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The Taylor Rule and the Practice of Central Banking

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The Taylor Rule and the Practice of Central Banking[*]

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Abstract: The Taylor rule has revolutionized the way many policymakers at central banks think about monetary policy. It has framed policy actions as a systematic response to incoming information about economic conditions, as opposed to a period-by-period optimization problem. It has emphasized the importance of adjusting policy rates more than one-for-one in response to an increase in inflation. And, various versions of the Taylor rule have been incorporated into macroeconomic models that are used at central banks to understand and forecast the economy.

This paper examines how the Taylor rule is used as an input in monetary policy deliberations and decision-making at central banks. The paper characterizes the policy environment at the time of the development of the Taylor rule and describes how and why the Taylor rule became integrated into policy discussions and, in some cases, the policy framework itself. Speeches by policymakers and transcripts and minutes of policy meetings are examined to explore the practical uses of the Taylor rule by central bankers. While many issues remain unresolved and views still differ about how the Taylor rule can best be applied in practice, the paper shows that the rule has advanced the practice of central banking.

Key words: Taylor rule, monetary policy, rules versus discretion

JEL classification: B22, B31, E52

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The Taylor Rule and the Practice of Central Banking

1. Introduction

The Taylor rule has revolutionized the way many policymakers at central banks think about monetary policy. It has framed the conduct of policy as a systematic response to incoming information about economic conditions, as opposed to a period-by-period optimization problem. It has emphasized the importance of adjusting policy rates more than one-for-one in response to an increase in inflation. And, various versions of the Taylor rule have been incorporated into macroeconomic models that are used at central banks to understand and forecast the economy.

As documented in Asso, Kahn, and Leeson (2007a), the Taylor rule evolved from a long intellectual history that debated the merits of rules versus discretion. But it was John Taylor who, at the November 1992 Carnegie-Rochester Conference on Public Policy (1993), articulated a rule that gave rise to a new way of thinking about monetary policy among policymakers at central banks. The rule, which was based on the U.S. experience in the late 1980s and early 1990s, suggested that the federal funds rate (r) should normatively (with qualifications) be set, and could positively be explained, by a simple equation:

$$r = p + 1/2y + 1/2(p-2) + 2,$$

where y represents the percent deviation of real GDP from trend and p represents the rate of inflation over the previous four quarters. With inflation on its assumed target of 2 percent and real GDP growing on its trend path of roughly 2 percent per year (so that y=0), the real ex post interest rate (r-p) would also equal 2.

Fed policymakers and Fed watchers quickly took notice. Salomon Brothers advised their clients that “a hypothetical policy rule, modeled on the policy behavior that produced the latest decline in inflation, also indicated that the Federal funds rate is now too low” (Lipsky, 1993, 9, 6,

n6). This advice was followed up with some more detail: the parameters of the Taylor rule "capture the stated intentions of virtually all Fed officials." The Taylor rule was used to predict future interest rate changes for the remainder of that year: "the Taylor rule is likely to prescribe some relaxation of policy, baring a sharp run-up in current inflation" (DiClemente and Burnham 1995, 6). The Taylor rule also figured in the *Financial Times* (Prowse, July 3, 1995) and *Business Week* (Foust, October 9, 1995).

Glenn Rudebusch attended the Carnegie-Rochester conference and began to apply the Taylor rule to monetary policy analysis as a member of the staff of the Board of Governors. In Spring 1993, Donald Kohn (then staff director for monetary affairs at the Fed and secretary to the Federal Open Market Committee (FOMC)) discussed the Taylor rule with its author during a stint as visiting professor at Stanford. This interest rapidly reached the FOMC: Governor Janet Yellen indicated that she used the Taylor rule to provide her "a rough sense of whether or not the funds rate is at a reasonable level" (FOMC transcripts, January 31-February 1, 1995). In August 1995, Kohn requested from Taylor an update on the rule. Taylor visited with Fed staff economists for three days in September 1995, and by November 1995 Board staff began providing the FOMC with a chart summarizing various versions of the Taylor rule. On December 5, 1995, Taylor discussed the rule with Chairman Greenspan and other members of the Board of Governors.[1]

In addition to *prescribing* a method of reducing the swings of the business cycle, the Taylor rule also apparently *described* the stabilization method unwittingly used by the Fed since the late 1980s. Deviations from the rule could also shed light on Fed discretion, excessive or otherwise (Taylor 2007). However, Chairman Greenspan (1997) regarded a substantial degree of discretion as desirable so as to respond to shocks that were "outside our previous experience …

[1] This paragraph is based in part on conversations with Rudebusch and Taylor.

policy rules might not always be preferable." The Taylor rule, Greenspan argued, assumed that the future would be like the past: "Unfortunately, however, history is not an infallible guide to the future." Just prior to the Carnegie-Rochester conference, Ben Bernanke and Rick Mishkin (1992) argued that "Monetary policy rules do not allow the monetary authorities to respond to unforeseen circumstances": a view from which Taylor (1992a) dissented.

This paper examines how the Taylor rule is used as an input in monetary policy deliberations and decision-making at central banks. Speeches by policymakers and transcripts and minutes of policy meetings are examined to explore the practical uses of the Taylor rule by central bankers. The paper characterizes the policy environment at the time of the development of the Taylor rule and describes how and why the Taylor rule became integrated into policy discussions and, in some cases, the policy framework itself. While many issues remain unresolved and views still differ about how the Taylor rule can best be applied in practice, the paper shows that the rule has advanced the practice of central banking.

Section II describes the policy environment at central banks around the time of the birth of the Taylor rule and discusses how the Taylor rule helped build a consensus among academics and policymakers in favor or rules over discretion. Section III explains how and why the Taylor rule became the predominant framework for describing monetary policy in macroeconomic models used at central banks and for thinking about how policy should be set in a systematic way. Section IV describes the influence of the Taylor rule on the Federal Reserve's conduct of monetary policy. Section V looks at its impact on other central banks, including the European Central Bank (ECB), the Bank of Japan, and the Bank of England. Section VI concludes.

2. The Power of the Taylor rule

Taylor-type rules have become the standard by which monetary policy is introduced in macroeconomic models both small and large. They have been used to explain how policy has been set in the past and how policy should be set in the future. Indeed, they serve as benchmarks for policymakers in assessing the current stance of monetary policy and in determining a future policy path.

2.1 The policy environment at the birth of the Taylor rule

In the years leading up to Taylor's 1993 paper, various institutional and procedural transformations were creating a new policy-making environment and culture. In 1991, when Mervyn King (2000, 2) joined the Bank of England and asked former Fed chairman Paul Volcker for a word of advice, Volcker obliged with the word, "mystique." Volcker (1990, 6) described the central bankers of the Bretton Woods system as "high priests, or perhaps stateless princes." Fed watchers sought to divine the *Secrets of the Temple* (Greider 1987) by closely monitoring the open market operations of the New York Fed and their impact on market interest rates. The process was further complicated by the fact that, from 1989 to 1992, most policy changes were made in conference calls between regularly scheduled FOMC meetings (Sellon 2008).

Yet important changes were taking place. In February 1987, the Fed announced that it would no longer set M1 targets, and in July 1993 Chairman Greenspan testified before Congress that the Fed would "downgrade" the use of M2 "as a reliable indicator of financial conditions in the economy." Having returned to an explicit federal funds rate operating target after a brief interlude from 1979 to 1982 in which the Fed targeted non-borrowed reserves, the Fed kept the funds rate constant at 3 percent from late 1992 to January 1994. When the Fed tightened policy in February1994, the tightening was accompanied by a new policy procedure: it was announced rather than left for financial markets to infer.

More changes were to follow. In 1995, the FOMC began announcing how changes in policy would be reflected in the Fed's target for the federal funds rate. In May 1999, the FOMC began to publicly announce its policy decision regardless of whether its policy rate had been adjusted. Further transparency was injected into the system with "direction of bias" announcements (May 1999), replaced by a "balance of risks" announcement (February 2000). Transcripts of FOMC meetings are now released (with a five year delay), and since January 2005, FOMC minutes are released expeditiously (three weeks after the announcement of the FOMC's policy decision at each regularly scheduled meeting).[2]

Similar changes were happening elsewhere. Central banks that were experiencing undesirably high inflation rates gained greater independence from governments and many began to introduce formal inflation targets—starting in New Zealand. There, a new government which came into power in July 1984, introduced substantial economic reforms (Brash 1996). The reforms included assigning the Reserve Bank of New Zealand (RBNZ) the goal of reducing inflation and granting the central bank more independence in its actions. The Reserve Bank of New Zealand Act of 1989, which took effect in 1990, formalized the goal of lowering inflation and required that the primary function of the central bank be to achieve and maintain price stability.[3] The Act stipulated that the Minister of Finance and the Governor of the Reserve Bank

[2] Transcripts were made available beginning in 1994 for meetings held five or more years earlier. Transcripts for meetings prior to 1994 were produced from original raw transcripts in the FOMC Secretariat's files. Shortly after each meeting beginning in 1994, audio recordings were transcribed and, where necessary to facilitate the reader's understanding, lightly edited by the FOMC Secretariat, and meeting participants were then given an opportunity within the next several weeks to review the transcript for accuracy.

[3] The Bundesbank and the Swiss National Bank had, for some time, already had price stability as their dominant goal. In fact, the Bundesbank Act of 1957 established an independent German central bank with the stated objective of "safeguarding the currency." Also, the 1991 Maastricht Treaty contained norms which ensured the independence of the forthcoming European Central Bank and set forth its primary objective of price stability.

of New Zealand establish an economic target for monetary policy through a formal *Policy Targets Agreement* (*PTA*).[4]

Other central banks soon followed suit. For example, in February 1991, the Governor of the Bank of Canada and the Minister of Finance jointly announced a series of formal targets for reducing inflation. The goal was to lower inflation to the midpoint of an assigned range—between 1 and 3 percent—by the end of 1995 (Thiessen 1998).

In the UK, on September 16, 1992, British interest rates and foreign exchange reserves were used in a futile effort to retain membership in the European Exchange Rate Mechanism with adverse consequences for housing foreclosures and Conservative Party re-election chances. King (2000, 2) believes that this episode facilitated a central banking revolution in the UK: "there are moments when new ideas come into their own. This was one of them … We decided to adopt and formalize a … commitment to an explicit numerical inflation target."

By 1994, at least nine central banks—including Sweden, Finland, Australia, Spain, Israel, and Chile, in addition to the ones mentioned above—had introduced formal inflation-targeting regimes (Kahn and Parrish, 1998).

2.2 The push for rules over discretion

Over much of this period, in a lead-up to formulating his rule, Taylor emphasized the importance of rule-like behavior on the part of central banks as a key conceptual framework in an environment committed to time-consistency, transparency, and independence. Taylor pushed back against the consensus view that full discretion was required in the conduct of monetary policy.

[4] Goodhart (2010) provides a detailed review of the discussions in New Zealand in advance of the passage of the Reserve Bank of New Zealand Act.

At a Bank of Japan conference on "Price Stabilization in the 1990s" (October 1991) David Laidler (1993, 336, 353) expressed the conventional wisdom of the day. He argued that the apparent instability of money demand functions required discretionary offsetting shifts in money supply. Faith that a "legislated, quasi-constitutional" money growth rule would produce price stability now appeared "naïve … uncomfortably like those for perpetual motion or a squared circle." Laidler saw the optimal route to price stability through independent central banks: "We are left, then, with relying on discretionary power in order to maintain price stability." Taylor (1992d, 38) noted that "Michael Parkin's oral comments at the conference were consistent with that view, and I think that there was a considerable amount of general agreement at the conference."

In April 1992, Taylor commented on Bernanke and Mishkin's (1992) "Central Bank Behavior and the Strategy of Monetary Policy," taking particular exception to the proposition that "Monetary policy rules do not allow the monetary authorities to respond to unforeseen circumstances." Taylor (1992a, 235) argued that "if there is anything we have learned from modern macroeconomics it is that rules need not entail fixed settings as in constant money growth rules." Taylor appeared to be suggesting that Bernanke and Mishkin were leading monetary economics in the wrong direction: their paper "eschews models and techniques, which endeavors to go directly to a policy making perspective … My experience is that there are far too many policy papers in government that do not pay enough attention to economic models and theory."[5]

[5] However, in September 1992 Bernanke and Blinder (1992, 910-912) published a paper with a section entitled 'Federal Reserve's Reaction Function': "If the Federal funds rate or some related variable is an indicator of the Federal Reserve's policy stance, and if the Fed is purposeful and reasonably consistent in its policy-making, then the funds rate should be systematically related to important macroeconomic target variables like unemployment and inflation." Bernanke and Blinder then present estimated policy reaction functions which "show this to be true … The results look like plausible reaction functions. Inflation shocks drive up the funds rate (or the funds rate spread), with the peak effect coming after 5-10 months and then decaying very slowly. Unemployment shocks push the funds rate in the opposite direction, but with somewhat longer lags and smaller

At the Federal Reserve System's Committee on Financial Analysis meeting (St. Louis Fed, June 1992) Taylor commented on an early draft of Jeffrey Fuhrer and George Moore's (1995) "Inflation Persistence." Taylor (1992b) noted that the authors had made "an important contribution to the methodology of monetary policy formulation … they look at the response of the economy to a policy rule which they write algebraically, arguing that the functional form comes close to what the Federal Reserve has been using in practice … Their results, taken literally, are quite striking. They find that a policy rule that is a fairly close representation of Fed policy for the last eight or 10 years is nearly optimal. The rule entails changing the federal funds rate, according to whether the inflation rate is on a target and whether output is on a target. Their results are not very sensitive to the choice of a welfare function. Basically, as long as price stability and output stability are given some weight, movements too far away from this particular rule worsen performance. This is a remarkable result and deserves further research. What are the implications for policy? The literal implication is to keep following that rule … It is perhaps too abstract for policymakers to think in terms of a policy rule, but it seems to me that this is the only way to think of implementing or taking seriously the policy implications of the paper."

At the Reserve Bank of Australia in July 1992, Taylor (1992c, 9, 13, 15, 26, 29) noted that the historical era of "great" inflation/disinflation was "concluding." A repeat of this unfortunate history was "unlikely." The intellectual justification for inflation (the Phillips curve trade-off) had been "mistaken" and based on "faulty" models. Taylor argued that "the most pressing task is to find good rules for monetary policy—probably with the interest rate as the instrument—that reflect such [short-term inflation-output] trade-offs … monetary policy should be designed in the future to keep price and output fluctuations low … the recent research on

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magnitudes. To our surprise, these relationships did not break down in the post-1979 period. Reaction functions estimated in the same way for the 1979-1989 period looked qualitatively similar."

policy rules … is very promising. There is a need to find ways to characterize good monetary policy as something besides pure discretion."

At the same conference, Charles Goodhart (1992, 326, 324) noted that "unspecified" 1946-era multiple goals had been replaced by a philosophy which was reflected in Article 2 of the Statute of the European System of Central Banks: "The primary objective of the ESCB shall be to maintain price stability." Goodhart pondered about a "backbone brace" rule in which interest rates should rise by 1.5 percent for each 1 percent rise of inflation above zero with a requirement that any divergence from that rule should be formally accounted for by the monetary authorities. But this 'Goodhart Principle' was inflation-first-and-foremost-based and possibly "too mechanical." Later that month, Taylor introduced his rule, giving equal weight to output and inflation.

3. Impact of the Taylor rule: the policy framework

The broad appeal of the Taylor rule comes from its simplicity, intuitiveness, and focus on short-term interest rates as the instrument of monetary policy. The rule is simple in that it relates the policy rate—the federal funds rate—directly to the goals of monetary policy—minimizing fluctuations in inflation relative to its objective and output relative to potential output (the output gap). In addition, as originally described, the rule requires knowledge of only the current inflation rate and output gap. Taylor provided his own parameters for the key unobservables in the rule.

The rule is intuitive because it calls for policymakers to move the funds rate to lean against the wind of aggregate demand shocks and take a balanced approach to aggregate supply shocks. In addition, the "Taylor Principle" embedded in Taylor's rule requires that the real federal funds rate be increased when inflation is above the inflation objective. In other words, the

nominal funds rate should rise more than one-for-one with an increase in inflation above objective. It emerges by reorganizing Taylor's equation as follows:

$$r = 1.5p + 0.5y + 1.$$

The principle is also intuitive as a device for ensuring inflation remains anchored over time at its objective.

The Taylor rule has gained widespread influence because it can be implemented in policy regimes with a dual mandate for price stability and economic growth as in the United States or in regimes where inflation is the primary target as in most inflation targeting countries. The equal weight that the Taylor rule places on deviations of inflation from target and real output from potential output makes the Taylor rule consistent with a dual mandate. However, for several reasons, the Taylor rule can also be applied in inflation targeting regimes. First, it incorporates an explicit target for inflation. Second, most inflation targeting central banks are *flexible* inflation targeters, meaning they give some weight to real economic activity and do not attempt to achieve price stability on a period-by-period basis, but rather over the medium term. Finally, interpreting the output gap as a harbinger of future inflationary pressures leads to a single mandate focused on current and future inflation.

The Taylor rule also has broad appeal because it approximates the way policymakers think about the conduct of monetary policy. In much, but not all, of the academic literature leading up to 1993, monetary policy was represented by an exogenous autoregressive process on the money supply. Needless to say, this was not how policymakers viewed themselves as making policy. Except perhaps for the 1979-1983 period, the main instrument of Fed policy in the post-Accord period (1951-) has been a short-term interest rate, with the federal funds rate gaining increasing importance through the 1960s (Meulendyke, 1998). And, by the time Taylor had

articulated his rule, policymakers in the United States were well on their way to abandoning the specification of target ranges for the monetary aggregates.

Of course the appeal of a simple, intuitive, and realistic policy rule would be considerably diminished if it could not describe past policy or provide guidance about the future. The Taylor rule did both. As Taylor (1993) showed, his rule closely tracked the actual path of the federal funds rate from 1987 to 1992. And because this was a period of relative macroeconomic stability, the rule subsequently became viewed as a prescription for conducting monetary policy going forward.[6]

However, Taylor (1993, 197) did not advocate that policymakers follow a rule mechanically: "…There will be episodes where monetary policy will need to be adjusted to deal with special factors." Nevertheless, Taylor viewed systematic policy according to the principals of a rule as having "major advantages" over discretion in improving economic performance: "Hence, it is important to preserve the concept of a policy rule even in an environment where it is practically impossible to follow mechanically the algebraic formulas economists write down to describe their preferred policy rules."

Given these features, the Taylor rule has had a profound influence on macroeconomic research. For one thing, it fostered renewed interaction and communication between academic and central bank economists. In the late 1970s and early 1980s, the rational expectations/real business cycle revolution had led many academics to question the effectiveness of activist monetary policy. A communication gap had emerged between academic economists studying the propagation of business cycles in flexible-price models and economists at central banks who

[6] Taylor (1993) emphasized the normative aspect of the rule and the desirability of systematic rule-like behavior on the part of policymakers. Taylor also discussed the use of discretion within the context of a policy rule and issues involved in the transition from pure discretion to a policy rule or from one policy rule to another. The close fit of the Taylor Rule to data from 1987 to 1992 suggested the rule was a feasible prescription for policy.

were still interested in designing stabilization policies in models where monetary policy had real effects. In combination with New-Keynesian sticky price models, the Taylor rule put academic and central bank economists back on the same research track. Today, economists and economic ideas move freely between academic and central bank research departments.

The resulting literature on Taylor rules has been both positive and normative, theoretical and empirical. It is vast and growing. While a thorough survey of this research is far beyond the scope of this paper, a number of key issues have played a critical role in policy discussion and, therefore, merit brief mention.[7]

First, as McCallum (1993) pointed out in his discussion of the original Taylor rule paper, the Taylor rule is not strictly operational since policymakers cannot observe current quarter GDP. So, one line of research has been to make the Taylor rule operational through the use of lagged output and inflation or the explicit use of forecasts.

Second, researchers have used the Taylor rule to evaluate historical monetary policy. This line of research led to the recognition that policy is conducted with contemporaneous data and that researchers need to be careful to use real-time data in assessing the historical record. One key source of potential real-time policy error is in the use of real-time estimates of the output gap. Whether policymakers responded aggressively enough to inflation in the 1970s given real-time data and corresponding estimates of the natural rate remains a topic of debate.[8]

Third, researchers have computed policy rules that are optimal with respect to a particular macroeconomic model and central bank loss function or that maximize a representative agent's

[7] See Asso, Kahn, and Leeson (2007a) for a more detailed discussion of the influence of the Taylor rule on macroeconomic and monetary policy research.
[8] See, for example, Orphanides (2003).

welfare in small DSGE models.[9] Attention is given in these models to the specification of Taylor rule parameters that rule out indeterminacies and sunspot equilibria. Typically, a coefficient on inflation that adheres to the Taylor principal and coefficients on inflation and output that are not too extreme generate favorable macroeconomic outcomes.[10]

Fourth, researchers have examined the robustness of policy rules across a variety of structural models.[11] Again, policy rules that are similar to Taylor's original specification appear relatively robust—although other specifications may be more robust across models with forward-looking behavior and rational expectations. One example is a first differenced version of the Taylor rule.

Other issues include the use of Taylor rules in small open economies, the identification of conditions under which it may be necessary or desirable to deviate from rule-like behavior, the use of forecast-based rules versus backward-looking rules, the generalization of Taylor rules to allow for regime switching or time variation in the rule's coefficients, the desirability of instrument rules versus target rules in central bank decision-making and communications, and the role of asset prices in policy rules.

4. Impact of the Taylor Rule: the FOMC

Taylor (1993, 202-03) argued that the FOMC appeared to have acted systematically and in accordance with his simple rule from 1987 to 1992: "What is perhaps surprising is that this rule fits the actual policy performance during the last few years remarkable well.... In this sense

[9] The loss function allows the relative weights on inflation stablization and output stabilization to vary, but are generally symmetric with respect to whether inflation is above or below target and whether output is above or below the natural rate. In fact, policymakers may place different weights on positive versus negative deviations of inflation from target and output from the natural rate.

[10] See, for example, the papers published in the Taylor (1999) conference volume and Woodford (2003).

[11] Again, see the Taylor (1999) conference volume and Levin and Williams (2003).

the Fed policy has been conducted as if the Fed had been following a policy rule much like the one called for by recent research on policy rules."

Taylor (1993, 208) suggested that a specific policy rule could be added to the list of factors—such as leading indicators, structural models, and financial market conditions—that the FOMC already monitored. "Each time the FOMC meets, the staff could be asked to include in the briefing books information about how recent FOMC decisions compare with the policy rule. Forecasts for the next few quarters—a regular part of the staff briefing—could contain forecasts of the federal funds rate implied by the policy rule. There are many variants on this idea. For instance, there could be a range of entries corresponding to policy rules with different coefficients, or perhaps a policy rule where the growth rate of real GDP rather than its level appears. Bands for the federal funds rate could span these variants."

The FOMC was likely unaware before 1993 that its behavior could be described by a simple policy rule. But the Taylor rule very quickly became a part of the information set that the FOMC regularly reviewed. And, Taylor's description of how a rule could be used in practice proved prescient. By at least 1995, FOMC members were regularly consulting the Taylor rule for guidance in setting monetary policy. A review of transcripts of FOMC meetings from 1993 to 2003—the last year for which transcripts have been made publicly available—shows that the FOMC used the Taylor rule very much the way Taylor recommended in 1993. Not only did the staff prepare a range of estimates of the current stance of policy and the future policy path based on various policy rules, but members of the FOMC also regularly referred to rules in their deliberations.

4.1 A guide for policy

According to the transcripts, the first mention of the Taylor rule at an FOMC meeting occurred at the January 31-February 1, 1995 meeting. At that meeting, Janet Yellen described the rule and its close approximation to actual FOMC policy decisions since 1986 and suggested that the rule was currently calling for a funds rate of 5.1 percent—close to the current stance of monetary policy. In contrast, she noted, the financial markets were expecting an increase of 150 basis points "before we stop tightening…," and the Greenbook (the document prepared for each FOMC meeting describing the staff's detailed forecast for economic activity and inflation) suggested the federal funds rate should be 7 percent. "I do not disagree with the Greenbook strategy. But the Taylor rule and other rules… call for a rate in the 5 percent range, which is where we already are. Therefore, I am not imagining another 150 basis points." As it turned out at the meeting, the federal funds rate target was raised 50 basis points to 6 percent, where it stayed until July 1995 when it was cut to 5 ¾ percent.

In subsequent meetings, Yellen pointed repeatedly to the Taylor rule as a guide to her views on the proper stance for monetary policy. Other Committee members—especially Governors Laurence Meyer and Edward Gramlich and San Francisco Fed President Robert Parry—also relied heavily on the Taylor rule.[12] Each made a number of references. For example:

> Governor Meyer, September 1996: "[My] judgment is reinforced by the Taylor rule projections that, as Governor Yellen pointed out at the last meeting, suggest that monetary policy is appropriately positioned today in light of prevailing inflation and utilization rates" (p. 37).
>
> President Parry, December 1996: "At our Bank, we consult two monetary policy rules as a starting point for thinking about the appropriate stance of policy: an estimated version of Taylor's rule and a nominal income growth rate rule…. [B]oth rules suggest that the funds rate should be left at about 5 ¼ percent at the present time, although when applied to our forecast they do suggest higher rates will be needed in the future" (p. 36).

[12] As discussed later, Gramlich later expressed skepticism about use of the Taylor rule in the absence of reliable estimates of the output gap.

> Governor Meyer, February 1997: "We should build in that procyclicality of interest rates that would occur normally, for example, under a monetary growth rule with a stable money demand function or under a Taylor rule" (p. 109).
>
> President Parry, February 1997: "…the two monetary policy rules we consult at our Bank … both suggest the need for an increase in the funds rate this quarter" (p. 108).
>
> Governor Gramlich, November 1997: "…I want to refer to some calculations that the staff has done on the Taylor rule. As I understand at least the fitted version of that rule, it, too, suggests that the funds rate is a bit on the low side" (p. 85).
>
> Governor Gramlich, August 1998: "If the real interest rate is about 3 percent, steady inflation is arguably about 2 percent, and both inflation and unemployment are reasonably close to their target values—this is my own mental version of the Taylor rule—policy is roughly about right at this point" (p. 54).

4.2 A framework for analyzing issues

From 1995 to 2003, the Taylor rule was also used to analyze a range of issues. Many of the discussions paralleled research being conducted by academic and Federal Reserve economists on policy rules. Although firm conclusions were not always reached, it is clear from the transcripts that the Taylor rule became over time a key input into the FOMC's policy process. Among the issues debated were the following:

4.2.1 The sensitivity of the rule to the inflation measure

At the May 1995 meeting, FOMC members discussed what measure of inflation should be used in determining the Taylor rule's prescription for policy. Chairman Greenspan asked what measure of inflation Taylor used and noted that, when the data on GDP were revised, the normative prescription from the rule would change. Donald Kohn indicated that using the implicit price deflator gave a policy prescription for the funds rate of 4 ¼ percent, while using the CPI gave a prescription of around 5 ¾ percent. Kohn noted, however, that a rule using CPI inflation would not track Committee actions in earlier years as well as the Taylor rule which relied on inflation as measured by the implicit GDP deflator. Alan Blinder, vice chairman of the

Board of Governors, added that the parameters of the Taylor rule would likely change if the variables on the right-hand side were to be changed (FOMC, May 1995, 30).

4.2.2 Staff concerns and caveats

By November 1995, Board staff began providing the FOMC with a chart summarizing various versions of the Taylor rule. In discussing the new chart at the November 1995 FOMC meeting, Board staff noted several caveats. First, the Taylor rule was not forward looking except in the sense that the inclusion of the output gap on the right-hand side provided an indicator of future inflationary pressure. It was noted that the performance of a rule-based monetary policy might be improved by incorporating forecasts of inflation and the output gap instead of their current levels.

Second, the equal weights on inflation and the output gap in the Taylor rule may not always be appropriate. While equal weights might be well suited for supply shocks, a greater weight on the output gap may be better suited for demand shocks. This would allow for a "prompt closing of the output gap" that would "forestall opening up a price gap."

Third, it was again noted that the Taylor rule's prescribed funds rate target is highly sensitive to how output and inflation are measured. According to the Taylor rule, the current setting of the funds rate was high relative to the equilibrium level, suggesting policy was restrictive. However, the current funds rate appeared close to its equilibrium level when measures of inflation other than the implicit GDP deflator were used in determining the deviation of inflation from Taylor's 2 percent objective.

Fourth, an estimated version of the Taylor rule that allows gradual adjustment in the funds rate target to the rate prescribed by the rule suggests the FOMC placed a greater weight on closing the output gap and less weight on bringing inflation down than in the Taylor rule. To

some extent, this result reflected "the influence of the credit crunch period when the funds rate for some time was below the value prescribed from Taylor's specification."

Fifth, Federal Reserve monetary policy from 1987 to 1993 was focused on bringing inflation down and, therefore, policy was generally restrictive. Policy remained slightly restrictive in November 1995 with an estimated real funds rate somewhat higher than the 2 percent equilibrium funds rate assumed in the Taylor rule. However, the Board staff's forecast called for steady inflation at the current nominal and real federal funds rate. In other words, the staff forecast implicitly incorporated a higher equilibrium real funds rate than that assumed in the Taylor rule: "The real funds rate is only an index or proxy for a whole host of financial market conditions that influence spending and prices in complex ways. Among other difficulties, the relationship of the funds rate to these other, more important, variables may change over time." Thus, the Board staff viewed the equilibrium real funds rate as a concept that changed over time, making the Taylor rule as originally specified less reliable (FOMC, November 1995, 1-5).

4.2.3 Deliberate versus opportunistic disinflation

At the same meeting, members briefly discussed the Taylor rule as a framework for deliberate, as opposed to opportunistic, disinflation. Gary Stern, president of the Minneapolis Fed, questioned whether policy should be tighter than indicated by the Taylor rule "to bend inflation down further from here." Governor Lawrence Lindsey responded that, with inflation above the assumed Taylor rule target of 2 percent, the prescription for policy from the rule itself was *deliberately* restrictive, placing steady downward pressure on inflation (FOMC, November 1995, 49-50).

This topic was taken up again at the next two meetings. For example in January 1996, President Parry suggested that an opportunistic disinflation strategy would involve a much more

complicated description of policy than a Taylor rule. An opportunistic strategy is one in which monetary policy aims to hold inflation steady at its current level until an unanticipated shock pulls inflation down. At that point, policymakers "opportunistically" accept the lower inflation rate as the new target for policy and attempt to maintain the lower inflation rate until an unexpected shock again pulls inflation down. Parry questioned whether such an opportunistic approach wouldn't require "a complicated mathematical expression of our policy processes with lots of nonlinearities?" Parry's concern was that adopting an opportunistic approach to further disinflation would inevitably lead to a "loss of understanding" in financial markets about how the FOMC reacts to incoming information (FOMC, January 1996, 51).

In Taylor's terminology, opportunistic disinflation involves a series of *transitions* from one policy rule to another as the target inflation rate is opportunistically lowered. Taylor (1993, 207) cautions that "in the period immediately after a new policy rule has been put in place, people are unlikely either to know about or understand the new policy or to believe that policymakers are serious about maintaining it. Simply assuming that people have rational expectations and know the policy rule is probably stretching things during this transition period. Instead, people may base their expectations partly on studying past policy in a Bayesian way, or by trying to anticipate the credibility of the new policy by studying the past records of policymakers, or by assessing whether the policy will work." Thus, Taylor appears to have anticipated Parry's concerns.[13]

4.2.4 Forward- versus backward-looking Taylor rules

In 1997, various alternative specifications for the Taylor rule began to be considered by FOMC members. Governor Meyer noted that, while the standard Taylor rule suggested policy

[13] See Orphanides and Wilcox (1996) and Orphanides, Small, Weiland, and Wilcox (1997) for other interpretations of opportunistic disinflation.

should remain on hold at the present time, the staff's forecast suggested policy would need to be tightened in the future. He argued that if current values of inflation and the output gap were replaced in the Taylor rule with forecasts, the rule would be prescribing an immediate tightening of policy. Using a "maxi/min" analysis, he viewed the cost of not tightening when tightening turns out to be the appropriate action as greater than the cost of tightening when not tightening turns out to be appropriate. The policy prescription coming from a forward-looking Taylor rule and the implications of a maxi/min strategy were among the reasons Meyer cited in support of a tightening of monetary policy (FOMC, March 1997, 54-57).

The issue came up again in 2003 as the Committee considered whether and how to raise the funds rate as economic conditions improved from its then-low of 1 percent. Governor Bernanke noted that a backward-looking Taylor rule was then recommending a federal funds rate of 1 ½ percent, while "[t]he actual current value of 1 percent presumably reflects in part our insurance policy against deflation." Removing that insurance gradually and following the path prescribed by the backward-looking rule would result in a gradual increase in the funds rate to 3.5 percent by the end of 2005. This path, Bernanke noted, was very close to what the fed funds futures market was predicting. In contrast, a forward-looking Taylor rule—which puts a high weight on inflation expectations—implied a much slower tightening process. According to that specification of the rule, "the funds rate will reach only 1.5 percent by the end of 2004 rather than the 2.25 percent forecast by both the futures market and the backward-looking rule."

Bernanke indicated he preferred the forward-looking version for two reasons. First, "it's a true real-time rule—that is, it estimates reaction functions given actual forecasts available at the time the policy decision was taken." Second, "we're now in a period that is very unusual, and historical relationships may not work. So it's useful that the forward-looking rule can take

into account explicitly how forecasts affect current policy decisions." The implication, Bernanke said, is that the Committee's policy stance going forward will depend on what it expects inflation to do. If the Committee expects inflation to remain low and stable, based on the estimated forward-looking rule, "our policy tightening should be slower and more gradual than suggested by historical relationships or by the funds rate futures markets" (FOMC, October 2003, 71-73).[14]

As it turned out, at the November 2004 meeting, the FOMC raised the funds rate target from 1.75 percent to 2 percent—between the 2003 backward and forward-looking rule prescriptions for the end of 2004, but closer to the backward-looking prescription.

4.2.5 The equilibrium real federal funds rate

In 1997, FOMC members began to question the constant 2 percent equilibrium real federal funds rate assumed in the Taylor rule. Governor Meyer said, "While I am a strong believer in some of the wisdom embedded in the Taylor rule, I have been concerned for a long time that we need to be more careful about how we set its level by coming up with a more reasonable estimate of the equilibrium funds rate" (FOMC, August 1997, 66-67). Two key issues at the time were the dependence of estimates of the equilibrium real rate on the particular measure of inflation and the possibility that the equilibrium real rate varied over time.

Later, as evidence mounted that trend productivity growth had increased, the issue of the equilibrium real rate reemerged. Members were concerned that maintaining Taylor's fixed 2 percent real rate would lead to an overly stimulative policy. Alfred Broaddus, president of the Richmond Fed, said "…an increase in trend productivity growth means that real short rates need

[14] Governor Kohn, in the December 2003 meeting, followed up on Bernanke's comments, saying "A zero real funds rate may not be way out of line for a 2 percent output gap, but it would be unusual to keep the funds rate that low as the output gap is closing next year. We can see this in the various versions of the Taylor rule, which all point to higher rates next year. ... Taylor rules are just rough benchmarks, and I would not argue that we ought to follow them in any mechanical way. But these results do underline the questions about how we position ourselves going forward" (FOMC, December 2003, 67).

to rise…. [T]he reason is that households and businesses would want to borrow against their perception of higher future income now in order to increase current consumption and investment before it's actually available…. The Taylor rule doesn't give any attention to that kind of real business cycle reason for a move in rates. It only allows reaction to inflation gaps and output gaps" (FOMC, June 1999, 99-100).

The issue of the equilibrium real rate came up again in August 2002. President Parry asked why the Taylor rule recommendation differed from the recommendation from simulations of a perfect foresight model reported in the Bluebook.[15] Vincent Reinhart, Director of the Board of Governors' Monetary Affairs Division and Secretary and Economist to the FOMC, responded that while the Taylor rule was consistent with what the FOMC had done in the past, it did not account for the shifts in the equilibrium real federal funds rate. In contrast, the perfect foresight simulations allowed for a downward shift in the rate (FOMC, August 2002, 69).

4.2.6 The zero interest rate bound

In 1998, Board staff briefed the FOMC on issues arising from the zero constraint on nominal interest rates. Again, a good part of the discussion was based on how the Taylor rule might be adjusted to address the issue. One alternative was to increase the coefficients on the inflation and output gaps in the Taylor rule when interest rates were near the zero bound. Another alternative was to act more aggressively only when inflation is already deemed "low." Jerry Jordan, president of the Cleveland Fed, suggested that conducting monetary policy "through a monetary base arrangement of supply and demand for central bank money" might be an alternative to the Taylor framework when interest rates were approaching the zero bound.

[15] The Bluebook or, more formally, "Monetary Policy Alternatives" is a document prepared for the FOMC by Board staff that provides background and context on monetary policy alternatives for the FOMC's consideration.

President Parry pointed out that policy would be more preemptive under either a more aggressive Taylor rule or a forecast-based Taylor rule (FOMC, June/July 1998, 89-96).

The issue of the zero bound arose again in early 2002 when inflation indicators available at the time signaled considerable downward pressure on core inflation and the federal funds rate was 1¾ percent and headed downward. At the January 29-30 meeting, Board staff members David Reifschneider and John Williams gave a presentation on the implications of the zero bound for monetary policy. They ran simulations of the Board staff's principal macroeconomic model, FRB/US, with policy represented by a standard Taylor rule. They found that at a low target inflation rate, the zero lower bound was hit frequently and that economic performance deteriorated with an inflation target below roughly 2 percent.

They concluded that the FOMC might want to move policy more aggressively than suggested by the standard Taylor rule when the economy was in imminent danger of hitting the zero bound. For example, they suggested that when the standard Taylor rule prescribes an interest rate below 1 percent, the FOMC might consider dropping it immediately to zero.[16] They also noted that one drawback of such a policy might be that it would be less transparent. At the same meeting, Marvin Goodfriend of the Richmond Fed's staff, proposed expanding the monetary base to stimulate the economy at the zero lower bound.

The discussion that followed among the FOMC members was wide ranging, but not tightly focused on policy rules. Chairman Greenspan, for example, questioned the robustness of the results across different models. He and others questioned how useful model simulations could be when they were based on a period in which the zero bound had never been hit. That

[16] They also suggested that the Committee respond to past deviations of inflation from target—for example, by targeting the price level or the average inflation rate.

view led to an extended discussion of Japan's experience at the zero bound and its relevance or lack of relevance for the United States (FOMC, January 2002).

In retrospect, this episode of monetary policy ultimately resulted in a funds rate of 1 percent that was maintained for a "considerable period." But the discussion of the zero bound foreshadowed what was to come in the aftermath of the global financial crisis of 2008-09 when the funds rate target fell to 0-25 basis points and was maintained there for an "extended period."

4.2.7 Uncertainty about the output gap

In February 1999, Governor Meyer pointed out that virtually all versions of the Taylor rule then tracked by Board staff for the FOMC—whether based on the CPI or GDP deflator, whether backward- or forward-looking, whether with Taylor's coefficients or estimated coefficients—prescribed a funds rate that was higher than the current funds rate target. He attributed this divergence from the rule to a number of factors including the Asian financial crisis, the Russian debt default, forecasts that had been calling for a spontaneous slowdown, and, importantly, structural change suggested by the combination of declining inflation and declining unemployment.

Meyer proposed an asymmetric strategy for setting the funds rate target in such an environment where there was uncertainty about the level of the non-accelerating inflation rate of unemployment (NAIRU). He suggested determining the level of the NAIRU under the assumption that the current setting of the funds rate was the one prescribed by the Taylor rule. Then, he recommended following the Taylor rule if above-trend growth pushed the unemployment rate even lower. In contrast, if the unemployment rate rose modestly, Meyer recommended taking no immediate action to ease policy. Similarly, Meyer recommended policy

respond to an increase in (core) inflation according to the Taylor rule, but respond passively to a decline in inflation (FOMC, February 1999, 65-66).

Other members offered other approaches to dealing with uncertainty about the output gap. For example, Governor Gramlich suggested a "speed limit rule." He argued that the FOMC "should target growth in aggregate demand at about 3 percent, or perhaps a bit less, and stay with that policy for as long as inflation does not accelerate" (FOMC, March 1999, 44-45). At a later meeting, Gramlich offered two additional approaches. First, the Committee could drop the output gap term from the Taylor rule and implement an inflation-targeting rule.[17] And second, the FOMC could adopt a "nominal GDP standard" (FOMC, May 1999, 45). Meyer viewed a temporary downweighting of the output gap as sensible but rejected ignoring output all together. "This is a difference between uncertainty and total ignorance" (FOMC, June 1999, 93-94). President Broaddus suggested finding another variable to substitute for the output gap that would serve as a forward-looking indicator of inflation expectations such as survey information or long-term interest rates (FOMC, June 1999, 99-100).

4.2.8 Uncertainty about the inflation target

As inflation moderated, FOMC members, in addition to questioning the role of the output gap, began to question Taylor's assumed inflation objective of 2 percent as measured by the implicit GDP deflator. Governor Gramlich complained that "we must have point estimates of our targets for both inflation and unemployment. At the very best I think we have bands; we do not have point estimates" (FOMC, December 1998, 45). Governor Meyer suggested it might be more reasonable for the FOMC to tell the staff what its inflation objective is as opposed to simply accepting Taylor's assumption (FOMC, June 2000, 90). He later expressed frustration that "we start off from the inflation target that John Taylor set but do so without any

[17] Gramlich actually discussed his approaches in terms of the associated unemployment gap.

communication from the Committee to the staff about the inflation objectives Committee members might have" (FOMC, January 2001, 187-88).

4.2.9 Interest rate smoothing.

In January 2003, the FOMC took up the issue of how quickly the stance of policy should be adjusted toward the Committee's desired target for the federal funds rate. In most industrial countries, the policy rate tends to be adjusted in small steps in the same direction. Moreover, estimated versions of the Taylor rule suggest that including a lagged value of the policy rate on the right-hand side is highly statistically significant and greatly increases the explanatory power of the rule. In setting the stage for the Committee's discussion, Fed staff presented simulations based on the FRB/US model.[18] Assuming the objective of policy was to minimize fluctuations in the output gap and in inflation around its long-run target, an "optimal" policy rule was derived. The resulting rule was considerably more responsive to current economic conditions that the inertia-prone rule estimated with historical data. In particular, the optimal rule incorporated higher coefficients on inflation and the output gap and a lower coefficient on the lagged federal funds rate than the estimated rule.

The issue was important in early 2003 because the optimal rule was recommending an immediate easing of the policy rate to zero percent followed by an aggressive unwinding in the second half of the year. In contrast, the estimated rule called for a much more muted response. The optimal rule, however, was based on a number of unrealistic assumptions. First, the private sector was assumed to continue to form expectations on the basis of the estimated rule. Second, the policymakers were assumed to know the structure of the economy with certainty. And third, policymakers were assumed to be able to observe the current state of the economy. Relaxing

[18] Brain Sack and Robert Tetlow from the Board of Governors staff and Dean Croushore from the Philadelphia Federal Reserve Bank made the presentations.

these assumptions moved the optimal policy reaction function in the direction of the estimated Taylor rule, but not all the way. With numerous additional caveats, the analysis suggested policy should be more responsive to current conditions than historically.

Glenn Rudebusch offered an alternative view—arguing "there is essentially no policy inertia at a quarterly frequency and that, in fact, the funds rate typically is adjusted fairly promptly to economic developments" (p. 18). In his view, the apparent inertia in estimated Taylor rules results from occasional, persistent and deliberate, deviations from a non-inertial Taylor rule in response to factors other than current output and inflation.

As evidence against policy inertia, he documented the unpredictability of quarterly changes in the funds rate several quarters ahead. If interest rates were smoothed, a regression of actual changes in the funds rate on predicted changes should have considerable explanatory power. In fact, they do not. "For example, Eurodollar futures have essentially no ability to predict the quarterly change in the funds rate three quarters ahead….An alternative explanation is that the Taylor rule is an incomplete description of Fed policymaking and that the Fed responds to other persistent variables besides current output and inflation" (pp. 19-20). Two examples of such behavior are the Fed's response to the persistent credit crunch of 1992-93 and to the global financial crisis following the Russian debt default in 1998-99. Rudebusch concludes that our models may not capture all of the important factors influencing policy and, therefore, policymakers should be cautious in concluding that policy responds too timidly to economic conditions.

A lengthy discussion followed the staff presentation. Some comments were technical, while others were philosophical. The discussion had the following flavor: Chairman Greenspan appeared to question the validity of the exercise, arguing that "the underlying structure of the

economy with which we are dealing and to which we are endeavoring to fit our models is in a continuous state of change."[19] He seemed to suggest that the analysis should be carried out not just with real-time data, but also with real-time models of the economy. He also suggested that risk aversion and concern about fragility of financial markets to large and unexpected changes in the policy rate were reasons for policymakers to move slowly. Then-Governor Bernanke argued that greater predictability of policy could give the central bank more leverage over long-term interest rates. Therefore, there should be more inertia in rates than suggested by the "optimal" Taylor rule. St. Louis Fed President William Poole stressed the importance of inertia in helping the public learn and understand the nature of the policy rule.

Governor Kohn gave an historical perspective of past episodes suggesting that the Fed acted gradually, but not as gradually as in estimated Taylor rules. These rules do not account for changes in the Fed's inflation target from 1987 to the second half of the 1990s while the Fed was pursuing opportunistic disinflation. In addition, the Fed was forward-looking and responding more to shocks that were perceived to be long-lasting than those that were expected to be short-lived. In short, the Committee was responding to a larger information set than just current output and inflation. Finally, he suggested that "It's better generally for policy to act too strongly than too weakly to developing situations. Serious policy errors have been made when policy doesn't react aggressively enough to a developing situation. Examples are the Federal Reserve in the 1970s or the Bank of Japan in the 1990s" (FOMC, January 2003, 42-43).

4.3 The Taylor rule and Fed policy since 2003.

While transcripts of FOMC meetings since 2003 have not yet been made public, it is clear that the Taylor rule—in all of its various forms and uses—has continued to inform

[19] The changing structure of the U.S. economy, and the difficulty of modeling it, was a common theme of Greenspan's. See, for example, the FOMC transcripts from the June 25-26, 2002, meeting, p. 20.

Committee discussions. One area, which will likely be debated for many years to come, is when is it appropriate to deviate from rule-like behavior? For example, in the aftermath of the 1987 stock market collapse and the 1998 Russian debt default, policymakers eased policy relative to the Taylor rule prescription to limit the impact of financial market turbulence on the real economy. These two relatively brief deviations from rule-like behavior have been viewed largely as successful examples of discretionary policy, although concern has emerged about the associated moral hazard.

More recently, policy deviated from the classical Taylor rule from 2003 to 2006, when the funds rate was kept below the Taylor rule prescription for a prolonged period in an effort to offset incipient deflationary pressures. Taylor (2007) criticized this use of discretion as contributing to the surge in housing demand and house-price inflation. According to counterfactual simulations, Taylor concluded that, if had policy adhered more closely to the Taylor rule, much of the housing boom would have been avoided. Moreover, the reversal of the boom, with its resulting financial market turmoil, would not have been as sharp.

Another issue of current concern, echoing back to 2003, is the divergence in the prescriptions of backward and forward-looking, estimated and non-estimated, Taylor rules in the Great Recession of 2008-09.[20] For example, estimated forward-looking rules suggest a funds rate in the vicinity of negative 5 percent. Since the funds rate cannot fall below zero, this prescription might be taken as suggesting the Fed should employ non-conventional means—such as credit market interventions and quantitative easing—to further stimulate the economy. In

[20] The debate largely comes down to the weight assigned in the Taylor rule to economic slack—either in the form of the output gap, as in the Taylor rule (Taylor 2009), or the difference between the actual and natural unemployment rate as in Rudebusch (2009) and Macroeconomic Advisers (2009). Rudebusch and Macroeconomic Advisers assign a much bigger weight to economic slack and, therefore, their rules prescribe a much lower federal funds rate than Taylor. Other rules place a lower weight than Taylor on economic slack. For example, Hall (2005) recommends a weight of zero on the output gap based on his view that the natural rate is an ill-defined concept. Hall's rule would recommend a funds rate *higher* than Taylor's.

contrast, non-estimated and non-forward-looking Taylor rules—such as Taylor's original 1993 rule—suggest the funds rate should be much nearer to zero. This prescription suggests limited need for nonconventional policies. Taylor, applying current data to his rule, clearly sides with the view that the funds rate should be closer to zero—about where the Fed is currently.

Looking ahead, the issue of discretionary deviations from rule-like behavior and the specification of policy rules themselves will likely continue to be debated among FOMC members. But few would argue against the merits of systematic policy, at least during normal times. In addition to the Taylor Principle, perhaps Taylor's biggest contribution to policy is that it is now viewed through the lens of the Taylor rule as a systematic response to incoming information about economic activity and inflation as opposed to a period-by-period optimization problem under pure discretion.

5. Impact of the Taylor at other central banks

Just as the Taylor rule became a central part of policy analysis at the Federal Reserve, to varying degrees, it also has become incorporated into policy analysis and decision-making at other central banks. Both academic and central bank researchers have used the Taylor rule framework to characterize, understand, and recommend monetary policy across a wide range of economies from the highly industrialized to emerging markets.[21] .

This section examines the extent to which the Taylor rule is used in practice by policymakers at central banks beyond the Federal Reserve. However, without access to transcripts of policy meetings at central banks other than the Federal Reserve, the analysis relies

[21] See, for example, Clarida, Galí, and Gertler (1998), who examined Germany, Japan, the UK, France, and Italy; Lubik and Schorfheide (2007) who examine Australia, Canada, New Zealand, and the UK; and Schmidt-Hebbel and Werner (2002) who examine Brazil, Chile, and Mexico. See also Aizenman, Hutchison, and Noy (2008) and references therein for more examples of studies of Taylor rules in emerging markets, and Loayza and Schmidt-Hebbel (eds.) (2002) for studies on Latin American countries (including Chile), the UK, Canada, Israel, and South Africa.

on policymakers' speeches, minutes of policy meetings, and/or staff reports. Because the level of the examination of these other central banks is less deep than that of the Federal Reserve, it is possible that the approach understates the importance of the Taylor rule in actual policy discussions at central banks other than the United States. For example, if the analysis of the Federal Reserve's use of the Taylor rule were based entirely on the minutes of FOMC meetings and speeches of FOMC members instead of complete transcripts of the meetings, it is likely that the Taylor rule would appear to have been less influential than it was in actual policy discussions. With this caveat, the analysis represents a diverse sample of central banks, relying on information that is publicly available and, to the extent possible, based on the stated views of policymakers.

In forecasting key macroeconomic variables, monetary policymakers must necessarily make assumptions about the future path of the policy rate they control. Forecasts can be based on assumptions ranging from a constant path set at the current level of the policy rate, a path based on the markets expectation for the policy rate, a path that is consistent with the policymakers own goals for the economy, or a policy reaction function such as the Taylor rule.[22] According to a survey of central banks conducted by the Bank for International Settlements (BIS), roughly a third of the 35 banks surveyed base their assumptions on an interest rate reaction function. Two fifths base their forecasts on "a neutral assumption such as unchanged rates," about two fifths base their forecasts based on the markets outlook for inflation, and "a number" of central banks provide forecasts based on several different assumptions (Nelson, 2008, 7-8).

Clearly, policy reaction functions play a role in central bank forecasting, but the question remains: Do they influence policy decisions? The remainder of this section examines practices

[22] Kahn (2007) describes the approaches chosen by 10 central banks and their pros and cons.

at a sample of central banks to shed light on the influence of the Taylor rule in the decision-making process of policymakers.

5.1. The ECB

The European Central Bank (ECB) views the usefulness of the Taylor rule with a degree of skepticism—at least based on official statements and publications. In part, this is due to the ECB's emphasis on price stability as its primary goal and the prominence of "monetary analysis"—analysis of monetary and credit conditions—in its policy assessment. The primary objective of ECB monetary policy is to maintain price stability, defined as inflation rates "below, but close to, 2 percent over the medium term." The strategy of the ECB in meeting its objective is based on two "pillars"—monetary analysis and economic analysis. The two pillars are used in "organizing, evaluating, and cross-checking the information relevant for assessing the risks to price stability" (*www.ecb.int*).

The monetary analysis pillar, which has no counterpart in the Federal Reserve, consists of a detailed analysis of the implications of money and credit developments for inflation and economic activity.[23] The analysis is contained in the *Quarterly Monetary Assessment* (QMA). This document analyzes developments in the monetary aggregates, not simply for their own sake, but to understand their implications for inflation and monetary policy. The analysis focuses not on short-run fluctuations but on the implications of money growth for inflation dynamics over the medium to long run. Finally, the analysis incorporates information from a variety of sources in addition to the monetary aggregates, including a range of financial assets, prices, and yields.

[23] The discussion of the use of monetary aggregates at the ECB draws heavily on Fischer, Lenza, Pill, and Reichlin (2006), pp. 2-11, and Kahn and Benolkin (2007).

The economic analysis pillar—where the Taylor rule potentially plays a role—takes the form of a broad-based economic assessment called the "macroeconomic projections exercise." In this exercise, the ECB's staff identifies and analyzes economic shocks and the cyclical dynamics of economic activity and inflation. The staff also produces forecasts of inflation and economic activity over the coming two to three years. The analysis is similar to the policy analysis conducted at the Federal Reserve and other central banks.

The ECB's area-wide model (AWM), used in assessing economic conditions, forecasting, and policy analysis in the Euro area, incorporates a money demand equation and a yield curve (http://www.ecb.int/home/html/researcher_awm.en.html). Short-term interest rates are determined by a standard Taylor rule. However, "it is worth pointing out … that the plausibility or policy relevance of [this otherwise standard relationship] is not at stake as such. In fact, [this] supplementary [equation is] used primarily because [it is a] necessary [element] to close the model as a full system, which would otherwise not converge to some steady-state path" (Fagan, Henry, and Mestre, 2001, 25).

The ambivalence suggested by the statement above can also be heard in the views expressed by members of the ECB governing council. For example, Otmar Issing has argued that a simple Taylor-type rule, had it been available during three past historical episodes, would not have been of help in preventing policy mistakes. Instead, he argues that a policy based on the quantity theory of money, using the money supply as a key indicator, "could have been instrumental in yielding a better macroeconomic outcome" (2002, 192-93). The three episodes include the Federal Reserve's conduct of policy in the 1920s and subsequent Great Depression, the Bank of Japan's experience in the second half of the 1980s in the face of an asset price bubble, and Europe's experience over the same period before the adoption of the euro. In each

case, Issing argues, a measure of "excess" money growth would have provided policymakers a better signal than the prescription from a Taylor rule.[24]

More generally, the ECB has spelled out its concerns about the usefulness of Taylor rules in an article appearing in its *Monthly Bulletin* (2001). Many of the concerns echo those of Greenspan and others regarding the use of Taylor rules by the Federal Reserve. First, it is argued that other policy strategies including ones based on money growth targeting, if successful in maintaining price stability over a long period, might be empirically indistinguishable from a policy based on the Taylor rule. Thus, a Taylor rule that fits the data well empirically may have little to say about what information policymakers actually responded to and how they reached policy decisions. Moreover, real-time data are required for any careful assessment of policy.

Second, more information—including data on such variables as money and credit growth, exchange rates, asset prices, fiscal indicators, commodity prices, and wages—may be needed in the conduct of policy. Decisions cannot be based solely on current inflation and the output gap. A simple Taylor rule would ignore insights gleaned from a wealth of additional information.

Third, different types of economic shocks require different policy responses. For example, do they arise from the demand side or the supply side, are they temporary or permanent? "In short, driving forces of different natures, possibly associated with the same inflation outturn or forecast, require offsetting actions of varying intensity and duration, as they set in motion quite different dynamics and are associated with possibly opposite tendencies in the

[24] Moreover, Jürgen Stark, Member of the Executive Board of the ECB, has questioned whether a simple Taylor rule captures all the information that the ECB responds to in setting interest rates: "Central banks which are concerned with domestic price stability seek to offset potentially destabilising shocks. In a globalised world, though, different central banks naturally respond in part to similar global factors. And, as we know, a number of these factors are not well captured by a mechanical policy rule of the type which John Taylor takes as a benchmark for good monetary policy-making. Adequate policy reactions to global factors, and to the risks that they pose for domestic price stability, will thus show up—within the context of a simple rule—in the residual term…. However, often the residual is a measure of the lack of explanatory power of the simple policy rule itself" (pp. 2-3).

evolution of real variables. Taylor rules, by unduly restricting the universe of information brought to bear upon policy decisions, are not a reliable guide for policy from this perspective" (ECB, 2001, 42).

Fourth, the Taylor rule as formulated is not strictly implementable since the output gap and the equilibrium real interest rate are not observable. Estimating these concepts in real time is a complicated task involving both empirical and theoretical considerations and questionable assumptions. The effort may lead to a range of estimates so large that the Taylor rule provides no clear policy prescriptions.

Fifth, a forecast-based Taylor rule would suggest a dual mandate for policy by making both inflation and the output gap distinct targets. This would be inconsistent with the ECB's mandate for price stability as its primary objective. Finally, the ECB questions whether Taylor rules can truly be stabilizing. One reason Taylor rules may fail to stabilize the economy is that interest rates cannot fall below zero—even though the Taylor rule might on occasion prescribe such a remedy. Another reason is that, if the Taylor rule is forward looking, it "can exacerbate the tendency of economic systems to be excessively sensitive to arbitrary revisions of expectations" (ECB, 2001, 41-43).

After leaving the ECB, Issing's views on the Taylor rule appear somewhat more sympathetic. At the Dallas Fed's conference on John Taylor's contributions to monetary theory and policy, he said "The Taylor rule has become a benchmark for monetary policy in many respects. At the ECB we were confronted with extreme uncertainty on data for the output gap and the equilibrium interest rate. Notwithstanding this difficulty it was important al3ways to monitor estimates of the Taylor rule using a variety of data."

5.2 The Bank of Japan

While the Federal Reserve and other central banks were incorporating the Taylor rule into their policy processes in the early to mid-1990s, the Bank of Japan was headed toward a zero interest rate policy—the result of a bursting of Japan's property price bubble, falling inflation and real GDP growth, and rising unemployment. Certainly, officials at the Bank of Japan were aware of the work on Taylor rules because Taylor was an Honorary Advisor to the Bank of Japan from 1994 to 2001. But, as the Japanese policy rate hit virtually zero in late 1995, the Taylor rule lost the practical relevance that it might earlier have had. Nevertheless, according to minutes of the Bank of Japan's policy meetings, the Taylor rule was cited in 1999 and 2000 by at least one member of the Bank's Policy Board in the debate over whether to engage in quantitative easing and, later, whether to end the Bank's zero interest rate policy.

In April 1999, according to the views of "many" members of the Bank's board expressed in the minutes, the Japanese economy appeared to have stopped deteriorating, but economic activity remained weak and the outlook for recovery was uncertain. Moreover "the current easy monetary policy" was supporting financial markets and "expected to spread gradually to economic activity." In these circumstances, a majority of Board members favored continuing the Bank's existing policy by "maintaining the overnight call rate at zero percent until deflationary concern was dispelled." One member argued, however, that the Bank should shift to quantitative easing: "[A]n estimate using the Taylor rule … showed that the current monetary easing, which had realized 4-5 percent annual growth in the monetary base, was insufficient. Such a low growth rate of the monetary base might cause market expectations for monetary easing to dwindle" (Minutes of Policy Meeting, April 22, 1999).

As it turned out, quantitative easing did not begin until March 2001. In the meantime, the Taylor rule was used as justification for both a continuation of, and end to, the Bank's zero

interest rate policy. For example in April 2000, “many members” thought the economy was “approaching but had not yet reached a situation where it could be said that deflationary concern had been dispelled.” A majority of members therefore favored continuing the zero interest rate policy. While one member advocated terminating the zero interest rate policy, another member called for “a certain amount of latitude.” His analysis was based on a Taylor rule that had been prescribing an overnight call rate below zero and that only recently had recovered to around zero. “On this basis, the member and some other members said that they were not confident about whether the momentum of a self-sustained recovery in private demand could absorb the shocks from the expected reduction in stimulative measures from the fiscal side, and that there was almost no risk of inflation.” The concern was that if the zero interest rate policy were terminated, the economy could stall and the zero interest rate policy would have to be reinstated (Minutes of Policy Meeting, April 10, 2000).

Later, in June 2000, Board member N. Nakahara dissented against the majority’s decision to maintain the zero interest rate policy. He argued in his dissent that it was necessary to further stimulate the economy, that economic conditions might deteriorate further because of increases in nonperforming loans and cautious lending by financial institutions, and that “some sort of explicit policy rule, such as the Taylor rule or the McCallum rule, should be employed to help enhance communication with the market” (Minutes of Policy Meeting, June 12, 2000).

In the following policy meeting, a member made reference to the interest rate prescription from an “optimal” Taylor rule—stating that it “might have risen close to zero percent depending on the assumption used for the calculation… Some might think it necessary to wait until the optimal interest rate had risen clearly above zero percent before it could be said that deflationary

concern had been dispelled. It should be noted, however, that the optimal interest rate derived from the Taylor rule was merely one factor, among many, that helped in decision-making" (Minutes of Policy Meeting, June 28, 2000). A similar discussion occurred at the July meeting.

Finally, in August 2000 after considerable debate, the Bank moved away from its zero interest rate policy by moving the overnight call rate target to on average around 0.25 percent. One member who was not convinced that the economy had reached the point where deflationary concern had been dispelled, "presented an analysis of the optimal interest rate derived from the Taylor rule, commenting that the level of the optimal interest rate should be evaluated with a certain amount of latitude. According to the calculations, the optimal interest rate in the current economic situation, where there was a large supply-demand gap, was in the range of slightly above to slightly below zero percent." As a result…"the Bank should continue the zero interest rate policy until the optimal interest rate had more clearly risen above zero." In response, another member who supported an end to the zero interest rate policy argued that it was not just the size of the supply-demand imbalance at a point in time but "the direction of changes in the gap was also a major factor that could affect price developments" (Minutes of Policy meeting, August 11, 2000).

The Taylor rule has also been used on an ex post basis to evaluate Japanese monetary policy during the 1980s and 1990s. Numerous studies have been conducted by researchers within and outside the Bank of Japan.[25] They generally find evidence that, relative to a Taylor rule prescription, policy was held somewhat too tight in Japan from 1993 onward. However, commenting in 2002 on the economic environment in which the Bank of Japan was operating, Deputy Governor Yamaguchi suggested that at the early stages of Japan's financial crisis "there

[25] See, for example, Ahearne, Gagnon, Haltimaier, and Kamin (2002), Billi (2009), Kuttner and Posen (2004) for the view from outside the Bank of Japan or Mori, Shiratsuka, and Taguchi (2001), Okina and Shiratsuka (2001), or Fujiwara, Hara, Hirakata, Kimura, and Watanabe (2007) for the view from the Bank of Japan.

was a presumption that shocks would be contained within the financial sector and would not spread to the real side of the economy." Therefore, there was a belief that economic conditions would improve, making the case for additional stimulus less clear.

More recently, in a speech, Board member Miyako Suda (2007) discussed his view of the Taylor rule: "Needless to say, the structure of an economy is complex in reality, and central banks should not mechanistically apply a particular policy rule. In addition, since there are many versions of the Taylor rule, the central bank and the market may not necessarily share an identical one when they communicate with each other. Nevertheless, the Taylor rule is helpful, at least as one of the benchmarks for the conduct of monetary policy when we consider how a central bank should respond to various shocks, and therefore its communication with the market will improve and its accountability will be enhanced."

5.3 Bank of England

The Bank of England is among a large group of central banks operating under a formal inflation targeting regime. As such, the Bank views itself as following a flexible "inflation targeting" rule as opposed to an instrument rule such as the Taylor rule. This does not suggest, however, that there is any inherent inconsistency in inflation targeting and the Taylor rule. Even in the extreme case, where a central bank placed no weight on output in its objective function, it may still include output in its instrument rule. For example, output may serve as an indicator of future inflation. Alternatively, in the case of a "flexible" inflation targeting regime, the central bank may still place a positive weight in its objective function on minimizing output fluctuations.

The key difference between an inflation forecast targeting rule and an instrument rule such as the Taylor rule relates primarily to the way policymakers communicate with each other and the public. Inflation targeters tend to talk in terms of adjusting the policy rate as needed to

bring a medium-term forecast of inflation into alignment with the inflation target, as opposed to adjusting the policy rate in response to a simple rule. One reason might be that they view themselves relying on "optimal" policy rules that are inherently complicated, model dependent, and difficult to communicate. Additionally, as discussed below, their forecast of inflation may be explicitly conditioned on an exogenously given future policy path as opposed to an endogenous rule.

The UK first established inflation targets in October 1992 after the suspension of sterling from the EMU when the Chancellor of the Exchequer announced the initial inflation target. At the time the Bank had little independence from the Treasury. In May 1997, however, the bank gained more autonomy when the Chancellor announced that the government was giving the bank "operational responsibility for setting interest rates to meet the Government's inflation target." In addition, the Chancellor announced that the bank's Monetary Policy Committee (MPC) was to make operational decisions (Bank of England, 1997, 16).

Under the Bank's inflation targeting regime, the MPC bases policy decisions on its forecast of inflation over the medium term. This does not mean that the Bank ignores real economic activity in setting policy. While the 1998 Bank of England Act establishes the inflation target as the Bank's primary goal, it also requires the Bank to support the Government's other goals. In practice, this requirement has meant the Bank considers how its actions will affect output volatility. As a result, the timeframe for bringing inflation back to target after an economic shock may vary depending on how the shock affects real output (Nikolov, 2002).

The MPC's inflation forecast is based on the market's expectation of the future path of interest rates.[26] Thus, the forecasting model does not incorporate a Taylor rule or any policy reaction function that tries to characterize the systematic response of the MPC to economic

[26] The Committee also considers alternative projections based on a constant interest rate path.

indicators. In addition, there is no mechanical link between the forecast of inflation, the uncertainty around the forecast, and the ultimate policy decision. According to King (2001, as quoted in Nikolov, 2002), "…if the deviation from the rule or target is too great then its use either as a means of discipline or a form of communication becomes low. But there is equally no mechanical link between any particular summary statistic of the inflation forecast and the choice of policy instrument…. There is always a judgment about what policy setting is appropriate given the outlook for inflation."

The Bank views its targeting rule as having a number of advantages over an instrument rule. For example, simple instrument rules such as Taylor's (that are easy to communicate to the public) are unlikely to be optimal, and optimal rules are unlikely to be simple (and therefore likely to be difficult to communicate). In addition, they imply a mechanical link between a narrow set of economic conditions and policy decisions to which few policymakers would be willing to commit. In contrast, targeting a forecast of inflation allows policymakers to respond flexibly to a wide range of indicators and to exercise considerable judgment. Moreover, the inflation target is transparent, easily communicated, and focused on the goals of policy rather than the instruments.[27]

While Taylor rules are not prominent in the policy framework of the Bank of England, they do play a background role—as they do in most other central banks. MPC members and staff "review the prescriptions of a number of measures of the stance of policy and inflationary pressure as part of its 'suite of models' approach to policy briefing and forecasting." Prescriptions of various policy rules—including the Taylor rule—are compared with the current

[27]See Nikolov for more details. Mishkin (1999) and Svensson (1999) also argue in favor of targeting rules rather than instrument rules.

policy rate. "But because of the disadvantages of all of these simple rules, the MPC does not place a large weight on any individual measure."

In the staff's version of the Taylor rule, the output and inflation gaps are lagged one period, the inflation target is 2.5 percent, the output gap is measured using a production function approach, the equilibrium real interest rate is derived from index-linked bonds, and the weight on the output gap is varied from 0.25 to 0.75. The staff analyzes and tries to explain differences between the Taylor rule prescriptions and the Bank's actual policy rates when they arise. In addition, the staff uses monetary policy rules "in both estimated and calibrated macroeconomic models to inform thinking about issues of monetary strategy" (Nikolov, 2002, 8-10).

5.4. Other Central Banks

Other inflation targeting central banks use Taylor rules in a similar fashion to the Bank of England. At the Reserve Bank of Australia, "Consideration of the current stance of policy … is supplemented by… the output of a suite of Taylor rule-type calculations… Staff research over the years has identified a couple of Taylor rule formulations which we think are worth checking periodically" (Stevens, 2001).

In the model used for forecasting and policy analysis at the Reserve Bank of New Zealand (RBNZ)—the original inflation targeting central bank—a specific reaction function characterizes the flexible inflation targeting regime. The policy rate is set equal to 1.4 times the sum of forecast deviations of inflation from target 6 to 8 quarters ahead (Black et al., 1997, as described in Huang et al., 2002, 6). Incidentally, the RBNZ claims to be the first central bank that "prepares *and* publishes economic projections based on endogenous interest rates—an approach we adopted in 1997" (Hampton, 2002, 5).[28]

[28] Since 1997, other central banks—including the central banks of Norway and Sweden—have begun to condition forecasts on the bank's own expected future path of the policy rate (Kahn, 2007).

The Swiss National Bank draws on a variety of models in developing the Bank's inflation forecast. A Taylor rule is incorporated in both its medium-sized and small-sized macro model. Other models in use at the Bank include a VAR model and an M3 model (Jordan and Peytrignet, 2002).

The use of Taylor rules at central banks in emerging market economies is complicated by the prominent role played by exchange rates in monetary policy in most of these countries. This prominence is due to the high degree of pass-through of the exchange rate to domestic inflation, the desire to maintain competitiveness in the tradable goods sector, and concern for financial stability (Mohanty and Klau, 2004, 1). Nevertheless, Taylor (2000) argues that "for those emerging market economies that do not choose a policy of a 'permanently' fixed exchange rate (perhaps through a currency board or a common currency (dollarization), then the only sound policy is one based on the *trinity of a flexible exchange rate, an inflation target, and a monetary policy rule*" (pp. 2-3).

Taylor acknowledged, however, that certain features of policy rules may need to be modified for application to emerging market economies. First, he suggested that policymakers in emerging markets might want to give consideration to a rule using a monetary aggregate as the instrument instead of an interest rate. Second, it may be appropriate to have a target for the exchange rate—provided it is consistent with the inflation target over the long run. Third, without well developed long-term capital markets, it may be necessary for central banks in emerging markets to move the policy instrument "more quickly and by a larger amount because short-term interest rates will have to do more of the work" (p. 14). Finally, based on a number of studies he concludes that a rule that focuses on minimizing inflation and output fluctuations

and does not react too much to the exchange rate might work well in emerging market economies.[29]

Less clear is how emerging market central banks actually use policy rules in practice.[30] Mohanty and Klau (2004) survey the objectives and instrument setting of central banks in a number of emerging market economies. All of the banks surveyed (from a sample of seven) sought to maintain stable inflation, reduce inflation, or hit an inflation target. Most of the banks, in addition, had goals for output as well as objectives for the exchange rate. Two banks had financial market conditions as an additional goal. Moreover, some central banks announce "guidelines" for setting interest rates. "These guidelines generally include how the central bank will react to a particular shock and under what circumstances it might choose to accommodate some of the shocks.

"For example, the Central Bank of Chile (2000) provides a clear statement of action in the event of a price shock: only shocks that affect trend inflation are neutralized by interest rate changes, and the response is symmetric to positive and negative deviations." Another example is Korea, where the Bank of Korea follows a "look-at-everything approach. In situations of conflict of objectives—for instance, an economic slowdown or financial market uncertainty coinciding with overshooting of the inflation from the target—it follows an eclectic approach and relies heavily on judgment in setting the policy stance. Moreover, save in exceptional situations, the Bank adjusts its policy rate in small steps, usually a quarter percentage point, each time it considers a rate change" (Mohanty and Klau, 2004, 3-4).

6. Concluding remarks

[29] These studies include Ball (1999), Svensson (2000), and Battini, Harrison, and Millard (2001).
[30] See Vašíček (2009) and Mohanty and Klau (2004) for estimated policy reaction functions for emerging market economies.

The Taylor rule expressed in simple terms the view that monetary policy should be considered a systematic response to incoming information about economic conditions, as opposed to a period-by-period optimization problem. It also imbued policymakers with the concept of the Taylor principal—the idea that the policy rate should be adjusted more than one-for-one with an increase in inflation.

The idea of policy as a contingency plan, clearly spelling out how to adjust policy instruments to changing circumstances, spread quickly from academic papers, conferences, and publications to the board rooms of central banks. At the Federal Reserve, various versions of the Taylor rule became integrated into macroeconomic models and policy analysis. FOMC members occasionally based policy positions on the recommendations of Taylor rules. Many economic developments and policy strategies were discussed in terms of policy rules. But some FOMC members, such as Alan Greenspan, remained skeptical.

While other central banks followed the Federal Reserve's lead, using Taylor rules recommendations in their models and as a cross check to policy decisions, the Taylor rule arguably played a less central role. At the ECB, analysis of monetary and credit market conditions took greater prominence. At the Bank of Japan, persistent deflation and a zero interest rate policy limited the applicability of any interest rate rule. At the Bank of England, policy may be more accurately described as flexible inflation forecast targeting rather than summarized by a simple instrument rule. And, in open and emerging market economies, the role of the exchange rate in practice is still hotly debated.

The Taylor rule can be seen as part of a broader movement in which commitment (and therefore credibility), transparency, and independence, replaced a culture of discretion, "mystique," and occasional political influence. While many issues remain unresolved and views

still differ about how the Taylor rule can best be applied in practice, the paper shows that the rule has advanced the practice of central banking.

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