflationary consequences of their actions, especially in times when inflation risks became a growing concern. Furthermore, the discussion of monetary developments served as a framework for an effective dialogue between the bank and the public, which stabilized long-run inflation expectations and helped the bank maintain a relatively steady policy course.

Recent models of IT adopt a similar perspective and stress the importance of the communication tools developed by IT central banks to improve the public's understanding of central bank intentions and to stabilize inflation expectations over the long run (Cukierman, 2000; Faust and Svensson, 2000; Geraarts, 2000). The evidence presented in this paper suggests that the positive impact on inflation expectations has been the most beneficial effect of the new regime. In the same vein, the reductions in short-term volatility of central bank interest rates in the IT countries is compatible with the view that IT has helped monetary policymakers to focus less on transitory, short-term developments and adopt a steadier course of monetary policy. From this perspective, then, IT matters if used effectively to structure policy debates both within the central bank and between the central bank and its public. This interpretation means that IT, like other monetary policy strategies, must be seen in the context of (economic) culture and traditions. Given the central bank's commitment to price stability and its willingness to bind its policy to an intermediate target that serves as the nominal anchor for monetary policy, the choice between an inflation target or a monetary aggregate then is probably more a question of culture than economic principles.

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Appendix

TAYLOR RULES FOR THE UNITED STATES

This appendix serves to show that the long-run response of the short-term interest rate to the rate of inflation critically depends on the price index used for measuring inflation.

We begin by reestimating the static equation provided by Taylor (1999) for quarterly U.S. data spanning the period 1987:01–1997:03. The dependent variable is the federal funds rate, the rate of inflation is the year-over-year rate of change of the GDP deflator, and the gap is measured as the percentage deviation of GDP from trend, applying the Hodrick-Prescott filter.

The first regression, shown in Table A1, is Taylor's original estimate, implying the familiar strong response of the funds rate to inflation of 1.5. The following regression, variant (1), serves to show that our data broadly reproduce Taylor's result though the estimated response to inflation is somewhat lower. Replacing GDP by industrial production reduces the estimated response for the output gap but provides the same inflation response; see variant (2). Variants (3) and (4), finally, repeat the exercise but employ the rate of inflation as measured by the CPI. This reduces the estimated response to inflation markedly. No longer is it different from unity for the sample period used by Taylor. Similar downward shifts of the estimated inflation response are found for the sample periods used in the text.

Next, we note that the estimates in Table A1 all exhibit very low Durbin-Watson statistics, indicating dynamic misspecification. Table A2 presents dynamic estimates for our subperiods, employing the GDP deflator and the CPI alternatively. These dynamic specifications use the lagged federal funds rate as an additional regressor. Here, we find that the estimated short- and long-run response to inflation is smaller when the CPI index is used instead of the GDP deflator.

Table A1

Taylor's Static Estimate for 1987:01–1997:03

	Constant	π_t deflator	CPI	Gap_t GDP	IP	$\bar{R}^2$	DW
Taylor	1.17*	1.53**		0.77**		0.83	
Variants							
(1)	2.03**	1.36**		0.93**		0.72	0.22
(2)	2.02**	1.37**			0.62**	0.81	0.23
(3)	2.31**		1.02**	0.91**		0.69	0.35
(4)	2.28**		1.02**		0.61**	0.78	0.45

NOTE: π is the average inflation rate over four quarters, computed from the GDP deflator or the CPI; *Gap* is the percentage deviation of output from trend, computed from GDP data or the index of industrial production (IP). * and ** indicate significance at the 5 and 1 percent confidence levels, respectively.

Table A2

Dynamic Estimates for Samples 1978:03–1992:02 and 1993:01–2001:01

	Constant	π_t deflator	CPI	Gap_t IP	i_{t-1}	$\bar{R}^2$	Long-run response to inflation
1978-92							
(1)	0.74		0.16*	0.15*	0.81**	0.85	0.87
(2)	0.82	0.35**		0.15**	0.72**	0.87	1.24
1993-01							
(1)	0.78**		0.18*	0.28**	0.76**	0.95	0.74
(2)	0.61	0.27*		0.29**	0.78**	0.95	1.25

NOTE: π is the average inflation rate over four quarters, computed from the GDP deflator or the CPI; *Gap* is the percentage deviation of industrial production (IP) from trend. * and ** indicate significance at the 5 and 1 percent confidence levels, respectively.

Commentary

Frederic S. Mishkin

Because inflation targeting is a relatively recent phenomena, in the past we have had insufficient data to conduct time-series econometric work to evaluate this important new monetary policy strategy. However, now that inflation targeting has been around for close to ten years, we are able to do some preliminary econometric work on this topic. This is exactly what Neumann and von Hagen do in their paper, and it is a welcomed addition to the literature.

I break my comments up into two parts. The first part looks at the empirical analysis in the paper, while the second examines the question of whether the non-inflation-targeting countries that Neumann and von Hagen look at are really that different from the inflation targeters they study.

EMPIRICAL ANALYSIS

Neumann and von Hagen produce several pieces of evidence quite favorable to inflation targeting.

- After countries adopt inflation targeting, the volatility of inflation, interest rates, and output falls to levels that are similar to those in the successful non-inflation-targeting countries (the United States, Germany, and Switzerland).
- Taylor rules display a greater focus on the control of inflation after adoption of inflation targeting.
- Vector autoregression (VAR) evidence indicates that the relative importance of inflation shocks as a source of the variance of interest rates rises after adoption of inflation targeting, and this might also suggest a greater focus on inflation control after adoption of inflation targeting.
- The response of inflation and output to oil price shocks is relatively more favorable after inflation targeting is adopted.

Neumann and von Hagen thus conclude that inflation targeting has improved monetary policy performance in the countries that have adopted it.

Given that my past research has been quite favorable to inflation targeting, it is not surprising that I like the conclusions in this paper. Unfortunately I am forced to point out that the evidence in the paper suffers from several problems and so is not completely convincing.

Although the reduction in volatility after inflation targeting is adopted is suggestive, there is the potential problem that possibly it is something else that produced these declines. Neumann and von Hagen are aware of this problem, and this is why they turn to other evidence to evaluate whether inflation targeting has been beneficial.

The Taylor rule evidence also looks quite favorable to inflation targeting because it suggests that the central bank puts a greater weight on the control of inflation relative to output stabilization, thus making it more likely that price stability will be achieved. However, a troubling feature of the Taylor rules estimated in the paper is that, even when the long-run coefficient on inflation has risen after inflation targeting has been adopted, it still remains less than 1. Values less than 1 on this coefficient indicate that the inflation process is unstable: When inflation and inflation expectations rise, the central bank raises interest rates by a lesser amount so that the real rate of interest falls. The lower real interest rate then stimulates inflation further and is thus likely to lead to an inflationary spiral. Indeed, as John Taylor (1993) has pointed out, an estimated Taylor rule for the United States in the pre-1979 period does have a coefficient less than 1 on inflation, and this is an explanation why inflation rose to double-digit levels by the end of the 1970s.

Therefore, although the estimated Taylor rules in the paper suggest that the weight on the inflation gap increases after inflation targeting has been adopted, the central bank is still not doing its job well enough if the long-run inflation coefficient remains less than 1, as it does for all inflation-targeting countries other than Sweden in the monthly estimates and Sweden and the United Kingdom in the quarterly estimates. The Taylor rule estimates do not suggest that inflation-targeting countries have improved monetary policy enough to achieve the goal of price stability. The fact that inflation-targeting countries have been so successful in inflation control should raise some concern about the Taylor rule estimates.

Furthermore, the Taylor rule estimates for the

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non-inflation-targeting countries also tend to have long-run coefficients on inflation that are less than 1. The exception is Germany in the post-1993 period. Especially troubling is that the long-run coefficient on inflation is less than 1 for the United States in both the 1978-92 and 1993-2001 periods. These results appear to be inconsistent with those of Taylor (1993) who finds that, for the United States after 1979, the coefficient on inflation rises above 1—which is an important reason why the performance of monetary policy improved so much in the post-1979 period relative to the pre-1979 period.

The authors point out in an appendix that the low coefficients on their estimated Taylor rules stem from using the CPI to measure inflation rather than the GDP deflator as Taylor does. This is somewhat troubling because it suggests large differences in results occur when slightly different inflation measures are utilized. The most serious problem with the Taylor rule results in the paper may not be that monetary policy does not respond sufficiently to changes in (CPI) inflation, but rather that estimated Taylor rules in the paper are misspecified. From my experience with central banks, it is quite clear that they respond to future forecasts of inflation rather than to current inflation. Indeed, this is exactly what theorizing on the design of optimal monetary policy suggests that they should do. Estimating Taylor rules with actual rather than forecasted inflation thus results in an errors-in-variables problem for the long-run inflation coefficient and is thus likely to bias this coefficient downward. Orphanides (2001) shows that this is exactly what occurs in estimates of Taylor rules for the United States. The fit is better when one-year-ahead inflation forecasts are used in the Taylor rule equations and the inflation coefficients are much higher and always above 1. Orphanides (2001) also shows that using revised data, rather than the data available in real time, creates a further errors-in-variables problem, as does possible improper measurement of the output gap. The bottom line is that, although I am sympathetic to the view that countries adopting inflation targeting increase their focus on inflation control, I am highly skeptical of the Taylor rule evidence in this paper that supports this.

I also am very skeptical of the VAR evidence in the paper. A basic problem with VARs is that they appear to yield a lot of useful evidence without putting a lot of structure in their models. However, as economists, we always need to be skeptical of getting something for nothing, because as we always say, "there is no such thing as a free lunch." This applies to econometrics just as much as it does to filling our stomachs. The paper uses an implicit identification scheme that inflation and output react to monetary policy only with a lag. This is a standard identification scheme, and although not without its problems, it is not unreasonable. However, a serious problem for the analysis in this paper arises from the fact that VARs don't have any structural model of dynamics, and such a structural model is needed if we are to interpret the response of monetary policy to inflation. The fact that the contribution of inflation shocks to the variance of interest rates rises does not tell us that monetary policy has an increased focus on the control of inflation. To see this, consider the following example. Suppose that the monetary authorities greatly increase their focus on inflation control and are able to develop a super-credible inflation-targeting regime. This regime would then change the time-series process of inflation so that, when inflation rises above its target level, the public and markets expect it to fall back down to the target level very quickly. Then the central bank doesn't need to respond much to the temporary upward blip in inflation because inflation expectations will keep inflation from deviating much from the inflation target. In this environment, we would expect a decreased contribution of inflation shocks to the variance of interest rates. Should the smaller impact of inflation shocks on interest rates then be interpreted as indicating that the central bank is less focused on inflation? Of course not, because in this example the opposite has actually occurred. The above reasoning suggests that the VAR evidence in the paper tells us little about the impact of inflation targeting on the conduct of monetary policy.

The most interesting evidence in the paper involves the examination of the different responses before and after inflation targeting to upward spikes in oil prices in 1978 and 1998. Neumann and von Hagen look at oil price shocks because it is reasonable to assume that these shocks are exogenous to most of the countries they are studying. (This might be less true for the United States in the 1978 episode because overly expansionary monetary policy might have driven up oil prices at the time; see Barsky and Killian, 2001.) It is also useful to look at the effect of the oil price shock in 1998 on inflation targeting because one commonly heard claim is that inflation targeting has not been tested because so many shocks in the 1990s have been favorable. However,

we recently made the point (Mishkin and Schmidt-Hebbel, 2002) that this view is incorrect. To the contrary, we point out that the oil price shock in 1998 was an adverse shock that was handled very well by inflation-targeting regimes, which is also the conclusion that Neumann and von Hagen reach.

Their paper uses the method of double differences to look at the difference in outcomes for inflation-targeting countries relative to non-inflation-targeting countries. To justify their analysis, they need several assumptions. First is that the response to other exogenous shocks is the same for both inflation-targeting and non-inflation-targeting countries. Second is that, when the oil price shock occurs, nothing else is occurring that affects inflation-targeting and non-inflation-targeting countries differently. Third is that the dynamic response to oil price shocks is the same in all inflation-targeting countries. It would be easy to cast some doubt on the first two assumptions, but they are pretty reasonable relative to other assumptions we often have to make in doing empirical work. However, there are more serious concerns about the third assumption that I think the authors of the paper share. Under the third assumption, double differencing would choose the same starting date, and this is what is conventionally done. However, Neumann and von Hagen instead make use of a nonstandard dating scheme that chooses the starting date for each country on the basis of when the trough and peak of the inflation rate is reached after the oil price shock. It is appropriate that they choose a date after the shock because it takes time for commodity price shocks to affect inflation. However, it is not clear under what assumption their procedure makes sense. I think that the reason they chose to use this procedure is because they have doubts about the assumption that the dynamic response to oil price shocks is the same in all the inflation-targeting countries, and this is a little worrisome. I am not sure how important this is because it is not clear that their results would be very different if they chose the same starting date for the double differencing.

To conclude my discussion of the empirical work in the paper: Although the research conducted by Neumann and von Hagen is worth doing, I have some doubts about the quality of the evidence. Thus I see the results as suggestive, but not much more than that. Should the fact that there are doubts about the evidence in this paper shake our faith in the benefits of inflation targeting? I think not. The doubts about the evidence just mean that we have to look at broader types of evidence. One reason why some of my recent research on inflation targeting (Mishkin and Posen, 1997; Bernanke et al., 1999; and Mishkin and Savastano, 2001) has focused on historical case studies is because of the difficulty of doing econometric analysis of the type done in this paper. (Neumann and von Hagen call their double-differencing empirical work a case study approach, but it really is more like an event study rather than a case study.) Case studies allow us to see how inflation targeting has worked in practice and so provide some evidence about the mechanisms through which inflation targeting has affected the interaction of the markets, the public, politicians, and central banks. Then we can see if that interaction has been likely to improve how monetary policy is conducted and whether it results in better policy outcomes. This type of evidence is also not without its faults because it is necessarily anecdotal. However, I think that we need to be honest and admit that all evidence, including econometric evidence, has its faults. This is why we need to take a broader view on what evidence to examine and try to understand what makes monetary policy strategies successful from alternative perspectives.

ARE THE SUCCESSFUL NON-INFLATION TARGETERS VERY DIFFERENT FROM INFLATION TARGETERS?

I want to address a final issue that is also very relevant to the interpretation of this paper. It is not at all clear that the successful non-inflation targeters that Neumann and von Hagen study (the United States and especially Germany and Switzerland) are very different in their monetary policy strategies from the inflation targeters.

As documented in my work with Ben Bernanke, Thomas Laubach, and Adam Posen (Bernanke et al., 1999), the successful non-inflation targeters' strategies for conducting monetary policy have many of the same elements as those pursued by inflation targeters. Indeed, my reading of Neumann and von Hagen's paper is that they would agree with the view that inflation targeters and the successful non-inflation targeters are not all that different. Both do focus on the long-run goal of price stability and stress transparency, accountability, and flexibility, the key elements of inflation-targeting regimes. Thus, the adoption of inflation targeting should be seen as a convergence to best practice in the conduct of monetary policy.

I agree with Neumann and von Hagen that monetary targeting worked well in Germany and that the evidence does not suggest that inflation targeting would have been superior to the monetary targeting approach used by the Bundesbank from 1974 to 1998. As pointed out by Neumann and von Hagen and also in my work with Bernanke, Laubach, and Posen, the Bundesbank's monetary targeting strategy was a success because it helped both the officials inside the central bank and the public and markets to focus on longer-run issues, particularly price stability. This view leads the authors to end their paper by stating that, "Given the central bank's commitment to price stability and its willingness to bind its policy to an intermediate target that serves as the nominal anchor for monetary policy, the choice between an inflation target or a monetary aggregate then is probably more a question of culture than economic principles." I agree.

However, it is important to point out that the context (culture) for the conduct of monetary policy in Germany is quite different from what it is in the European Monetary Union. Because of its history in which it experienced horrendous costs from hyperinflation, the German public is far more sophisticated about monetary policy than other Europeans and has much greater support for a central bank that focuses on inflation control. As a result, the complicated explanations provided by the Bundesbank when it missed its monetary target ranges were accepted by the public and did not weaken the support for the Bundesbank's monetary policy strategy. This is much less likely to work with the wider European population.

Some evidence for this view is that the European Central Bank (ECB) (or, more accurately, the European System of Central Banks) has received a tremendous amount of flack since its inception, although its policies seem to be reasonable and inflation has remained under control. I believe this has occurred because the ECB suffers from a "communications gap" and not a "policy executions gap." Part of the problem stems from the two-pillar strategy, which I believe is confusing to the European public and hinders effective communication. Given the instability of the money-income relationship, the monetary reference value requires complicated explanations that are not fully understood by the European public. It would be much clearer for the ECB to focus its explanations of the conduct of monetary policy on the second pillar, which addresses whether it is meeting its inflation goal. In other words, one pillar is better than two. I thus believe that the ECB would reduce its communications gap if it adopted a flexible inflation-targeting framework akin to that followed by inflation targeters, just as Switzerland has done recently. It is important to note that dropping the monetary-reference-value pillar does not rule out a role for monetary aggregates in the formulation of policy. Many inflation targeters, including the Bank of England, do follow monetary aggregates quite closely in thinking about the future path of inflation, and this could certainly be an element in an inflation-targeting framework for the ECB.

The Federal Reserve's monetary policy actions under Alan Greenspan have probably also been quite consistent with what would have been done under an inflation-targeting regime. Furthermore, as I have pointed out elsewhere (Mishkin, 2000), the United States has a nominal anchor that has been very effective in recent years—it is Alan Greenspan. Thus it is not at all clear that adoption of inflation targeting in the United States would have improved recent monetary policy performance. However, there is still a strong argument for adoption of inflation targeting by the United States. No matter how good a nominal anchor Alan Greenspan is, he won't be around forever. It is better to depend less on individuals and more on institutions to achieve good policy results. Thus we need to take steps now that will institutionalize the desirable features of the Greenspan Fed with its focus on price stability and the use of preemptive strikes against either inflationary or deflationary impulses in the economy. This is exactly what inflation targeting is intended to achieve.

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Panel Discussion: Transparency in the Practice of Monetary Policy

The Value of Transparency in Conducting Monetary Policy

Charles Freedman

In this paper, I discuss transparency in the conduct of monetary policy from three perspectives. First, I look at why central banks have chosen to become more transparent in recent years. I then set out the measures taken by the Bank of Canada to increase transparency. The third section of the paper examines a number of issues that could be grouped under the heading "Are there limits to what should be made public?"

WHY HAVE CENTRAL BANKS BECOME INCREASINGLY TRANSPARENT?

There are two key factors behind the move to increased transparency on the part of central banks. The first is the relationship between transparency and the effectiveness of monetary policy. The second is the link between transparency and accountability. Let me examine each of these motivations in turn.

The way in which monetary policy is conducted by central banks has changed significantly in recent years. Not too long ago, central banks said relatively little about their monetary policy and allowed their actions to speak for themselves. Today, in contrast, central banks are very explicit in setting out the objectives of policy, the way in which they view the operation of the transmission mechanism between their policy actions and their goal variables, their outlook for economic activity and inflation, and their setting of the policy interest rate. It is now generally believed in the central banking community that this increased transparency improves the functioning of monetary policy in a number of dimensions.

The first dimension involves the understanding of the general public, both directly and through the media. Like all public policies, monetary policy benefits from increased public support and understanding. In particular, monetary policy, which at times involves the need to take tightening actions to prevent the economy from overheating, would find itself the subject of considerable public criticism if the public did not understand the reason for its actions. The key point in developing such an understanding is to make clear what monetary policy can do, as well as what it cannot do. Thus, central banks should emphasize that the role of monetary policy is to control inflation in the medium-to-long run[1] and that an environment of low inflation will help the economy to achieve a higher level or rate of growth of productivity. Moreover, a monetary policy aimed at inflation control will tend to moderate the economic cycle, although it cannot eliminate it. In focusing on these benefits, the central bank should make clear that the objective of low inflation, or price stability, is a means to an end, the end being a well-functioning economy, and not an end in itself. Examples from postwar economic history that focus on the poor performance of the economy at times of high inflation and its better performance at times of low inflation can be very helpful in this regard.

In addition to generating broad public support for the goal of low inflation, transparency (along with the credibility of policy) can contribute to behavior that will facilitate the achievement of the goal. Thus, wage and price setting that is done in the context of an environment of confidently held expectations of low and stable inflation will make the task of the central bank easier.

The second dimension of the relationship between transparency and the functioning of monetary policy involves the behavior of participants in financial markets. When financial markets understand and anticipate the actions of the central bank, the first steps in the transmission mechanism between policy actions and economic activity and inflation work more smoothly.

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[1] This could be done in the context of an explicit inflation target (as in Canada) or a more general commitment to low inflation (as in the United States).

For example, when the central bank and market participants have a similar interpretation of factors affecting the economic outlook, data releases will tend to lead to movements in market interest rates (and the exchange rate) in advance of, and consistent with, the policy actions that are subsequently taken by the central bank. Thus, new data indicating increased pressures on capacity and, hence, an increased likelihood of higher future inflation will result in higher interest rates across much of the yield curve, while signs of weakness in the economy and an increased likelihood of lower future inflation will result in lower interest rates.

I would emphasize at this point that central banks should not and do not simply follow the market. If views differ between the central bank and the market as to the likely outlook and the appropriate policy, the central bank must follow its own best judgment and explain to the market the reasons for its actions. But the enhanced transparency and improved communications of recent years reduce the likelihood of sharply different views as to appropriate policy, although they do not entirely eliminate it. In short, if market expectations are broadly in line with the direction of policy, there is likely to be less volatility in financial markets and smoother incorporation of policy actions into interest rates and exchange rates.

Communications play an important role in the transmission of the views of the central bank to the public and to markets. Hence, a great deal of attention is now paid to the way that central banks present their key messages (see Blinder et al., 2001, and Jenkins, 2001). Improving the effectiveness of monetary policy through greater transparency requires proactive and well-planned communications.

The second key factor motivating the trend to greater transparency is the tendency toward greater accountability, an important element in the framework supporting the independence of central banks. On this, I can be brief. Increasingly around the world, central banks are being given responsibility for carrying out monetary policy in the context of objectives that are defined in legislation or treaty and/or agreed upon by the government and central bank. As nonelected bodies, central banks are typically held accountable to government or parliament or the general public for their stewardship of policy. In order for this accountability to be effective, the oversight body must have sufficient information to evaluate the conduct of policy by the central bank. Such information is provided by central banks in the context of their overall communications strategy, and the need to provide this information has played an important role in the increased transparency of monetary policy.

HOW HAS THE BANK OF CANADA BECOME MORE TRANSPARENT?

While I now turn to the ways in which the Bank of Canada has become more transparent in recent years, I would note that similar (although not identical) changes have been put in place in most central banks. Changes in the direction of increased transparency can be grouped under a number of headings—the goal of policy, the transmission mechanism, the outlook, the policy instrument, and the means by which the Bank communicates information.

Goal of Policy

In February 1991, the Bank of Canada and the government of Canada publicly announced their jointly agreed inflation-control targets. The initial targets aimed at a gradual reduction of the target rate of inflation from 3 percent at the end of 1992 to 2 percent at the end of 1995. Since then the targets have been renewed three times, each time with a target range centered on 2 percent. The most recent agreement, announced earlier this year, extended the 2 percent target to the end of 2006. The move to a five-year term for the agreement (from the three-year term in previous agreements) is aimed at enhancing the longer-term predictability of the rate of inflation.

The range for the target has been plus or minus 1 percent throughout. The Bank has also been very explicit that the horizon for bringing inflation back to the target midpoint if it moves away from that level would be six to eight quarters. While the target has been defined in terms of the 12-month rate of increase of the total consumer price index (CPI), the Bank has used a publicly announced measure of core inflation as a policy guide in assessing future inflation developments.

Transmission Mechanism

The Bank of Canada has explained in some detail the way in which it views the transmission mechanism from its policy actions to market interest rates and the exchange rate, and then to output and inflation (see Thiessen, 1995). It has also published a number of articles on the large macroeconomic

model, the quarterly projection model, or QPM (Poloz, Rose, and Tetlow, 1994), that currently provides the basis (combined with staff judgment) for the principal staff projection. An alternative view of the transmission mechanism focuses on the way that developments in the monetary aggregates directly affect the spending behavior of households and businesses. (See Engert and Selody, 1998, and Laidler, 1999, for expositions of this approach.) The various multi-equation and single-equation models linking monetary aggregates to economic activity have also been made public. And the Bank has explained how the staff projection, the monetary-based forecasts, and the information gathered by the Bank's regional offices (through formal surveys and anecdotally) are integrated in the course of making monetary policy decisions (see Longworth and Freedman, forthcoming).

Economic and Inflation Outlook

Central banks differ in the degree of detail that they publish on their economic and inflation outlook. And they also differ in the interest rate and exchange rate conventions that underlie their projections.

The Bank of Canada presents a detailed discussion of recent economic and inflation developments as well as its outlook for the future once per quarter either in its monetary policy report (in April and October) or in its update (in January and July). The outlook typically focuses on expected developments over the next 6 to 18 months in gross domestic product (GDP), the output gap, total CPI, and core CPI. A qualitative assessment is given of the risks surrounding the outlook, but there is no attempt to quantify the risks.

Speeches by the Governor and other members of the Governing Council of the Bank are used to sketch out changes in the outlook between publications. As well, a press release is issued on each of the eight preannounced fixed action dates, whether or not the policy interest rate is changed, and this gives the Bank a further opportunity to give some sense of its views of likely future developments in the economy and inflation.

Policy Interest Rate

Until a few years ago, markets had to infer a central bank's target for the policy interest rate from its actions, and it was not always immediately clear from these actions whether or not the policy rate target had changed. Now, the target for the policy rate is announced explicitly, normally on preannounced dates, almost everywhere.

In Canada, there were a number of changes that made the setting of the policy interest rate increasingly transparent. In 1994, the Bank established an operational target band of 50 basis points for the overnight interest rate. Market participants recognized a change in the rate when the Bank informed them of its intention to intervene at the new limits of the band (using repos or reverse repos to enforce those limits). In early 1996, the Bank began to issue a press release whenever there was a change in the band, giving an explanation for the change. Shortly thereafter, the Bank Rate (the rate charged by the Bank on advances to participants in the payments system) was set at the top of the band.[2] In 1999, the target rate was explicitly set as the midpoint of the band. With the movement to fixed announcement dates in late 2000, a press release was issued on each date regardless of whether or not there was a change in the policy rate.

Communications

The Bank now aims at an integrated communications strategy in order to disseminate its key messages to the various target audiences throughout the year. As noted earlier, each year this involves two monetary policy reports, two updates to the report, eight press releases on the fixed announcement dates, and speeches by the Governor and other members of the Governing Council (in many cases as part of a regional outreach program). In addition, there are background briefings, press conferences with the Governor following the release of the report and the update, and testimony by the Governor before the House of Commons Finance Committee following the publication of each report.

In recent years, the Bank has instituted a media "lock-up" arrangement in which the media can read key Bank reports and write their stories prior to the official publication time, for release at that time. As well, there are regular media briefings during the lock-up, where officials can deal with technical questions and clarify other issues (on an unattributed basis) for the media that are present. The result has been a clear improvement in the quality of the reporting compared with the period when the media received the reports at the official

[2] It had previously been set equal to the average rate on Treasury bills at the weekly auction plus 25 basis points.

release time and the wire services competed to get out the first headline.

The establishment of the fixed announcement dates has also had a beneficial effect on the discussion surrounding Canadian monetary policy by both journalists and market commentators. Whereas previously there had been a tendency for the discussion to center on whether or not the Bank would follow the Fed's movements, the focus has shifted to what is appropriate for the Canadian economy in its current and prospective economic circumstances.[3]

ARE THERE LIMITS TO WHAT SHOULD BE MADE PUBLIC?

On the surface, this seems like an odd question. Can there ever be too much of a good thing? But as one reflects on the nature of transparency and communications, it becomes clear that certain steps in the direction of increased transparency could actually be counterproductive. Let me begin with an admittedly extreme example, turn to the principle at issue, and then return to some examples.

Should the policymaking body's deliberations before its decisions be televised or Web-cast? Even strong proponents of transparency come to the conclusion that such an initiative could be harmful for a number of reasons. First, policymakers could be inhibited from taking different points of view in the course of the discussion (i.e., playing devil's advocate). Second, it would make it more difficult for them to change their minds on the appropriate decision for the policy interest rate as the debate progressed and as different perspectives on the issue were discussed, since they would appear to be "waffling" on the decision. Third, making the deliberations public would likely lead to participants making more formal presentations (with perhaps a more entrenched initial position), replacing the more informal discussion in which the dynamic of the debate plays an important role in arriving at a decision.[4] In short, the view that opening the deliberations to the public could well lead to a deterioration in the quality of the decisionmaking process has acted to prevent such a development even in those central banks that are the most enthusiastic supporters of transparency. (See Blinder et al., 2001, for a detailed discussion of this issue.)

Let me now examine the question of the limits of transparency from a broader perspective, drawing on an interesting and insightful paper by Bernhard Winkler (2000) of the European Central Bank (ECB). Winkler argues (p. 18) that "in a world where—unlike in most standard economic models—cognitive limits matter, more information and greater detail does not by itself translate into greater transparency and better understanding, nor does it necessarily lead to more efficient decision-making." Winkler notes that there are several aspects of transparency, which may possibly conflict with each other. These include (i) openness, or the amount and precision of information provided; (ii) clarity in the presentation and interpretation of information; (iii) common understanding by the sender and receiver of information; and (iv) honesty, or the correspondence of the internal framework of analysis with the presentation used for external communication.

As an example of potential conflict, we can compare openness and clarity. Central bank projections typically produce time paths for dozens or even hundreds of economic variables. Yet most central banks communicate to the public their quantitative outlook only for the broadest economic measures, such as output and inflation.[5] This reflects the view that increased openness, in the sense of presenting enormous amounts of detail, would reduce the clarity of the central bank's message about future developments rather than increase it.

In passing, I would note that one issue that all central banks are struggling with is how to characterize and communicate the risks around their baseline case forecast. Some, such as the Bank of England and the Riksbank, present a form of probability distribution that is intended to indicate the variance around the central forecast. Others, such as the Federal Reserve and the Bank of Canada, are more qualitative in their presentation of the balance of risks. But I do not think that any central bank has been completely successful thus far in communicating the nature of the risks surrounding its outlook for the economy and inflation.

The notion of "honesty" in the correspondence of the internal framework of analysis and external communications also gives rise to some interesting

[3] See Bank of Canada (2000) for a discussion of the benefits anticipated from the movement to fixed announcement dates.

[4] Presentations at FOMC meetings by Board members and Reserve Bank presidents appear to have become somewhat more formal since 1993. In the fall of that year, the FOMC was made aware that the transcripts of the tape recordings of the meetings since March 1976 had been retained. The FOMC subsequently decided that lightly edited verbatim transcripts of the meetings would be released with a five-year delay.

[5] There is often considerable qualitative discussion of some of the components of these broad measures, but most central banks do not give precise estimates of their projections of these components.

issues. Economists, whether in universities or markets, would like central banks to be more explicit in setting out their reaction function to various contingencies. But central banks, while they spend a lot of time considering the appropriate response to various shocks, do not have an explicit, quantitative pre-agreed reaction function for every type of shock. To quote John Vickers (1998, pp. 370-71):

> In situations of any complexity, there is a tension between a complete contract (i.e. one that specifies what is to happen in every eventuality) and having a good contract (i.e. one that entails good decisions in every eventuality). If the same is true for policy reaction functions, then residual discretion is sensible and so residual uncertainty is inevitable.

One reason that it is not possible to develop a simple reaction function is that there is no model of the economy that is universally accepted.[6] With model uncertainty, there cannot be a simple reaction function, especially when different weights are attached to the projections from the various models in different circumstances. In this context I would note that one of the perceived advantages of the Taylor rule is that it is robust across models. But while the Taylor rule can be useful as an indicator of policy in many circumstances, it is not a reaction function that sets out a monetary policy response to all contingencies. A second reason that there cannot be a simple reaction function is that the information used in coming to a decision involves more variables than can be incorporated in any such function. For example, in the early 1990s, the reluctance of commercial banks to extend loans (Chairman Greenspan's "headwinds") played an important role in the Fed's conduct of policy. More recently, the increased rate of growth of productivity operated through a number of channels to affect economic behavior and thereby to influence the Fed's decisionmaking. And, currently, the confidence of firms and households in light of the terrorist attacks of September 11 is playing an important role. While a simple relationship such as a Taylor rule can be a helpful guide to policymaking, it cannot incorporate all the factors that feed into the decisionmaking process (especially in an open economy).

CONCLUDING REMARKS

Central banks have come a long way in recent years in the direction of increased transparency. And this has been very helpful in improving the effectiveness of monetary policy and enhancing the accountability of the central bank.

But there continue to be interesting challenges as to future directions in which central banks should go. How much detail should be included in the outlook? Whose forecast is being released—that of the staff (as in the case of the ECB) or that of the policymaking body (as in the case of the Bank of England)? What convention, if any, should be used for the interest rate path on which the outlook is based?[7] How does the central bank communicate most effectively that its outlook is conditional on current information and that the outlook will change as new information is received? How can it best communicate the risks and uncertainties surrounding its outlook?

In my view, the central bank's approach to answering each of these questions should be based on an analysis of what would be most effective in enhancing the understanding of the public, the markets, and the media. This may be different in different countries. And it may change over time as the sophistication of the targeted audiences changes.

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[6] See, for example, Bank of England (1999) for the various models that the Bank uses in its policy formulation.

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The Value of Transparency in Conducting Monetary Policy: The Czech Experience

Václav Klaus

My remarks reflect more my political experience during the last decade, after the fall of communism in my country and elsewhere, than any well-defined theoretical position.

As I see it, *transparency does not represent the main and most important issue of monetary policy*. Transparency itself is undoubtedly a positive feature, but to concentrate on transparency without taking into consideration other things means missing, if not hiding, something that is more relevant.

In my understanding, the more relevant issues or the prior issues are the quality of the monetary regime and the way in which monetary policy reflects the preferences of society. An error in either of them is very costly.

Let me start with the second issue, with the problem of the independence of the central bank. I must admit I have a problem with it—as someone who, as minister of finance, introduced it into my country. I can probably afford to make such a "politically incorrect" statement here because I have some justification for it. In the communist era, we were—among other things—dreaming about rational monetary policy and we considered the independence of a central bank to be a necessary precondition for it. Now, after 12 years of its absolute independence in my country, I see this issue in a more complicated way. I see it as a *principal-agent problem*. There are many arguments that the central bank should be just an agency that operates to meet policy objectives set by society or its legal representatives. In accordance with this view, the independence of a central bank should be limited to the independence in choosing instruments, not policy objectives. This is not, however, the case in my country. Transparency is, therefore, not the main issue.

Looking at the title of this discussion, we are supposed to speak not about *monetary regimes* but about *monetary policy*. Nevertheless, it seems to me that there is a difference in transparency between the regime of discretionary monetary policy and the regime of policy of rules. Discretionary policy cannot be—perhaps even should not be—transparent (as I understand transparency).

My personal experience with pegged exchange rate policy, which was considered to be the most suitable policy for transition economies 10 years ago, is not a good one. I was very much afraid of accepting it at the end of 1990, but at that time the International Monetary Fund did not listen to any arguments in this respect. This policy, however, in the first half of the 1990s brought about (or at least made possible) better economic fundamentals in my country than in other transition economies. It

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was, however, undermined by the premature introduction of full convertibility of the Czech crown and by the resulting (or perhaps parallel, but independent) large inflow of foreign capital into the country. This coincidence of events led, of course, to the excessive growth of the money supply.

Our central bank tried not to be passive and started to interfere with the money supply, which was an expected error. The combination of two different rules (or regimes) whether in a transparent or nontransparent way—pegged exchange rate and monetary targeting—had very unpleasant consequences.

To return to our topic, we can say that the policy of pegged exchange rates was transparent, but in the world of global massive movements of capital it contained *inherent risks*. When investors lose trust in the currency and start speculative attacks against it, the pegging must be abandoned, which is not costless. The transition from one type of monetary rule to another is connected with instability, which is especially true for a small, open, transition economy with weak and shallow markets.

Our country finally moved to *inflation targeting* which is, in a favorable interpretation, a more complex policy regime than a simple monetary targeting or pegged exchange rate regime. In another interpretation, it is a resignation on accountable policy. It requires using the whole mix of central bank instruments, but no one knows in advance which of them will be used. In this respect, inflation targeting is not transparent and our experience forces me to argue that its results (at least its short-term results) are very dubious.

The Czech experience demonstrates that pegged exchange rate policy is suitable before deregulation of capital flows, whereas, after it, floating is inevitable. It shows as well the problems of inflation targeting in a transition economy. Our central bank *did not have sufficient experience with monetary policy and, in addition, chose an extremely low inflation target which slowed down the economy too much. After that we could not get out of deflation*.

Inflation targeting can have meaning only on condition of hitting the inflation target, which in our case was not done. The missing of the target was enormous; instead of 6 percent inflation we got deflation. Somebody could argue that it was a mistake, but I am not so sure.

To conclude, transparency has a meaning and plays a positive role only when all other preconditions of monetary policy are in place.

Transparency in the Practice of Monetary Policy

J. Alfred Broaddus Jr.

This has been a very useful conference in my view, and I am honored by this opportunity to be a part of it. As some of you may know, I was the second choice for this slot, but that doesn't bother me at all because the first choice was Don Brash, the Governor of the Reserve Bank of New Zealand and a pathbreaker in bringing both transparency and accountability to central banking in practice. I won't be able to fill Don's shoes completely, but I have a strong interest in this topic, and I am very happy that Bill and Dan saw fit to give me the opportunity to share some thoughts with this distinguished group.

Actually, it is hard to imagine that anyone interested in improving the conduct of monetary policy would *not* be interested in this topic. There is a growing consensus among monetary economists at this point that the impact of monetary policy on expenditure is transmitted primarily through the effects of policy actions on expectations regarding the future path of short-term interest rates rather than the current level of the overnight rate (see Woodford, 2001, p.17). Further, the more financial markets know about the reasons for a central bank's current policy actions and its longer-run policy intentions, the more likely it is that market reactions to policy actions will reinforce these actions and increase the effectiveness of stabilization policy. It follows that central banks should be highly transparent regarding both their long-term policy objectives and the shorter-term tactical actions they take with policy instruments.

Against this background, it seems to me that the Fed, along with other central banks, has made considerable progress in increasing transparency

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in recent years. When I first joined the Fed back in 1970, to the extent that anyone thought explicitly about transparency issues at all, the idea seemed to be that limited transparency—or even no transparency—was best. Central banks in industrial democracies were thought to work most effectively behind the scenes, away from the glare of public scrutiny, at least in part because they could then quietly take appropriate actions that might be politically unpopular or, more broadly, difficult to explain to a public not well versed in the intricacies of finance (see Goodfriend, 1986). There was also a belief in some quarters that central banks could enhance the effects of certain policy actions—most notably foreign exchange market intervention operations—if they kept market participants uncertain about their intentions.

Attitudes toward transparency appeared to change in the 1980s, partly reflecting progress made by economists in understanding the monetary policy transmission mechanism, and probably partly because of public demand, particularly in the United States, for greater openness in government and public policy in general. (As you may recall, the most widely read popular book about the Fed and Fed policy in the 1980s was somewhat derisively titled *Secrets of the Temple*.) Further, in the early 1980s Chairman Volcker publicly took responsibility for reducing inflation from its then high level, and subsequently took strong and temporarily painful actions to accomplish the reduction. Some public explanation of the need for these steps was required, and this need probably facilitated the transition to viewing transparency in a more favorable light. In any case, given the normal resistance to change in bureaucratic organizations, I believe the Fed has made remarkable progress over the last decade or so in opening up its conduct of monetary policy to market and public scrutiny.

Since the Fed is now quite open regarding many important aspects of its policy strategy and operations, and in view of the strong performance of the U.S. economy in recent years, at least up until the last several quarters, one might reasonably ask whether still greater transparency is necessary or even desirable in U.S. monetary policy. I think it is, and I will try to make this case in the next few minutes. Let me comment briefly on four points: (i) the transparency of our long-term inflation objective, (ii) what I'm going to refer to as the "intermediate-term transparency problem," (iii) the transparency of our policy directive including its "tilt," and (iv) the role of testimony, speeches, and other public statements by Fed officials in providing transparency.

TRANSPARENCY OF THE LONG-TERM INFLATION OBJECTIVE

Probably the most important thing about Fed monetary policy that the public wishes to know and needs to know with some precision is our long-term objective for inflation. Longer-term inflation expectations are obviously critical to households and businesses in committing to long-term investments, home purchases, insurance contracts, and wage and benefit agreements. Conversely, the Fed needs the public to understand and trust its long-term commitment to low inflation to achieve maximum benefit from this long-term strategy.

How to convey this objective credibly to the markets and the public has been a major focus of our policy research at the Richmond Fed for a long time. For many years I've personally been convinced that controlling inflation should be the Fed's overriding objective, that this objective should be explicit, and that it should be supported by a Congressional mandate. At one level, abstracting, for example, from political obstacles, this seems obvious. We know that the Fed has the ability to determine the long-run inflation rate with monetary policy, and theoretical analysis and all of our practical experience suggests we should use that power in the public interest to maintain low and stable inflation over time.

An explicit long-term inflation objective supported by a Congressional mandate would be a substantially beneficial step, in my view, even if it were limited to a verbal statement along the lines of the language in the proposed Neal Amendment to the Federal Reserve Act (see Black, 1990, and Greenspan, 1990). Quantifying the objective in terms of an explicit numerical rate (say, 2 percent per annum using the core personal consumption expenditures [PCE] inflation index) would make the objective even more transparent and probably more effective.

Committing to an explicit inflation objective would achieve at least three things. First, it would help anchor longer-term inflation expectations and therefore facilitate the longer-term transactions I noted earlier. Second, it would help prevent inflation scares in financial markets, which would allow the Fed to act more aggressively in response to downside risks in the economy with less concern that rising long-term interest rates might neutralize the effect of the action.

Third, and most importantly, an explicit inflation objective would discipline the Fed to explain and justify short-run actions designed to stabilize output and employment against our commitment to protect the purchasing power of the currency over the long run. An explicit objective would force such explanations and justifications to be more sharply focused than in the current regime without such an objective. Routine, clear explanations of short-term actions would build confidence in the Fed's commitment to price stability and over time help reinforce credibility for low inflation. If the explanations were made in testimony before Congress, supplemented perhaps by a written inflation report along the lines of the Bank of England model, Congress would be positioned to enforce an accountability for monetary policy that arguably is now weaker in the United States than in the United Kingdom and the European Monetary Union.

One final point here: The Fed's long-term commitment to price stability is now largely embodied in our current Chairman's demonstrated commitment to this objective, rather than being institutionally grounded in an explicit objective. It is therefore inherently tenuous, since its continuance will depend on the preferences of future chairmen and their susceptibility to political pressure to pursue other goals.

For all these reasons, it seems clear to me that the increased transparency that would be provided by an explicit long-term inflation objective would increase the probability that we will attain our goal over time. Some argue strongly for a dual objective that refers explicitly to output or employment as well as inflation. But both theory and experience indicate that the Fed cannot control real variables directly with monetary policy, and in my view there are reasonable grounds to presume that the Fed will optimize its contribution to the economy's overall performance by maintaining credibility for low inflation (see Goodfriend and King, 2001). A unitary goal focused on low inflation would strengthen credibility by making the Fed's commitment to this objective definite and unambiguous.

It is one thing to advocate an explicit inflation objective; it is another to actually put one in place. I doubt seriously that an explicit objective set and announced unilaterally by the Fed would be credible. Any explicit inflation objective would need to be accepted by the government as a whole through legislation or some other formal agreement, as such objectives are in countries that employ them. With its public standing high, the Fed seems well positioned currently to make the case for such a mandate.

INTERMEDIATE-TERM ISSUES

Even if the Fed obtains a price stability mandate, transparency issues are still likely to arise in practice—specifically, when current inflation or near-term inflation projections deviate from the long-term objective. For example, inflation may rise above its objective at a time when real output is below potential and unemployment is rising. It would be difficult or impossible in this situation for the Fed to ignore the weakness in the real economy and act aggressively to bring inflation quickly back to target.

Some have argued that precisely this possibility makes an explicit inflation objective for the United States impractical. I don't find this objection particularly compelling. Especially if the Fed has previously established credibility, inflation may remain above its objective for some time without undue damage to the Fed's credibility if the Fed is transparent regarding its medium-term strategy for bringing inflation back to path. Even with established credibility, explaining this strategy clearly and convincingly to market participants and the general public would be challenging. Strategies and the accompanying explanations will have to be tailored to each case. In particular, the Fed may anticipate bringing inflation back to the objective more quickly in some cases than in others. Consequently, it may be useful for the Fed to announce intermediate-term inflation forecasts to assist the public in making financial and business decisions during the transition back to the long-term objective.

Beyond this, even if inflation is stable at or near its long-term objective, unanticipated shocks may push employment and output growth temporarily away from their sustainable noninflationary rates. Here, too, Fed transparency about its intentions will help the public gauge how production, employment, and interest rates will evolve in the medium term as the economy adjusts to the shock. Transparency is in the Fed's interest as well since it can help build confidence in the following: that, first, monetary policy can be effective in dealing with temporary departures of real activity from its long-term potential and, second, that the Fed has the competence to exploit this capability. More generally, I believe that the Fed's expertise regarding the functioning of the U.S. economy—while far from perfect—is now of high enough quality that transparency of our thinking about the economy's medium-term

prospects can build public confidence and trust in periods of economic stress. To be sure, actual developments may deviate from our announced expectations in particular situations, but trust can be maintained if the Fed provides reasonable explanations for the deviations.

TRANSPARENCY OF THE FEDERAL FUNDS RATE TARGET AND THE DIRECTIVE "TILT"

Having dealt with longer-term and intermediate-term issues, let me now make a few comments about transparency as it relates to short-term policy tactics: specifically, transparency regarding the current federal funds rate target, the "tilt" of the directive language, and the statement released to the press after each Federal Open Market Committee (FOMC) meeting. It is in this area that the greatest progress has been made in increasing transparency over the last decade. Since February 1994, the funds rate target set at a particular FOMC meeting (previously released only after the next FOMC meeting) has been announced shortly after adjournment of the meeting where it is set. So markets now know the current target. And the Committee has released the tilt (or absence of a tilt) in the directive language along with the current funds rate target since its meeting on May 18, 1999. Previously, it too had been released only after the next FOMC meeting.[1]

This increased instrument transparency, in my view, is all to the good. I believe the immediate release of the tilt language is especially useful. Again, the effect of monetary policy is transmitted to the economy not only through the current level of the funds rate target but also through market expectations about the *future* level of the target, which are reflected in the short-term yield curve. Market participants are going to form these expectations in any event. By announcing the tilt immediately, the FOMC shares its best current estimate of emerging economic conditions that might affect the direction of any near- or intermediate-term change in the funds rate target, which should increase the efficiency with which markets form their expectations, help prepare markets and the public for changes in the target, and reduce short-term disruptions caused by leaks. In particular, since markets know the current tilt, they are better positioned to interpret the likely policy implications of incoming current economic data. For example, the release of strong data after disclosure of an upside tilt in the directive language should increase the probability that long-term rates will be bid upward in response. Consequently, immediate disclosure of the tilt should enable long-term interest rate adjustments to perform their stabilizing role in the economy more effectively.

While, again, considerable progress has been made in increasing the transparency of the Fed's short-term instrument settings, and its short-term expectations regarding at least the direction of future settings, in my view there is room for further progress. In particular, there may be different views about the extent to which a tilt in the directive in one direction or the other commits or obliges the Fed to a future funds rate change. To the degree that markets interpret a tilt as committing the Fed to future action, failure to take action may surprise or "whipsaw" markets. It should be possible for the Fed to mitigate this problem by emphasizing publicly that a tilt only implies a greater likelihood that any near- or intermediate-term change in the funds rate will be in a particular direction, and is not a commitment to any action. It might seem tempting to consider eliminating the tilt in the formulation of short-term policy to remove any confusion it may produce. But such a reduction in transparency would deprive the FOMC of the benefits of announcing the tilt noted above. Moreover, beyond these benefits, abandoning it would deprive the Committee of a useful way to keep in touch with the strength of its internal consensus regarding policy at any point in time and a valuable supplementary tool for reaching agreement on a funds rate target when there is a significant divergence of views regarding the appropriate level of the target.

Finally, it is important to recognize that the language of the press statement announcing the funds rate target and any tilt after each meeting also influences market expectations regarding future policy actions. This language is widely reported and interpreted currently in media coverage of FOMC meetings. In essence, the language in the statement,

[1] Initially, the FOMC tilt statement referred to the likelihood of a future increase or decrease in the targeted federal funds rate. In January 2000, the Committee announced that it had adopted new language for this portion of the statement. The new language describes the FOMC's assessment of the "balance of risks" with regard to heightened inflationary pressures or economic weakness in the foreseeable future, without reference to future policy actions. The objective of the change was to avoid potential confusion regarding the implications of the tilt announcement for future policy. In practice, however, financial market participants continue to draw inferences from the announcement regarding the likelihood of possible future policy actions.

like the tilt language in the directive, is viewed by market participants as an additional short-term policy instrument.

TESTIMONY AND SPEECHES

The role of the Fed's explicit policy announcements in shaping market expectations of future policy actions is obviously important, but as anyone even slightly interested in Fed policy is well aware, public statements by individual FOMC members (including Reserve Bank presidents who are not currently voting Committee members) are at times especially important. This is particularly so in today's environment where media coverage of these utterances by cable television financial news channels, instant e-mail transmission of market analysis, and the like is much more extensive than even just a few years ago. Obviously, the Fed Chairman's remarks in congressional testimony (including answers to questions as well as prepared testimony), his speeches, and his interviews are followed more intensely than the comments of other FOMC participants, since the Chairman is clearly the most influential Committee member and only he speaks for the Committee as a whole. At times, however, comments of other participants can affect market expectations, at least in the short run: for example, if a comment is the Fed's first public reaction to a new economic report (particularly if the content of the report was unanticipated by markets) or if the comment comes at a time when markets are especially uncertain about near-term policy prospects. Consequently, we also receive our share of media attention. Bill Poole and I and, I expect, all of our colleagues at other Reserve Banks can tell stories about being covered by several reporters even when making speeches in fairly remote parts of our respective Districts.

Some argue that this form of Fed transparency may be counterproductive, at least at times, if the views expressed in these comments seem inconsistent—particularly if they appear to conflict with a recent FOMC decision or a public statement by the Chairman. On occasion I have personally received criticism and complaints from market professionals and others when they have found my statements at variance with other Fed statements or confusing in some other way, and I will acknowledge that on a few occasions my remarks may have briefly complicated the formation of market expectations.

Over time, however, speeches and other public statements by individual FOMC participants provide markets and the public with a more robust and complete understanding of thinking inside the Fed about current economic and financial conditions and near-term prospects than that provided solely by the policy announcements I just discussed. Also, it is important to recognize that market analysts are adept at filtering and appropriately weighting press reports of individual FOMC participant remarks in the context of the broad range of Fed public statements from all sources. In short, I believe a convincing case can be made that the public remarks of individual Reserve Bank presidents and other FOMC participants increase the efficiency with which markets form short-term policy expectations.

I would offer one other—admittedly speculative—note on this point. It is obvious, again, that the Fed Chairman speaks with by far the most influential voice among FOMC participants. It might appear superficially that comments by other participants that seem to be "off message" might create confusion about the Fed's intentions and undermine the force of the Chairman's statements. As I just suggested, there might be a little of this from time to time, but I doubt these instances are of much significance. Again, markets are well aware of the much greater weight of the Chairman's statements and discount the remarks of other FOMC participants accordingly. Perhaps more importantly, public commentary by other participants reinforces the Chairman's credibility in the eyes of informed observers of Fed policy, since they demonstrate that the Chairman leads, builds consensus among, and speaks for a thoughtful, competent group of policy professionals who naturally have diverse views on specific policy choices. If the public believed the Chairman was conducting policy unilaterally, he or she would be more vulnerable to an abrupt loss of public confidence. This might not be a risk for the current Chairman, who justifiably enjoys exceptionally high public respect, but it could be a problem for a future Chairman.

CONCLUSION

Again, I have enjoyed participating in this panel discussion. This conference has addressed what is clearly a crucial topic in understanding how monetary policy affects the economy and how it might be improved. The subject deserves continued research. Thanks to this conference, I am confident it will get it.

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