ECONSTOR
Make Your Publications Visible.

A Service of
ZBW
Leibniz-Informationszentrum Wirtschaft
Leibniz Information Centre for Economics

Orphanides, Athanasios

Working Paper

The quest for prosperity without inflation

ECB Working Paper, No. 15

Provided in Cooperation with:
European Central Bank (ECB)

Suggested Citation: Orphanides, Athanasios (2000) : The quest for prosperity without inflation, ECB Working Paper, No. 15, European Central Bank (ECB), Frankfurt a. M.

This Version is available at:
https://hdl.handle.net/10419/152449

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

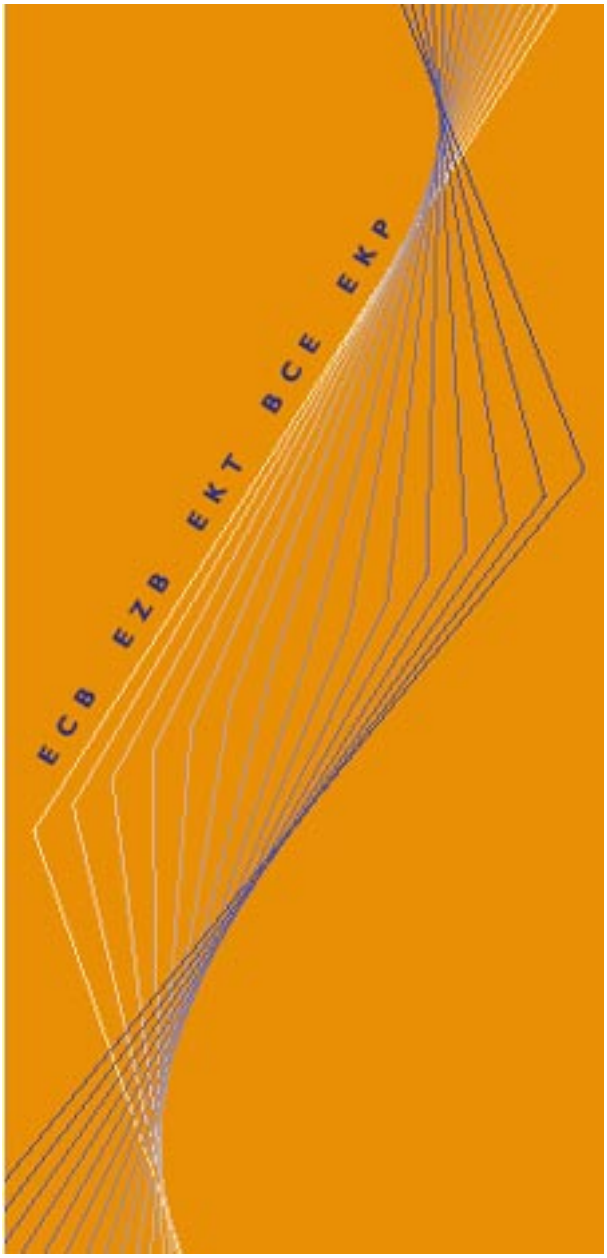
If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

WWW.ECONSTOR.EU

Mitglied der Leibniz-Gemeinschaft

EUROPEAN CENTRAL BANK

WORKING PAPER SERIES



WORKING PAPER NO. 15

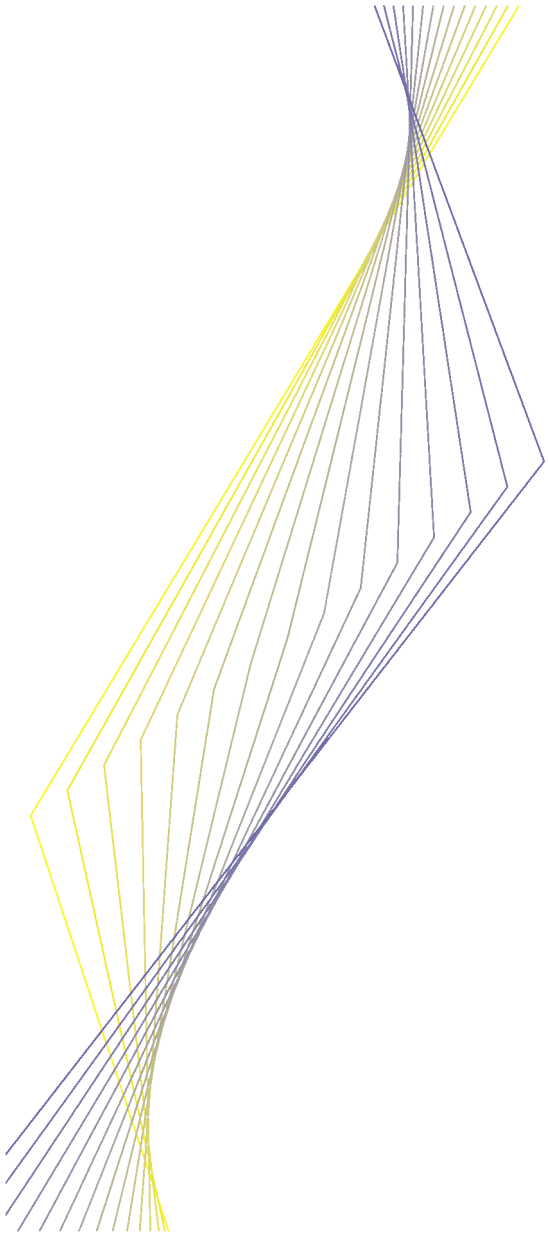
THE QUEST FOR PROSPERITY WITHOUT INFLATION

BY
ATHANASIOS ORPHANIDES

MARCH 2000

EUROPEAN CENTRAL BANK

WORKING PAPER SERIES



WORKING PAPER NO. 15

THE QUEST FOR PROSPERITY WITHOUT INFLATION

BY

ATHANASIOS ORPHANIDES*

MARCH 2000

* This paper was presented at the joint ECB/CFS conference on Monetary Policy-Making Under Uncertainty, European Central Bank, Frankfurt, Germany, December 3–4, 1999. The text has been reformatted for this series from the May 1999 draft presented at the conference. The author is at the Board of Governors of the Federal Reserve System. The opinions expressed are those of the author and do not necessarily reflect views of the Board of Governors of the Federal Reserve System.

© European Central Bank, 2000

Address	**Kaiserstrasse 29** **D-60311 Frankfurt am Main** **Germany**
Postal address	**Postfach 16 03 19** **D-60066 Frankfurt am Main** **Germany**
Telephone	**+49 69 1344 0**
Internet	**http://www.ecb.int**
Fax	**+49 69 1344 6000**
Telex	**411 144 ecb d**

All rights reserved.

Reproduction for educational and non-commercial purposes is permitted provided that the source is acknowledged.

The views expressed in this paper are those of the authors and do not necessarily reflect those of the European Central Bank.

ISSN 1561-0810

Abstract

In recent years, activist monetary policy rules responding to inflation and the level of economic activity have been advanced as a means of achieving effective output stabilization without inflation. Advocates of such policies suggest that their flexibility may yield substantial stabilization benefits while avoiding the excesses of overzealous discretionary fine-tuning such as is thought to characterize the experience of the 1960s and 1970s.

In this paper, I demonstrate that these conclusions are misguided. To illustrate this fact, I construct a database with data available to policymakers in real time from 1965 to 1993 and, using an estimated model, I perform counterfactual simulations under alternative informational assumptions regarding the knowledge policymakers can reasonably have had about the state of the economy when policy decisions were made. Using realistic informational assumptions overturns findings favoring activist policies in favor of prudent policies that ignore short-run stabilization concerns altogether. The evidence points to misperceptions of the economy's productive capacity as the primary underlying cause of the 1970s inflation and suggests that apparent differences in the framework governing monetary policy decisions during the 1970s compared to the more recent past have been greatly exaggerated.

Keywords: Great Inflation, Arthur Burns, FOMC, activist monetary policy, Taylor rule, prudent policy rule, real-time data, potential output, full employment.

JEL Classification System: E3, E52, E58.

1 Introduction

In his 1957 lectures on *Prosperity Without Inflation*, Arthur Burns eloquently explained that economic policies since the enactment of the Employment Act of 1946 had introduced an inflationary bias in the U.S. economy which had "marred our nation's prosperity in the post-war period" (p. v). By promoting "maximum employment," the Act encouraged stimulative policies which, by prolonging expansions and checking contractions, resulted in an upward drift in prices. Burns called for an amendment to the Act, "a declaration by the Congress that it is the continuing policy of the federal government to promote reasonable stability of the consumer price level" (p. 71). Such an amendment, he thought, would lead to a greater policy emphasis "on the outlook for prices and on how reasonable stability of the price level is to be sought" (p. 72). And a reasonable price stability objective "could go a considerable distance in dissipating the widespread belief that we are living in an age of inflation and that our government, despite official assertions and even actions to the contrary, is likely to pursue an inflationary course over the long run" (p. 71). With the appropriate policies, Burns concluded, "[r]easonably full employment and a reasonably stable price level are not incompatible" (p. 88).

Burn's proposed price stability amendment was never enacted. Instead, with the beginning of the 1960s, economic policy was further refined placing even greater emphasis on achieving and maintaining full employment. As Arthur Okun later explained: "The revised strategy emphasized, as the standard for judging economic performance, whether the economy was living up to its potential rather than merely whether it was advancing" (1970, p. 40). The resulting activist stabilization policies were not meant to be inflationary. "Ideally," Okun added, "total demand should be in balance with the nation's supply capabilities. When the balance is achieved, there is neither the waste of idle resources nor the strain of inflation pressure" (p. 40).

Despite the best of intentions, the activist management of the economy during the 1960s and 1970s did not deliver the desired macroeconomic outcomes. Following a brief period of success in achieving reasonable price stability with full employment, starting with the end of 1965 and continuing through the 1970s, the small upward drift in prices that so concerned Burns several years earlier gave way to the Great Inflation. Amazingly, during much of this period, specifically from February 1970 to January 1977, Arthur Burns, who so opposed policies fostering inflation, served as Chairman of the Federal Reserve. How then is this macroeconomic policy failure to

be explained? And how can such failures be avoided in the future?

Many excellent studies have identified a number of contributing factors to this experience.[1] By several accounts, blame for the failure is to be attributed to the discretionary management of the economy during the period.[2] One potential explanation relies on the possibility of a built-in inflationary bias in monetary policy either because of political concerns or a fundamental dynamic inconsistency problem. Another explanation suggests incorrect economic analysis which may have led to a futile attempt to exploit a non-existent long-run inflation-unemployment tradeoff.[3] Both arguments lead to a simple and direct conclusion. Had monetary policy followed a rule focused towards maintaining reasonable price stability, the Great Inflation would have been averted. Well known alternatives that could achieve this objective are constant money growth rules as well as strategies that aim for a stable price level, stable low inflation or a stable growth of nominal income in line with the economy's natural growth rate.[4] An apparent drawback of these alternatives, though, is that by focusing on price stability, they might result in undesirable employment and output volatility.

Much like a discretionary policy framework, monetary policy rules can be designed to balance multiple objectives instead of just concentrating on price stability. Along these lines, over the past several years, simple activist monetary policy rules have been advanced as a means of achieving effective output stabilization consistent with near price stability. These rules prescribe that monetary policy respond to inflation and the level of economic activity. Advocates of such policies suggest that these rules provide a flexibility that yields substantial stabilization benefits but simultaneously maintain a discipline which avoids the excesses of overzealous discretionary fine-tuning such as is thought to characterize the U.S. experience of the 1960s and 1970s. (See e.g. Taylor, 1998a,b).

The critical aspect of these activist rules that differentiates them from alternative guides for monetary policy such as inflation, nominal income or money growth targeting, is the emphasis they place on the level of economic activity in relation to a

[1] Any short listing of studies on this question is bound to be incomplete. The fascinating recent historical accounts provided by De Long (1997), Hetzel (1998), and Mayer (1999) provide extensive bibliographies.

[2] An alternative is to point towards unfavorable supply shocks, especially in energy prices. Barsky and Kilian (1998), present convincing evidence that such shocks cannot account for the inflation experience.

[3] Sargent (1999) presents a novel interpretation which brings together elements of both explanations.

[4] Fischer (1990) reviews these alternatives and their historical origin.

concept of the economy's potential when resources are fully employed. Unfortunately, as a practical matter, the measurement problems associated with the concept of full employment present substantial difficulties. Thus, while the strategy of attempting to stabilize the economy at its full employment potential would be highly successful if the full employment objective were properly measured, in practice, these activist strategies may not yield the desired results.

In this paper, I demonstrate that the stabilization promise suggested by these activist policy rules is indeed illusory. The apparent improvement in economic performance that these rules suggest over alternative policies that ignore completely short-run stabilization objectives can be attributed to unrealistic informational assumptions regarding the knowledge policymakers can reasonably have about the state of the economy at the time when policy decisions are made. To demonstrate this fact, I construct a database with data available to policymakers in real time from 1965 to 1993 and, using an estimated model, I employ these data to perform counterfactual simulations of the U.S. economy under alternative informational assumptions. Specifically, I contrast the performance of the economy under the assumption that policymakers could have implemented activist stabilization rules with perfect information with the performance under the realistic alternative that policymakers could have relied only on the information available to them in real time. Unlike previous findings that do not account for the informational limitations, the comparison reveals that these activist policy rules result in worse performance since 1965 than actual experience, especially regarding inflation.

Although these results might appear paradoxical at first, upon reflection they should be rather obvious. The emphasis on the output gap in activist policy rules suggests that the premise underlying these rules does not to differ fundamentally from the rationale underlying the activist discretionary policy of the 1960s and 1970s. Elaborating on the importance of the output gap at that time, Okun observed that "the focus on the gap between potential and actual output provided a new scale for the evaluation of economic performance, replacing the dichotomized business cycle standard which viewed expansion as satisfactory and recession as unsatisfactory. This new scale of evaluation, in turn, led to greater activism in economic policy: As long as the economy was not realizing its potential, improvement was needed and government had a responsibility to promote it" (1970, p. 41). Despite outward appearances, the activist discretionary policies advocated and practiced during the 1960s and 1970s

and the activist policy rules advocated more recently share fundamental similarities.

The problem leading to the Great Inflation, then, was not necessarily that policy relied on discretion rather than a rule but that policy was inappropriately *activist*, much like an inappropriately activist policy rule would have suggested at the time. Examination of the information available to policymakers at the time clarifies the source of the problem. Both inflation and the output gap appeared to have been mismeasured, especially during the early 1970s, but the bulk of the error was due to the mismeasurement of potential output. To clarify the underlying cause of the problem, I examine the evolution of estimates of potential output and resulting assessments of the output gap during the 1960s and 1970s. My analysis suggests that the resulting measurement problems could be attributed in large part to changes in the trend growth of productivity in the economy which, though clearly seen in the data with the benefit of hindsight, was virtually impossible to ascertain in real-time.

In retrospect, this danger should perhaps have been given greater attention. After all, the information problem was and remains one of the most significant impediments to successful stabilization policy. Further, the information problem has been central in monetarist arguments favoring non-activist policy rules over activist discretionary policies long before the Great Inflation. As early as 1947, Milton Friedman had sharply criticized reliance on unrealistic informational assumptions for Keynesian prescriptions to maintain "full employment." More recently Allan Meltzer (1987) has again illustrated how lack of information limits short-run stabilization policy. As Karl Brunner summarized: "Discretionary management ultimately fails to deliver, even with the best of intentions, on its promise. The information problem separates the reality and the rationale of discretionary management by an unbridgeable gulf." (1985, p.12.)

The likely policy lapse leading to the Great Inflation, therefore, can be simply identified. It was due to the overconfidence with which policymakers believed they could ascertain in real-time the current state of the economy relative to its potential. The willingness to recognize the limitations of our knowledge and lower our stabilization objectives accordingly would be essential if we are to avert such policy disasters in the future.

2 Policy Rules

Over the past several years, a number of authors have examined the stabilization performance of simple rules for monetary policy.[5] These rules set the policy instrument as a function of one or two indicator variables that provide information about deviations of the state of the economy from some desired path. Using the short-term interest rate as an instrument, a characteristic family of such rules prescribes that the short-term nominal interest rate, R_t, be set so that its deviation from a neutral setting, R_t^*, responds linearly to the deviation of a variable serving the role of an intermediate target, X_t, from a predetermined desired path, X_t^*.

$$R_t - R_t^* = \theta(X_t - X_t^*) \tag{1}$$

Starting with the large-scale model comparison studies reported in Bryant, Hooper and Mann (1993), many authors have investigated rules of this type in depth. The performance of the economy has been examined in several models with variables such as monetary aggregates, exchange rates and nominal income serving as intermediate targets. A strategy that was found to yield particularly promising outcomes in the Bryant, Hooper and Mann volume was to target the sum of inflation and output deviations from their desired levels. A number of later studies confirmed the advantages of such a strategy and also examined the performance of a more general family of rules which allows for possibly different responses to inflation and output deviations from their desired levels. These rules respond linearly to the output gap, y_t, defined as actual minus potential output expressed as a fraction of potential output, and deviations of the annual rate of inflation, π_t^a, from a desired target, π^*:

$$R_t - R_t^* = \gamma(\pi_t^a - \pi^*) + \delta y_t \tag{2}$$

A common finding favoring rules (2) is that if the objective of policy is to stabilize the level of output at the economy's potential while avoiding inflation, policy rules that respond directly to inflation and the output gap appear to result in better macroeconomic performance than policies that target alternative intermediate variables.[6]

As is well known, the family of rules (2) nests an intriguing parameterization due to Taylor (1993) which describes actual policy since the late 1980s in the United States

[5] McCallum (1998), Taylor (1998a), Clarida, Gali and Gertler (1999) provide surveys of this literature.

[6] A number of authors, including Ball (1997), Clarida, Gali and Gertler (1999), Orphanides and Wilcox (1996), Rotemberg and Woodford (1998), Svensson (1997) and Woodford (1999), have shown how reaction functions related to (2) can be reconciled with optimizing central bank behavior in the absence of informational problems.

rather well.[7] Taylor's rule uses the sum of the annual inflation rate, π_t^a, and the natural real rate of interest, r^*, as a proxy for the neutral nominal interest rate,

$$R_t^* = r^* + \pi_t^a \tag{3}$$

and substitutes the parameters $r^* = \pi^* = 2$, and $\gamma = \delta = 1/2$.

Taylor Rule

$$R_t = 2 + \pi_t^a + 0.5(\pi_t^a - 2) + 0.5y_t \tag{4}$$

Subsequent research, importantly many of the studies in Taylor (1999), has shown that a modified version of this rule with a stronger response to the output gap may have even better stabilization properties while continuing to describe recent monetary policy decisions reasonably well. This modification is:

Revised Taylor Rule

$$R_t = 2 + \pi_t^a + 0.5(\pi_t^a - 2) + 1.0y_t \tag{5}$$

A detailed description of the historical performance of the original and revised parameterizations of the Taylor rule is provided by Taylor (1998b).

The macroeconomic performance of the U.S. economy over the recent period when Taylor's rule successfully describes the contours of interest rate settings has been remarkably good by historical standards. As a result of both this apparent success and the promising findings from the simulation studies, it has been tempting to associate good macroeconomic performance with setting policy based on the Taylor rule and even associate deviations of the federal funds rate from such rules as policy "mistakes."

Taylor (1998b) identifies two episodes of systematic policy "mistakes" over the past thirty years that would have been avoided if policy had followed the Taylor rule. Specifically, Taylor suggests that the acceleration of inflation in the late 1960s and 1970s was the result of policy that was systematically easier than the policy Taylor's rule would have prescribed and concludes that these systematic deviations from the rule can account for the resulting inflation. And in the early 1980s, Taylor finds that Chairman Volcker's disinflation policies were excessively harsh, with the federal funds rate being systematically higher that what the Taylor rule would have prescribed.

[7] Although the apparent fit is not nearly as close as originally suggested the rule does broadly capture the contours of the federal funds rate during this period. This is confirmed in section 6.

This "mistake," Taylor concludes, accounts for the dismal performance of output in the early 1980s and the depth of the 1982 recession.[8]

A potential difficulty in assessing the validity of such conclusions is that the retrospective policy evaluations upon which they are based rely on unrealistic informational assumptions. One problem, in particular, is that, as specified, these rules incorrectly assume that the policymaker has accurate information regarding the current values of inflation and the output gap when setting the interest rate. In fact, however, both inflation and the output gap are measured with considerable noise that should be taken into account in constructing an accurate depiction of realistic policy alternatives. Most importantly, the measurement of the economy's productive capacity—a necessary element for computing the output gap—presents notoriously complex problems whose understanding is absolutely critical for evaluating activist stabilization strategies.[9] To address this issue, let $\tilde{\pi}_t^a$ and $\tilde{y}_t$ denote the policymaker's observations regarding the annual inflation rate and the quarterly output gap, respectively, when decisions are made. In practice, policymakers recognize that the information they possess in real-time is imperfect and subject to revision. Following Orphanides (1998), let x_t denote the noise in the observation of the true rate of inflation, π_t^a, and z_t the noise in the observation of the true output gap, y_t:

$$\pi_t^a = \tilde{\pi}_t^a + x_t$$

$$y_t = \tilde{y}_t + z_t$$

Rewriting (2) to conform to what is actually known at the time the policy decision is made about inflation and output gives:

$$R_t - \tilde{R}_t^* = \gamma(\tilde{\pi}_t^a - \pi^*) + \delta\tilde{y}_t \tag{6}$$

[8]Other authors have also suggested similar findings. Employing estimated policy reactions similar to the Taylor rule, Clarida, Gertler and Gali (1998) and Judd and Rudebusch (1998) suggest that the inflation of the 1970s might have been avoided if monetary policy followed policy rules they identify with the 1980s and 1990s. (Indeed, these studies argue that monetary policy during the 1970s may have been inherently unstable.) To be sure, all these studies offer careful qualifications of their findings and recognize the interpretation difficulties arising from the usage of current data for historical analysis, especially regarding the definition of the economy's productive capacity.

[9]Several authors, including Estrella and Mishkin (1998), Orphanides (1997), McCallum (1998) and McCallum and Nelson (1998) have recently discussed this problem at length. Orphanides (1998) and Smets (1998) have shown explicitly how the efficient choice of the response coefficients γ and δ in a policy rule such as (2) is distorted once the uncertainty regarding the measurement of the output gap is incorporated in stochastic simulation comparisons. Orphanides and van Norden (1999) detail the pervasiveness of the output gap measurement problem across alternative estimation methods. A number of other issues, including model mispecification and parameter uncertainty may pose additional related difficulties that could also complicate retrospective evaluations. Several recent papers including, Levin, Wieland and Williams (1998), Sack (1998), Onatski and Stock (1999) and Williams (1999), have illustrated aspects of these problems.

where $\tilde{R}_t^* \equiv r^* + \tilde{\pi}^a$. Written in terms of the true measures of inflation and the gap, the interest rate policy corresponding to rule (6) is:

$$R_t - R_t^* = \gamma(\pi_t^a - \pi^*) + \delta y_t - \underbrace{((1+\gamma)x_t + \delta z_t)}_{\text{noise}} \tag{7}$$

This equation reveals the nature of the information problem. Setting the federal funds rate in reaction to the output gap and inflation, as the rules in (2) suggest, introduces inadvertent deviations into policy choices from what the policymaker would have liked to do had the policymaker known the true underlying measures of inflation and the output gap. The resulting undesirable movements in the interest rate that feed back to the economy through the noise terms could adversely influence macroeconomic performance. For instance, a policymaker attempting to follow the Taylor rule may at times inappropriately ease policy in response to a perceived opening of the output gap only to discover, perhaps many years later and after inadvertently fueling inflationary pressures in the economy, that the perception upon which the original policy easing was based was false.

Consequently, a proper examination of the historical performance of the economy that evaluates outcomes had the Federal Reserve counterfactually followed the activist stabilization policies prescribed by rules (2), needs to take into account the noise in the underlying data. Only after accounting for the presence of such informational limitations and only if the properties of activist policies such as the Taylor rule continue to obtain once these practical limitations are accounted for can the conclusions regarding the desirability of such policies be confidently entertained.

3 An Estimated Model of the U.S. Economy

In order to perform the counterfactual simulations necessary to compare policy outcomes under alternative informational assumptions we need a structural model of the economy. To some extent, the comparisons are conditional on the specification of the model as well as the underlying assumptions regarding its structure. And for the results to be informative, the model should fit the historical data reasonably well. With these considerations in mind, I rely on a three equation system of the economy which can be interpreted as a mildly restricted structural vector autoregression (VAR) estimated with quarterly data. The two key variables describing the state of the economy are the quarterly rate of inflation, π_t and the output gap, y_t. The third variable is the policy instrument, the federal funds rate, f_t. Assuming that monetary

policy changes influence inflation and output with a lag of at least one quarter, and recognizing that the federal funds rate will be determined by the choice of the policy rules that I will be considering for the simulations, we need concentrate on just two equations, those for inflation and output. Assuming, further, that inflation does not contemporaneously influence output implies that we can identify the underlying VAR with an ordering that places output first, inflation second and the federal funds rate last. With these assumptions, and employing four lags in the VAR, the evolution of output is:

$$y_t = b_0 + \sum_{i=1}^{4} b_i^{\pi} \pi_{t-i} + \sum_{i=1}^{4} b_i^{y} y_{t-i} + \sum_{i=1}^{4} b_i^{f} f_{t-i} + u_t \tag{8}$$

Ordering output before inflation in the system has the advantage of allowing the dynamics of inflation to take the form of traditional estimated linear Phillips curves with the output gap simply taking the place of the unemployment gap. Following the work of Gordon (1997) and Staiger, Stock and Watson (1997), the evolution of inflation can then be written as:

$$\pi_t = \sum_{i=1}^{4} a_i^{\pi} \pi_{t-i} + \sum_{i=0}^{4} a_i^{y} y_{t-i} + e_t \tag{9}$$

Two additional restrictions are imposed in estimating the system in order to enforce the classical dichotomy. First, I ensure that only sustained changes in real interest rates can have a sustained influence on output by imposing the restriction $\sum_{i=1}^{4} b_i^{\pi} + \sum_{i=1}^{4} b_i^{f} = 0$. Second, I impose the accelerationist restriction $\sum_{i=1}^{4} a_i^{\pi} = 1$. Imposing these two additional restrictions serves two useful purposes: It greatly simplifies the evaluation of alternative policies by separating the choice of a long-run inflation target, π^*, from the evaluation of alternative policy rules which influence the stochastic performance of the economy. And, perhaps more importantly, it conforms with views central bankers express in discussing the formulation of monetary policy.[10]

Finally, as with any empirical model of this nature, the Lucas critique of econometric policy evaluation is a source for concern. This would hinder comparisons of alternative policies that are drastically different from the actual historical policy. Fortunately, as will become evident, the alternative policies we need to consider are such that it would not be implausible for the public to consider them as stochastic realizations from a fixed distribution of policies. Therefore, as Sims (1998) explains, counterfactual

[10] See e.g. Blinder (1996), Yellen (1996) and Meyer (1998). There are, however, longstanding theoretical and empirical issues regarding the classical dichotomy that have not yet been resolved. Orphanides and Solow (1990), and King and Watson (1994), respectively, present some of these theoretical and empirical issues.

simulations of a model of this nature remain useful for policy evaluation.

I estimate the model with quarterly data from 1960:1 to 1993:4 using data available as of 1994:4. Inflation reflects the quarterly change of the GDP deflator, in percent. The output gap is the difference between actual real output and potential output measured as a fraction of potential output, also in percent. Although more recent data on output and the output deflator are available from the Commerce Department, 1994:4 marks the latest series for historical potential output data that is currently publicly available from the Federal Reserve. As one of my central objectives is to rely exclusively on information available to the Federal Reserve for comparisons, I restrict attention to this data.[11]

The estimated model is similar to the semiannual model in Orphanides (1998) and the quarterly model in Rudebusch and Svensson (1998). Two important properties of the model for monetary policy are the cost of disinflation and the sensitivity of output and inflation to changes in the federal funds rate. The implicit sacrifice ratio is about three and a half, which is similar to the ratio in the RS model and also that reported by Mauskopf (1995) for the Federal Reserve's MPS model.[12] To examine the interest sensitivity of output and inflation, I computed the dynamic responses of these variables to a two-year tightening of the federal funds rates by 100 basis points. By the end of the second year output is about a percentage point below a baseline that does not reflect the tightening and inflation about half a percentage point lower. Finally, implicit in the output equation specification is an estimate of the equilibrium real interest rate, $r^* = -b_0/(\sum_{i=1}^{4} b_i^f)$. The point estimate of 2.1 percent is close to the average ex post interest rate for the estimation sample, 2.2, and conveniently close to the two percent equilibrium real interest rate assumption reflected in the Taylor rule.

4 The Promise of Activist Stabilization Policy

To demonstrate the stabilization promise of following activist policies under the heroic assumption of perfect information regarding the state of the economy, I perform dynamic counterfactual simulations of the model starting with 1965Q4 and ending

[11] In a sense, for the purposes of this study I treat the data available at the end of 1994 as reflecting the "truth" regarding historical inflation and the output gap data. Of course, I recognize that this is only approximately correct!

[12] Direct comparisons with the new Federal Reserve model (FRB/US) are not immediate. The FRB/US model allows a wide range of implicit sacrifice ratios which span the point estimates in the MPS, RS and the model I employ here. Reifschneider, Tetlow and Williams (1999) present some illustrative simulation results based on the FRB/US model.

in 1993Q4. The simulations use equations (8) and (9) but substitute an activist policy rule in place of the actual federal funds rate. More precisely, the simulations employ the historical values of all variables up to 1965Q4 as initial conditions and the estimated residuals from equations (8) and (9) from 1966:1 to 1993:4.

First, I examine the counterfactual historical performance of inflation and output for the original and revised Taylor rule under the favorable assumption that policymakers could have observed the simulated performance of inflation and output gap as it evolved in real-time without noise. This assumption is highly unrealistic—of course—but indicates the promise of following an activist stabilization rule. The results are shown in figure 1 (for inflation) and figure 2 (for output.) In each figure, the solid line denotes the actual historical evolution of the variable shown from 1966 to 1993. The dashed line indicates the counterfactual alternative if policy were to follow the Taylor rule with perfect information and the dotted line the counterfactual alternative corresponding to the Revised Taylor rule.

Figure 1 unambiguously confirms the promise of following these activist rules with regard to stabilizing inflation. Had either of these rules been followed (assuming always that this *could* be done), then as Taylor (1998b) concludes, the "mistake" that led to the inflation of the 1970s would have been avoided. To be sure, the commodity price shocks and oil shocks of 1973 and 1979 are still visible in the simulated counterfactual paths of inflation. But inflation is successfully stabilized around the two percent target and only exceeds five percent briefly at the end of 1974, compared with the eleven percent rate in the actual data. Comparing the two activist rules, the revised version performs marginally better but the difference is small relative to the improvement in performance that either of the two activist rules indicates relative to the actual history of inflation. As well, the simulations confirm that actual inflation since the late 1980s has been nearly identical to what the simulations based on the Taylor rule would imply.

Equally impressively, figure 2 confirms the promise of these activist rules with regard to stabilizing output. The two simulated paths are clearly less volatile than the actual output gap. Only in 1975 and 1976 would the counterfactual policies have induced more severe contractions than actual history, and this would have an been entirely appropriate response to the inflation situation resulting from the unfavorable shocks in 1973 and 1974. Remarkably, the simulations also confirm the "mistake" associated

with Volcker's disinflation policies. At its worst, the recession of 1982 would have resulted in an output gap smaller than three percent (in absolute value) had either variant of Taylor's rule been followed whereas in reality the output gap was more than twice as large. Finally, the actual data and simulated paths are nearly identical since the late 1980s, once again confirming that actual policy was rather similar to the rule prescriptions.

Indeed, based on such promising results, it *is* rather tempting to conclude that activist stabilization policies following a rule such as Taylor's perform remarkably well. But are these apparent remarkable outcomes real?

5 The Reality of Activist Stabilization Policy

5.1 Information in Real-Time

The greatest difficulty associated with attempting to reconstruct counterfactual simulations based on realistic information is the need to recover the information upon which policymakers could actually base their decisions in real-time. Using this information, the counterfactual simulations can then be designed to provide the parallel simulated paths of both the actual and perceived inflation and output had policy actions followed a different path from historical decisions.

From 1965 to 1993, the period of interest, the FOMC held regular scheduled meetings either two or three times in every quarter and occasionally had additional unscheduled conference calls to discuss possible policy actions. To simplify the task at hand, and since the frequency of my data is quarterly, I concentrate on just one FOMC meeting per quarter, the one corresponding as closely as possible with the middle month of the quarter. For each of these meetings, I rely on information that was available from the production of the Board of Governors staff analysis of the economic situation just prior to the meeting. The Greenbook, which is distributed to FOMC members by the staff a few days before each meeting, provides a valuable source for this information. As explained in more detail in Orphanides (1998), all the necessary information to reconstruct inflation and the output gap in real-time for the 1980s and 1990s is available from Federal Reserve documents. For the earlier period, however, reconstructing the data is somewhat more involved. While the Greenbook provides real-time information on nominal and real output from which I can complete a time-series of real-time inflation measures, I have not been able to recover a complete time-series for potential output estimates from Federal Reserve sources. This limitation

is not a reflection on the availability of the series at the Federal Reserve, however. Indeed, in discussing the process employed in the analysis of the economic outlook while he was Governor at the Federal Reserve, Maisel (1973) lists the potential output series as one of the key macroeconomic variables associated with the development of the staff forecasts.[13] Further, discussion of output gap measures appears in the FOMC Memorandum of Discussion throughout this period.

From those occasions when quantitative measures of the output gap appear in the Memorandum of Discussion or the Greenbook, I was able to confirm that throughout the 1960s and 1970s these measures were based on the Council of Economic Advisers estimates of potential output. Indeed, from 1961 until 1981 the Council regularly produced and updated estimates of potential output and for a number of years these estimates were considered (in fact referred to) as the "official" estimates. The starting date for the availability of these data was not accidental. Data on the gap between actual and potential output were first presented by the Council of Economic Advisers during the first appearance of president Kennedy's Council before the Joint Economic Committee on March 6, 1961.[14] (Heller, Gordon and Tobin, 1961.) By June 1961, the Council's measures of the output gap had already been employed in staff presentations regarding economic developments at the Federal Reserve and appeared in FOMC discussions.[15] Indeed, from 1968 to 1976 the Council estimates were "officially" treated as data, updated and published every month by the U.S. Department of Commerce together with actual output data. Based on this information, I rely on the real-time Council potential output estimates to complete my time-series of the real-time output gap available to policymakers.

Figures 3 and 4 show the real-time and final data for inflation and the output gap. These data provide time series of estimates for x_t and z_t, the noise in inflation and the output gap measures faced by policymakers in every-quarter from 1965Q4 to 1993Q4

[13] Governor Maisel's account is particularly valuable in this regard as he joined the Board in June 1965 and was instrumental in the introduction of formal forecasts at the Federal Reserve later that year.

[14] The 1962 *Economic Report of the President* provided a comprehensive discussion of the data. Okun (1962), detailed the underlying methodology.

[15] Okun's (1962) methodology for estimating potential output and the resulting Council estimates were adopted rather quickly by many, including Federal Reserve economists. Characteristic of this is the fact that the only other paper in the session of the 1962 American Statistical Association Meeting where Arthur Okun presented his analysis was an investigation of the full employment budget surplus using the Council concepts by Robert Solomon of the Board of Governors (Solomon, 1962).

and form the basis for the realistic policy rule simulations that follow.

As is evident from these figures, the noise in the data is not trivial. For inflation, deviations between the real-time and final data often exceed one percentage point, especially in the first half of this sample. As well, the real-time data appear to understate the final inflation estimates somewhat during the 1970s. But the mismeasurement of inflation appears to be a relatively minor issue when compared to the mismeasurement of the output gap. Comparing the real-time and final series on the output gap reveals systematic one-sided measurement errors. Output gap mismeasurement, of course, reflects two types of errors. The first source is errors in the measurement of actual output. Although such errors are at times substantial, they are comparable in magnitude to errors in the measurement of inflation and cannot account for the magnitude of the mismeasurement shown in figure 4. Rather, the bulk of the problem is due to errors in the measurement of potential output. As is now evident, real-time estimates of potential output severely overstated the economy's capacity relative to the recent estimates, in this sample. The resulting error in the measurement of the output gap, although already substantial at the beginning of the sample in 1965, worsened significantly during the early and mid 1970s before gradually improving later on. In section 7, I provide an accounting of the forces that contributed to this massive measurement error.

5.2 Simulations with noisy data

Given the noise in the real-time data from 1965 to 1993 exhibited in figures 3 and 4, one would expect at least some differences in the performance of activist policy rules once the imperfections in the data are accounted for. The next step is to investigate the quantitative magnitude of these differences.

In parallel with the earlier simulations, the counterfactual simulations based on the real-time data employ the historical values of all variables up to 1965Q4 as initial conditions and the estimated residuals from equations (8) and (9) from 1966:1 to 1993:4. In addition, in determining the interest rate setting these simulations employ the noise in the historical data, x_t, and z_t. Thus, in every quarter, the policymaker is assumed to set the interest rate responding to the *perceived* simulated paths of inflation and output which equal the *true* simulated path minus the historical noise for that quarter. This implementation, of course, is equivalent to setting the interest rate based on equation (7), with the appropriate response coefficients for γ and δ,

corresponding to the original and revised Taylor rules.

Implicit in the simulations is the assumption that for the range of alternative policies examined, the specific choice of policy would not significantly influence the noise pattern in the data. This assumption exactly parallels that regarding the usual invariance of the structural shocks of the model to the choice of policy.

The realistic simulation results for the two activist rules are shown in figures 5 and 6. Once the real-time data imperfections facing policymakers are incorporated into the analysis, all of the promising results regarding stabilization policy based on the Taylor rule vanish. In particular, inflation in the 1970s is as high with the Taylor rule as actually occured. Indeed, with the revised Taylor rule, inflation becomes significantly worse than actual experience. But while the Volcker disinflation at least brought inflation under control in the early 1980s, if policy had followed the Taylor rule, inflation would have exceeded eight percent as late as 1990. With the revised Taylor rule, inflation would have exceeded 13 percent in 1981 and would have remained into double digits into the 1990s. Not only would these activist policies in a sense have produced the inflation of the 1970s, they would have greatly inhibited the disinflation of the 1980s as well.

6 The Great Inflation

The counterfactual simulations based on the Taylor rule appear surprisingly useful for understanding the path of inflation in the United States since 1965. Next, I provide a more detailed account of this experience, starting with the working hypothesis that policy based on the Taylor rule would have been reasonably successful if only it could have been implemented in real-time without any informational problems.

6.1 Two Suggested Interpretations

Figure 7 compares the path of actual inflation to the two counterfactual simulations based on the original specification of the Taylor rule. Figure 8, shows the corresponding paths for the output gap. Each of the two counterfactual simulations offers a distinct interpretation of monetary policy since the mid 1960s.

The first interpretation, based on the simulation without noise, suggests that inflation accelerated in the late 1960s and 1970s because policy must have *deviated* from the sensible prescriptions suggested by the Taylor rule and was instead systematically too

easy. Following an abrupt reversal, policy became exceedingly tight and engineered a harsh disinflation in the first half of the 1980s. Since then, it appears that the economy has been more or less successfully stabilized much as it would have been under the Taylor rule.

The second interpretation, based on the simulation with noise, suggests instead that inflation accelerated in the late 1960s and 1970s because policy must have *actually followed* a strategy indistinguishable from the Taylor rule! Belatedly recognizing the inflationary consequences of this strategy, policymakers adopted a policy that was appropriately tighter than the prescriptions suggested by the Taylor rule in the first half of the 1980s.

The two alternative readings of the history of policy decisions can be reconstructed by comparing the actual path for the federal funds rate to the Taylor rule prescriptions based on the real-time and final data for inflation and the output gap. The results are shown in figure 9. Here, for each quarter, the dotted and dashed lines show what the Taylor rule would have prescribed for the federal funds rate for that quarter based on the actual historical inflation and output information for that quarter. The dashed line reflects information available during the quarter the federal funds rate was set ("then"), the dotted line reflects the final data ("now"). The solid line shows the actual history of the federal funds rate.

Surely, if policy is to be evaluated based on information that is now available, the Taylor rule appears to represent reasonable policy and indeed, two "mistakes" are evident by comparing the dotted and solid lines in figure 9. Policy was easier than the rule during the late 1960s and 1970s and tighter than the rule in the first half of the 1980s. But if policy is to be evaluated based on information that was actually available when policy decisions were made, a different conclusion emerges. This is evident by comparing the dashed and solid lines in figure 9. If anything, the policy "mistake" of the late 1960s and 1970s is that actual monetary policy "followed" the Taylor rule, too closely! Rather than "follow" the Taylor rule, policy should have been considerably tighter. Given the "mistake" of "following" the Taylor rule in the 1970s, the deviation from the Taylor rule in the early 1980s and the policy tightening associated with the Volcker disinflation was an appropriate response to the inflation problem created by "following" the rule.

6.2 A Decomposition

The two alternative interpretations suggest that a useful accounting of the sources of the Great Inflation may be obtained by comparing the actual path of inflation to the path of inflation from counterfactual simulations based on the Taylor rule using alternative information assumptions. Figure 10 provides such an accounting.

Each line in the figure shows the difference in inflation between a baseline simulation and an alternative path. The baseline is always the counterfactual simulation based on the assumption that policy could follow the Taylor rule with no informational limitations. The solid line, reflects the difference between actual inflation and the baseline. As can be seen, this difference increases almost continuously from 1966 to 1979. At the peak of the discrepancy, in 1979 and 1980, actual inflation was about 7 percentage point higher than what a policy based on the Taylor rule with perfect information could have delivered. The dashed line reflects the difference between the baseline and a simulation that assumes that the policymaker faced noise only with respect to the measurement of inflation. Based on this difference, about one and a half percentage point of the discrepancy between the actual inflation and the baseline Taylor rule simulations during the 1970s can be attributed to inflation noise. The dash-dot line reflects the difference between the baseline and a simulation that assumes that the policymaker faced noise only with respect to measurement of the output gap. At its worst, in the late 1970s, the mismeasurement of the output gap squarely contributed about 5 percentage points to the inflation discrepancy.

Finally, the dotted line reflects the difference of the simulation based on the real-time data, including both inflation and output gap noise from the baseline. That is, it reflects the discrepancy between the Taylor rule as it could have been actually implemented and the infeasible implementation that assumes away the noise in the data. Comparing the solid and dotted lines reveals that only about one-half percentage point of the inflation discrepancy at its peak in 1979-80 can be attributed to policy deviations from the Taylor rule, as could have been implemented in practice. The rest simply reflects the unintended consequences of policy responding to noise.

Following the decomposition further into the 1980s is also illuminating. By 1987, a discrepancy of five percentage points relative to the baseline would have remained, had policy followed the Taylor-rule with the imperfect data. In contrast, by adopting the strategy associated with the Volcker disinflation actual policy resulted in a path

of inflation that eliminated the discrepancy with the baseline simulation and restored stability in the economy. I return to the disinflation experience later on.

7 The Mismeasurement of the Output Gap

Since the real-time mismeasurement of the output gap appears a key source of the policy failure associated with the Great Inflation, a more detailed examination of its sources is warranted.

One possibility is that potential output and the resulting output gap were constructed in a way that would render them inconsistent with price stability. If that were the case, then surely policymakers should have never incorporated this data into any analysis without making an appropriate adjustment. But this was not necessarily the case. As Okun (1962) emphasized in implementing the methodology he proposed for measuring the output gap, "[t]he full employment goal must be understood as striving for maximum production without inflationary pressure."

As is evident in retrospect, however, the underlying assumptions built in to the estimates of potential output during the late 1960s and 1970s were seriously misguided. Two key assumptions, in particular, proved overly optimistic. The first is the level of unemployment compatible with full employment, what later became known as the "natural rate" of unemployment or the "non-accelerating-inflation rate" of unemployment (NAIRU). When the Council first produced their estimates of potential output in 1961, it was assumed that four percent was a reasonable estimate. Given the experience of the past thirty years, this now surely appears to have been unreasonably low. Unemployment averaged 6.3 percent from 1966 to 1993. But four percent was an entirely reasonable assumption to make in 1961. Indeed, four percent was considered a rather pessimistic assessment of the American economy's full employment potential at the time. Unemployment had averaged just 4.5 percent from 1947 to 1960—not a period of remarkable economic stability—and was under 4 percent in several of these years, without much discernible inflation from the current perspective.[16] And

[16] The fact that the full employment level of unemployment was presumed to be half a percentage point below the average unemployment over the several years prior to 1961 with fairly stable prices might suggest at least some unwarranted optimism. But this would be the case only from a modern perspective based on a linear accelerationist Phillips curve. However, at the time, it was believed that the Phillips curve in the U.S. economy was non-linear with the implication that greater macroeconomic stability alone would reduce the average rate of unemployment—other things being equal. And, of course, increased stability at full employment was the ultimate objective. Baily (1978) and more recently Laxton, Rose and Tambakis (1999) have reexamined the implications of this argument with a non-linear accelerationist Phillips curve.

looking across the Atlantic, the experience in Germany, the United Kingdom and other countries suggested than even lower rates might have been possible with the appropriate policies. Stein (1984), who served as member and chairman in Nixon's Council, credits the Kennedy Council for exercising caution in formulating their full employment objective, noting parenthetically: "Another evidence of this caution, which we do not usually associate with the Kennedy economists, is that they thought of full employment as being 4 percent unemployment, whereas there were others in the administration, especially in the Department of Labor, who wanted to make 3 percent the goal."[17]

The second crucial assumption necessary for assessing the economy's full employment potential concerns the rate of labor productivity improvement and its translation to the natural growth rate of output. Okun's calculations in 1961 suggested that the experience of the U.S. economy in the post-war period was consistent with potential output growing at a rate of 3 1/2 percent per year. But the absence of any inflation during the first half of the 1960s and an apparent increase in the rate of growth of the labor force led to upward revisions of the estimates of potential output growth. By the time Arthur Okun became chairman of the Council in the final year of the Kennedy-Johnson administrations potential output was assumed to grow at four percent. But again, these estimates were, if anything, believed to be conservative. Contemporaneous academic studies based on alternative methodologies, suggested an even brighter outlook for the economy. Thurow and Taylor (1966) estimated a 4.7 percent potential output growth for the second half of the 1960s, and although more conservative, Black and Russell (1969) still concluded that there was "a clear acceleration in the rate of growth of potential GNP in the late 1960s to a rate slightly above 4 per cent." (p. 75). Of course these estimates now appear unreasonably high. In retrospect, Okun's original estimate of 3.5 percent appears to have been a more reasonable estimate of potential output growth throughout the 1960s, after all.

As overly optimistic as the assessment of the economy's potential proved to have been, the mismeasurement of potential output during the 1960s was almost trivial relative to the subsequent errors. Following the democratic loss of the White House in 1968, the caution exhibited by the Council's estimates of the economy's potential gave way to greater, and unfortunately unwarranted, optimism. Emboldened by the growth performance of the economy during the 1960s, Nixon's Council adopted less

[17] The real significance of this parenthetical remark will become evident in the context of the Nixon Council assessments of full employment that I discuss below.

conservative estimates of potential output. From 1970 to 1973, the Council adopted a 4.3 percent potential output growth estimate for the 1970s. Amazingly, the 1970 Economic Report of President also reflected a temporary reduction in the Council's estimate of the rate of unemployment consistent with full employment, from 4 percent to 3.8. The Council prudently abandoned this lower estimate rather quickly, returning to the original assessment of 4 percent. And over the next several years, the issue became one of questioning the optimism reflected in the assessment of the economy's potential and a gradual downgrading of expectations.

In a way, 1970 marked a change in the tide. In a series of steps, estimates of both the natural rate of unemployment and the natural growth of output became gradually more pessimistic and the Council's estimates of potential output were brought down. Figure 11, shows the effects of these changes on historical estimates of the output gap based on the data published in the Economic Report of the President in 1973, 1976, 1977 and 1979, compared to the current data. (For each year, the estimates shown were published in January or February of that year, so the data upon which the analysis underlying the potential output estimates would have been as of the end of the previous year.) The most striking element in these revisions is that despite moving in the right direction throughout the decade, the mismeasurement of the output gap worsened during the first half of the decade. As early as 1972 the Council recognized that the confidence with which they could provide estimates of the economy's potential had deteriorated but this did not result in any significant progress. The energy crisis in 1973 and 1974 compounded the problem and raised the degree of uncertainty regarding the measurement of potential output. Not only additional complexities regarding the treatment of energy became apparent, the underlying national income accounts data became less reliable as well.[18] By 1976, the Council recognized that a major revamping of its estimates was required. The resulting revision was presented in the 1977 Economic Report of the President. The new estimates provided a drastic correction to the mismeasurement problem. The size of the revision was substantial. It implied that output for the previous year (1976) was four percentage points closer to potential than the earlier estimates had suggested.[19] As large as it was, this revi-

[18]The problems with the underlying GNP data led the Office of Management and Budget to establish The Advisory Committee on GNP Data Improvement which provided a comprehensive evaluation of the underlying data and led to a subsequent effort to improve their measurement. (United States Department of Commerce, 1977). Of course the Council was intimately aware of these difficulties, especially after a member of the Advisory Committee, Alan Greenspan, became Chairman of Ford's Council.

[19]Peter K. Clark (1977), presented details of the underlying methodology for the Council's new estimates following a request made at the Congressional Hearings. As could be anticipated follow-

sion only corrected about half of the problem, as it appears from today's perspective. But again, this could not have been known in 1977. Although at the time it was widely recognized that the 1976 estimates of potential output overstated the economy's capacity, the extent of the overstatement was a matter of controversy and the Council's new estimates were well within the range of reasonable alternatives. Thus, while Rasche and Tatom (1977) provided somewhat lower estimates of potential output than the Council's, Perry (1977) suggested somewhat more optimistic estimates. Unsurprisingly, none of these estimates was anywhere as pessimistic as the present perspective would suggest would have been appropriate.

The most fascinating element of the Council's 1977 analysis, however, was the identification of the sources of the mismeasurement of the output gap since the late 1960s. One source was not difficult to identify. The rate of unemployment consistent with full employment had drifted upwards during the decade. Another important source of mismeasurement, however, was a dramatic drop in labor productivity growth. As noted in the 1977 Report, while productivity growth in the private sector had averaged 3.3 percent per year from 1948 to 1966, between 1966 and 1973 the productivity growth rate had fallen to only 2.1 percent and if anything, appeared to have fallen even further after 1973. Since it was not yet possible to accurately separate the cyclical influence of the 1974 recession from the additional suspected long-run trend change in productivity after 1974, most of the Council's analysis concentrated on the pre-1974 slowdown.

In retrospect, much of the systematic mismeasurement of the output gap estimates could be squarely attributed to a delay in recognizing that the underlying trend of labor productivity had shifted unfavorably in the late 1960s. And that was in 1977. By 1979, the additional data validated the suspicion of a further slowdown after 1973, leading to the last revision in the estimates shown in Figure 11. Estimates of productivity growth subsequently fell even further, so much in fact that most current discussions concentrate on the slowdown after 1973 without mention of the deterioration of the late 1960s and early 1970s.[20] Unsurprisingly, this disappointing performance led to the further revisions in potential output that now suggest that, despite their best efforts, the Council's revisions even during the late 1970s were far

ing such a major downward revision in the estimates of the nation's productive capacity, Council Chairman Greenspan faced an unusually intense questioning by the members of the Joint Economic Committee.

[20] Compare, for instance, Chart 3 in the 1977 Report which suggests a single break in productivity after 1967 with Chart 2-5 in the 1996 Report which suggests instead a single break after 1973.

too optimistic after all.

In summary, the systematic mismeasurement of the economy's productive capacity during the late 1960s and 1970s is hardly surprising. After all, accurate measurement would have required information about what is appropriately known as Solow's *residual*, following Robert Solow's (1956) seminal growth accounting decomposition. The accuracy of our measurement, then, should reflect the accuracy of what Moses Abramovitz (1956) aptly characterized as a "measure of our ignorance."

8 The View from Constitution Avenue

Given the obvious difficulties associated with striving to achieve an ill defined full employment objective and given the Federal Reserve's undisputed responsibility for maintaining price stability, a natural question is whether FOMC actions during the late 1960s and 1970s could have been guided by an activist stabilization objective.

A superficial answer would be in the affirmative. As Figure 9 and the interpretation of the Great Inflation offered in section 6 suggest, Federal Reserve policy could indeed be characterized as consistent with a misguided activist strategy indistinguishable from following a rule such as Taylor's, based on the aggregate activity and inflation measures available to the FOMC in real-time. But appearances can be misleading. Of course, as explained earlier, many recent studies would suggest that true activism would have called for placing much greater emphasis on the output gap, a policy at least as ambitious as what would be suggested by the Revised Taylor rule. More to the point, however, this characterization would require the FOMC to actually base their policy decisions on measures of economic activity that the FOMC should perhaps have known could not be relied upon.

A closer look at the record suggests that the FOMC recognized the difficulties associated with the measurement problem. But not all FOMC members were equally distrustful of the data and, indeed, all were exposed to and faced the risk of being misled by what turned out to be a massive measurement error. And although, based on the glimpses of their discussions that sifted through in the FOMC Memoranda of Discussion, I can conclude that FOMC members shared a desire to maintain a stable currency, many members would also argue in favor of using policy to stimulate the economy during recessions. And this secondary objective did make the FOMC

vulnerable to the measurement problems.

Nobody would accuse Chairman Martin as being a slave to naive data-based policy prescriptions. As Maisel later noted: "The press frequently reported Martin's dismay over the number of economists appointed to the Board. He felt that the economy was too complex to explain in detail; *intuition would be lost and false leads followed if too much stress were put on measurement.*" (p. 114, emphasis added.) Being one of these "economists," Governor Maisel often stressed his disagreement with the Chairman on this issue. He also noted that the Board of Governors was split on this issue during the late 1960s and that "Chairman Martin led the group who felt that Federal Reserve policy had to remain an art rather than a science." (p. 169.)

In February 1970, Arthur Burns became Chairman of the Federal Reserve Board. A respected academic who had served as Chairman in Eisenhower's Council, and arguably the nation's leading expert on business cycles at the time, Burns joined the Board with impeccable credentials but also an approach to policy that was radically different from Martin's. "Burns's view was almost diametrically opposed to that of Martin. He sees the Federal Reserve as primarily an economic agency which cannot function without a clear view of where the economy is and of what economic policy is necessary to move it closer to the best possible track," Maisel wrote in 1973 (p. 115).

But Burns was no less aware of the significant measurement problems facing policy-makers than his predecessor was. If anything he was much more intimately familiar with at least some of these problems as he had frequently come across them earlier during his career. In a largely forgotten study he published in 1936, Burns had in fact already demonstrated the theoretical impossibility of accurately measuring potential output. And in 1966, he explained in detail the difficulties inherent in interpreting the Council's estimates of the output gap, anticipating correctly much of the confusion associated with the supply issues that only became widely understood after the 1973 oil crisis.

> "However, the Council's calculations of the gap between actual and potential output, quite apart from being fragile, cannot be treated as measures of demand shortages. If aggregate output falls short of its potential, the gap may have nothing to do with any weakness of demand. It may instead reflect obstacles on the side of supply or a failure of the constituent parts of demand and supply to adjust sufficiently to one another. Since the structure of our economy keeps changing, these changes as well as difficulties on the demand side must be reckoned with in a scientific diagnosis." (p. 28.)

Although possibly as distrustful of the usefulness of the output gap as Martin was, however, Burns did pay attention to the closely related gap between unemployment and the natural rate and consequently did remain vulnerable to the measurement problem. Further, he did differ fundamentally from Martin in that he believed that he had a solid grasp of business cycle and inflation dynamics. In part, this was justified, based on his previous experience. Unfortunately, in one particular dimension he proved to be wrong.

In retrospect, the policy mistakes of the 1970s started with Burns' very first FOMC meeting, on February 10, 1970. The consensus at the Federal Reserve during the previous year and leading to Chairman Martin's last meeting was that the main problem facing the economy was inflation. With the conclusion of the year, inflation data became available for 1969. The situation was not encouraging. For the first time since 1951, inflation as measured by the implicit output deflator had risen by over four percentage points. The Federal Reserve had tightened policy drastically during 1969, raising the federal funds rate by almost four percentage points. In doing so, policy had succeeded in stemming the unexpectedly rapid growth of the economy during 1968 leading to a period of essentially no output growth. By the third quarter of 1969, this had already caused a welcome reversal in output gap estimates which had earlier indicated an overheated economy. Although the tightening was expected to be accompanied by some increase in the rate of unemployment, the predominant concern of reducing inflation led to a consensus that the relatively tight policy needed to be maintained going into 1970. This policy was adopted by unanimous vote during Chairman Martin's last meeting on January 15, 1970.

Coming from the National Bureau of Economic Research, Burns was tuned into the cyclical indicators of the performance of the economy and arrived at the Board with a great concern. A recession loomed large on the horizon. And Burns strongly believed that if a recession had already started, that would be sufficient to reverse the inflationary tendencies of the economy, based on the experience of earlier recessions. As a result, he suggested the FOMC ease policy. According to the Memorandum of Discussion:

> "[Chairman Burns] personally arrived at that position partly on the basis of an independent study he had made of the current state of the economy. As he assessed the evidence, it was consistent with the hypothesis that the economy was now entering a recession, although it did not prove that to be the case. He thought the Committee could not ignore that possibility." (1970, p. 208-209.)

Chairman Burns' view did not go uncontested and was especially challenged throughout the meeting by FOMC Vice Chairman Hayes:

> "Mr Hayes said it was not at all clear to him that a shift in policy was needed now. The Committee's greatest mistakes in the past, he thought, had resulted from moving too soon. At the moment inflation appeared to be a greater risk than recession; from the evidence available so far, any recession was likely to be quite mild." (1970, p. 212-213.)

But after what appears to have been a heated debate, the new Chairman had won his first battle. With an unusual three dissenting votes, the FOMC agreed to start easing policy. And despite continuing concerns from several members, policy was eased further in a number of steps during 1970.

Later the NBER confirmed that a recession had indeed started in December of 1969. A peculiar feature of the 1970 recession, however, quickly became increasingly difficult to interpret. Contrary to expectations inflation kept creeping up. This despite worsening unemployment, falling capacity utilization measures and an opening of the output gap. Indeed, the gap, which had already turned negative in the third quarter of 1969, remained negative through 1970 and into 1971. Something, had gone terribly wrong.

In retrospect, of course, all is perfectly clear. The utilization measures were exceedingly misleading. Despite the usual connotations associated with the NBER calling this episode a recession, the behavior of the economy in 1970 looked more like a somewhat bumpy landing from a state of unsustainably high economic activity to a more or less normal state of affairs. In no quarter did the unemployment rate exceed six percent. Surely, this was a disturbing figure for those associating full employment with a four percent rate, but it is totally unremarkable from today's perspective. And contrary to the prevailing view at the time, output hardly fell below potential based on what we now know. Of course, all these measures appeared very different then.

Moreover, the 1970 recession was the first in the era of the new economic policies, and marked the first such episode following a period of low but sustained and continuing inflation. None of the econometric models of the time could have predicted the outcome based on earlier similar episodes because no truly comparable episodes could be identified. 1970 must have been an extremely disturbing year for the new Chairman.

Unfortunately, by easing policy in 1970, the Federal Reserve missed the opportunity

to reap the benefits of the 1969 tightening to eradicate the increasingly more virulent inflation. Even worse, Chairman Burns misinterpreted the causes of the 1970 economic outcomes. In retrospect, the faulty assessment of the economy's productive capacity seriously misled him. He explained his predicament during a Congressional testimony in July of 1971:

> "A year or two ago it was generally expected that extensive slack in resource use, such as we have been experiencing, would lead to significant moderation in the inflationary spiral. This has not happened, either here or abroad. The rules of economics are not working in quite the way they used to. Despite extensive unemployment in our country, wage rate increases have not moderated. Despite much idle industrial capacity, commodity prices continue to rise rapidly." (Burns, July 1971, p. 656)

A natural response to a situation interpreted as a change in the rules of economics is to seek new remedies. In August 1971, with Burns' encouragement, President Nixon imposed price controls on the economy. Aside from proving to be bad policy that did not resolve the inflationary situation, the price controls proved rather unfortunate in that they distorted the very information that could be used to reassess what was wrong with the underlying economic assumptions. An unintended side-effect of the controls was to impede efforts that could have led the Council to improve their "official" estimates of the economy's potential. Consequently, to the extent policy continued to be influenced in any way by the faulty measurement of potential output and the uncertainty about the natural rate of unemployment, the error was becoming worse. In a sense, bad policy and bad measurement were reenforcing each other.

Going into 1973, policy was decidedly too expansionary and remained so for too long. Despite an attempt to reverse course with tighter policy, inflation was headed to frustrating higher levels—even without an influence from the oil embargo which came later, in November. Following the oil shock, the policy problem became decidedly more complex as policy choices now involved invariably bad and rapidly deteriorating alternatives. In 1974, the Council succinctly summarized the success of the various programs targeted at containing inflation and the outlook for the future as follows: "Inflation seemed a Hydra-headed monster, growing two new heads each time one was cut off." (p. 21). But by then, the major policy errors had already been committed.

Shortly after he left the Federal Reserve, Burns explained the role of mismeasurement in precipitating the policy errors of the early 1970s. The first element appeared in

a rather circumspect paragraph in his aptly titled lecture "The Anguish of Central Banking."

> "In a rapidly changing world the opportunities for making mistakes are legion. Even facts about current conditions are often subject to misinterpretation. Even before World War II ended, some economists were trying to determine how much frictional and structural unemployment would exist when the demand for labor and the supply of labor were in balance; in other words, the rate of unemployment that would reflect a state of full employment. Before long, a broad consensus developed that an unemployment rate of about 4 percent corresponded to a practical condition of full employment, and that figure became enshrined in economic writing and policymaking. Conditions in labor markets, however, did not stand still. ... The unemployment rate corresponding to full employment is now widely believed to be about 5 1/2 or 6 per cent, and this year's report of the Council of Economic Advisers appears to concur in that judgment. But governmental policymakers, while generally aware of what was happening in the labor markets, were slow to recognize the changing meaning of unemployment statistics, whether viewed as a measure of economic performance or as a measure of hardship. The Federal Reserve did not escape this lag of recognition and, once again, I believe that other central banks at times have made similar mistakes." (Burns, 1979, p. 17)

Plainly and justifiably, Burns was suggesting that the FOMC was in good company when it incorrectly based policy on an incorrect natural rate assumption. In a later speech, after first repeating the role of faulty measures of the natural rate, he provided the final piece solving the puzzle:

> "A second major reason for the grave inflation that got under way in the late 1960's is the flattening out of the historical upward trend in output per man-hour of our nation's workshops. " (1981, p. 9.)

9 Prudent Policies

The major problem with activist policies such as the Taylor rule is that they prescribe that the FOMC react to the level of underutilization or overutilization of the economy's potential. Successful implementation of such policies requires accurate measurement about the economy's potential which is simply not available with high confidence and, as just demonstrated, plainly invites policies that could lead to disaster.

But alternative policies can be designed that avoid reacting to the levels of slack in the economy as measured by output, employment or any other economic-capacity-related indicators. Instead, these policies can simply target objectives that policymakers

can be more confident about attempting to achieve over intermediate horizons, while simultaneously not losing sight of the central bank's primary objectives.

The background for designing such policies is far from new. Even before the ambitious stabilization policies that started in 1961, many economists, notably Milton Friedman, had identified the likely problems of activist policies and advocated the need for a more balanced and much less activist approach. Following the experience of the 1960s and 1970s, other economists, including many who had earlier been more optimistic, recognized the wisdom of adopting less ambitious stabilization objectives. For instance, Arthur Okun agreed that "[policymakers] do not serve the nation well if they concentrate on output and employment targets—whether the objective is set forth as achieving full employment, the natural unemployment rate, or potential GNP." (1981, p. 354.) Rather, he concluded, an efficient macroeconomic strategy could be designed based on "adoption of the objective of growth in nominal GNP." (p. 357.) Concentrating on nominal income for guiding policy appeared to evolve into a strategy with many proponents seeking to balance the desire for reasonable economic performance against the temptation of excessive activism.[21]

Milton Friedman and, later on, other monetarists advocated concentrating attention on stable money growth targeting in order to achieve this balance. An advantage of money growth targeting rules is that at one extreme they encompass a useful benchmark of complete passivity—a "k-percent" money growth rule that rules out completely the policymaker's possible temptation for ambitious stabilization goals. A serious disadvantage that has discouraged policymakers from entertaining such policies in the U.S., however, is the unpredictability of velocity that at times decouples stable money growth from stable income growth. Of course, less extreme strategies can also be designed, such as Meltzer's (1987) and McCallum's (1987) proposals to adjust the money growth targets in a way that reduces the adverse consequences of possible velocity shifts. As well, prudent policies that forego a full employment stabilization objective in favor of a more balanced approach geared towards robust stability can also be stated in terms of interest rates. As an illustration, I investigate two such simple alternatives here, and compare their performance to the activist policies I examined earlier.[22]

[21] See, for instance, McCallum (1985) and the comments by Tobin (1985) regarding the usefulness of concentrating on nominal GNP growth.

[22] McCallum (1998), offers an enlightening discussion that relates closely to some of the issues raised here. In particular, he discusses in detail the potential drawbacks of rules that target the output gap, such as the Taylor rule, and forcefully argues in favor of rules that target nominal income. He also

9.1 Two Alternatives for a Prudent Policy Rule

The first, and simplest alternative is a strategy that requires that the FOMC respond only to current inflation developments in the economy. An operational specification of this well known strategy written in the form of a simple policy rule would be:

Inflation Targeting

$$R_t - R_t^* = \theta(\pi_t^a - \pi^*) \tag{10}$$

Surely, such a policy will, at times, appear to be inadequately addressing concerns regarding real activity in the economy. This weakness, however, also reflects the major strength of inflation targeting. This policy is completely immune to the mismeasurement errors that can occasionally contaminate, and at times by substantial amounts, what would otherwise appear to be more promising activist policies. The remaining errors, those associated with the measurement of inflation, are much smaller.

A second alternative is to concentrate on strategies that attempt to stabilize the growth of nominal income relative to the natural growth rate of nominal income in the economy. Such a strategy relates closely to the widely discussed policies of targeting nominal income. Let n_t^a be the growth rate of nominal income over four quarters ending with the current quarter and n_t^* the natural growth rate of nominal income over the same period. Then, written in the form of a simple policy rule, this strategy is:

Natural Growth Targeting

$$R_t - R_t^* = \theta(n_t^a - n_t^*) \tag{11}$$

By definition, the natural growth rate of nominal income in the economy, n^*, is the sum of the inflation target and the rate of growth of potential output—the natural growth rate of output. If the rate of growth of potential output were equal to a known constant, this rule would obviously be equivalent to nominal income growth targeting. But of course, potential output growth does vary somewhat in practice, so it is sensible to vary the targeted natural rate of growth with it. As well, targeting the natural growth rate resolves the related implementation problem associated with identifying the appropriate fixed growth rate or path for nominal income required for nominal income targeting. In this sense, natural growth targeting can be viewed as a somewhat more flexible and strictly operational formulation of a nominal income

compares the use of the monetary base and the federal funds rate as instruments for nominal income targeting.

growth targeting strategy.

The natural growth targeting rule can also be decomposed and written in terms of the two components of nominal income growth, n, namely inflation and output growth. Furthermore, the deviations of real output growth from the real natural growth rate can be simply expressed as the annual change in the output gap. Thus, the rule can be re-written as:

$$R_t - R_t^* = \theta(\pi_t^a - \pi^*) + \theta\Delta^a y_t$$

Once this is recognized, a more general family of natural growth targeting rules can be introduced that allows for different interest rate responses to the inflation and real natural growth gaps.

$$R_t - R_t^* = \gamma(\pi_t^a - \pi^*) + \delta\Delta^a y_t \tag{12}$$

Obviously, this strategy is more vulnerable to measurement problems than inflation targeting since, in practice, policymakers are uncertain about the natural growth rate of the economy. However, the extent of this mismeasurement is likely much smaller than that for the output gap itself.

Figure 12 demonstrates the empirical validity of this presumption. The figure compares the change in the output gap over four quarters as it appeared in real-time (dashed line) and in the final data (solid line.) The information is directly comparable to the data shown in figure 4 for the output gap. As shown in figure 12, there are, at times, significant errors in the measurement of the deviation of real income growth from the natural growth rate. Not unexpectedly, the worst errors in the data appear right after the first oil shock, in 1974 and 1975. However, overall these errors are considerably smaller—by an order of magnitude—than the corresponding errors in the measurement of the output gap, shown in figure 4.

It is worthwhile noting that neither the inflation targeting rule nor the natural growth rate targeting rule is "passive," since in each case the Federal Reserve is required to change the federal funds rate in response to deviations of inflation or income growth from their desired targets. But as Okun (1970) remarked, "[P]assivity in economic policy is a meaningless objective. The only meaningful goal is stability in the growth of the economy" (p. 118). What is of fundamental importance is that these rules are decidedly non-activist in that they do not respond to resource gap levels despite the fact that policymakers may ultimately value maintaining the level of output as close

as possible to the economy's elusive potential.

Finally, in implementing either of these rules, equation (3) can be used as a proxy for the nominal neutral level of interest, again recognizing that this is not an innocuous choice and is also subject to error.

9.2 Inflation Targeting

In figures 13 and 14, I present counterfactual simulations of the economy based on policy following the inflation targeting rule (10). My purpose is not to design the most efficient such rule based on the estimated model but rather to allow for a useful comparison with the activist rules examined in sections 3 and 4. Consequently, I concentrate my attention to a parameterization that sets the responsiveness parameter in the rule, θ, equal to one half. As well, I retain the assumptions that the natural rate of interest and inflation target equal two percent. The resulting inflation targeting rule then is directly comparable to the Taylor rule (4). The inflation targeting rule in the simulations reacts to inflation in an identical fashion as the Taylor rule but, unlike the Taylor rule, it does not respond to the output gap at all.

Because data revisions are much less important for the dynamics of inflation and output when only the noise regarding inflation distorts policy decisions, the resulting simulated paths shown in figures 13 and 14 do not differ by nearly as much as the corresponding paths under the activist policies. Obviously, had an inflation targeting rule been adopted starting in 1965, the Great Inflation would have been avoided, even considering the inflation measurement problems shown in figure 3. However, as the counterfactual output paths suggest, this policy would have caused a rather deep recession following the 1973-74 oil crisis. And in the 1980s, it would have allowed output to exceed potential for many years.

Figure 15 shows the policy prescriptions corresponding to the inflation targeting rule based on real-time and final data. The difference between the real-time and final data based prescriptions are fairly small by comparison to the Taylor rule, but they still exceed 100 basis points in many quarters. An inflation targeting rule would have called for significantly tighter policy during most of the Great Inflation period. However, during the 1980s, the contours of the prescriptions from this inflation targeting rule are roughly similar to the contours of actual policy.

9.3 Natural Growth Targeting

Figures 16 and 17, present counterfactual simulations of the economy based on policy following a natural growth targeting rule. To retain simplicity and comparability, I only examine the simpler variant of natural growth targeting here, (11), and again use one half as the value of the response parameter, θ. I also retain the assumptions that the natural rate of interest and inflation target equal two percent. Natural growth targeting would also have been successful in containing inflation during the 1970s and without as deep a recession as the inflation targeting rule would have created. However, during the late 1980s this rule would have produced a pickup in inflation about two percentage points higher than what actually occured. One reason for this discrepancy can be seen in Figure 17. The natural growth targeting rule would have permitted output to inappropriately exceed potential for many years during the 1980s without responding sufficiently to dampen its inflationary impact. This result is due to the fact that this rule only reacts to deviations of growth from the natural growth rate, ignoring the level of the gap. Despite this difference, inflation would have peaked at just over six percent in 1989-90, considerably below the nine percent level that the Taylor rule would have yielded in 1989 had it been followed in real time.

The prescriptions from the natural growth targeting rule based on the real-time and final data are shown in figure 18. As expected, by avoiding reliance on the output gap, the rule would have prescribed considerably higher rates than actual policy during the 1970s. Another interesting observation is that based on this data, policy prescriptions based on the natural growth targeting rule from 1979 to 1991 track the contours of actual policy rather closely. I return to this observation shortly.

9.4 A Summary Comparison of the Activist and Prudent Policies

Figure 19 summarizes the performance of the four alternative policy rules based on the counterfactual simulations with and without noise. The concentric circles represent iso-loss surfaces for a policymaker who places equal weight of output and inflation stabilization. Relating the performance of each rule to the iso-loss surfaces facilitates comparison of the performance of the alternative rules. To evaluate performance, for each simulation I compute the root mean square errors of the simulated final output gap and simulated final inflation deviations from the assumed two percent target from 1966:1 to 1993:4.

Comparing the rules without noise (solid squares and diamonds) indicates that the

two activist rules perform better than the prudent rules. In simulation, both the Taylor and the Revised Taylor rule yield both better inflation and better output stability than either the natural growth rule or the inflation targeting rule. Comparing the original Taylor with the Revised Taylor rule also confirms that with perfect hindsight, the Revised Taylor rule dominates by producing both better inflation and better output stability. However, once we account for the noise in the data, these conclusions are reversed. As shown by the blank squares and diamonds, the Revised Taylor rule actually yields the worst performance in this case and both the Taylor rule and Revised Taylor rule in fact do far worse than the actual performance of the economy, shown by the star.

The comparison is also instructive for explaining why earlier attempts have failed to identify why nominal income targeting strategies might hold promise. A number of earlier studies have attempted to compare the performance of nominal income targeting relative to hybrid targeting which concentrated in part on the output gap—as in the Taylor rule.[23] Invariably, the simulation comparisons in these studies have indicated that the hybrid rules performed better in terms of stabilizing inflation and output lending support to the view that targeting inflation and the output gap directly is likely superior to just relying on nominal income. However, all of those comparisons were based on the assumption of perfect information. And in these terms, my results confirm those findings. When I compare the Taylor rule with either the inflation targeting or natural growth targeting rule under the unrealistic assumption of perfect information, the Taylor rule appears superior. But once the realistic informational limitations facing policy makers in practice are introduced, this conclusion is shown to be incorrect. With realistic information, the performance of the U.S. economy from 1966 to 1993, would have been considerably better with either the inflation targeting rule or the natural growth targeting rule than with the Taylor rule.

The implications are obvious. If policymakers could be confident that they can correctly assess the economy's potential, then activist policies might indeed be sensible. But if policymakers believe the data at present are as likely to yield an unreliable indication of the present economic situation as history over the past thirty years suggests, then it is best to avoid activist policies altogether.

[23] These studies include Taylor (1985), several of the contributions in Bryant, Hooper and Mann (1993), and Hall and Mankiw (1994).

10 Rules versus Discretion and Prudence versus Overconfidence

Simple rules, including the activist as well as the prudent policy rules just compared, can provide guidance to policymakers even if they are not blindly followed at all times. Conversely, interpreted as simple policy-reaction functions meant to describe historical discretionary policy, simple rules can help us organize our understanding of the goals and strategies guiding historical decisions.

As an even casual reading of the FOMC's historical decision making record would indicate, at no time during the period I examine did monetary policy in the U.S. blindly adhere to any specific monetary policy rule. In this sense, policy was discretionary.[24] As pointed out, first by Taylor (1993) and many others since, the decisionmaking outcomes during the late 1980s and early 1990s could be interpreted as broadly consistent with the FOMC following the Taylor rule. Following the strategy of identifying what simple rule might be broadly consistent with historical discretionary decisions we can similarly examine the historical record starting in 1965. To that end, figure 20 plots the actual path of the federal funds rate over this period against the prescriptions that the Taylor rule and the natural growth targeting rule would have suggested in each quarter based on the data available to policymakers during that quarter. Broadly, the data suggest that both during the Great Inflation period, from 1965 to 1979, as well as more recently, perhaps from 1989 to 1993, the discretionary policy outcomes were rather similar to what the Taylor rule would have suggested. Also, the data suggest that during both the Volcker disinflation starting in 1979 and the subsequent period, perhaps until 1991, the discretionary policy outcomes were rather similar to what the simple natural growth targeting rule would have suggested.

One lesson from this experience is that simple activist rules can easily be as disastrous as activist discretionary policy. Another is that discretionary policy can potentially achieve outcomes as good as, or perhaps better than those based on simple prudent rules. Fundamentally, it may matter not so much whether policy is driven by rule versus discretion but whether policy reflects prudence versus overconfidence. This indicates the profound importance of appreciating the information problem for successful policy design.

A simple prudent policy rule, such as inflation targeting or natural growth targeting

[24] The brief "monetarist experiment" from late 1979 to 1982 possibly represents the most rule-like period in the sample. See Bernanke and Mihov (1998) and Lengwiler and Orphanides (1998) for a discussion.

can potentially safeguard policymakers against the temptation of excessive activism. Activist discretionary policy as well as activist rules will fail to deliver on their promise when they are based on a false presumption of confidence about the policymaker's understanding of the economy.

However, when the policymaker can be appropriately confident about the structure of the economy and when inflation is already subdued and the risks of an inflationary aberration much reduced, then policy can appropriately afford to constructively entertain the possible benefits of greater activism.[25] This strategy of disciplined discretion requires continued vigilance against mechanical attempts to exploit historical relationships to fine-tune the performance of the economy and an appreciation that the continuing evolution of the economy requires a considerable trimming of stabilization ambitions.

In this light, monetary policy in the United States over the past two decades can be understood as one of disciplined discretion. As Chairman Greenspan explained:

> "The monetary policy of the Federal Reserve has involved varying degrees of rule- and discretionary-based models of operation over time. Recognizing the potential drawbacks of purely discretionary policy, the Federal Reserve frequently has sought to exploit past patterns and regularities to operate in a systematic way. But we have found that very often historical regularities have been disturbed by unanticipated change, especially in technologies. The evolving patterns mean that the performance of the economy under any rule, were it to be rigorously followed, would deviate from expectations. Accordingly we are constantly evaluating how much we can infer from the past and how relationships might have changed. In an ever changing world, some element of discretion appears to be an unavoidable aspect of policymaking." (Greenspan, 1997.)

Monetary policy strategies in many other countries have also exhibited these characteristics of disciplined discretion over the past several years. Specifically, the inflation targeting framework for monetary policy, as adopted in several countries especially during the 1990s can be interpreted as a rule-like framework for providing monetary discipline.[26] Similarly, the monetary policy framework adopted by the European Central Bank, as recently described in detail by Angeloni, Gaspar and Tristani (1999),

[25] As shown by Orphanides (1998), the appropriate degree of policy activism, as measured by the efficient policy response to the current observation of the output gap, may be smaller or larger than what is implied by the Taylor rule depending on the reliability of the measurement of economic performance.

[26] Bernanke and Mishkin (1997), Bernanke et al (1998) and Svensson (1998) offer detailed expositions of inflation targeting in theory and in practice. King (1997) and Vickers (1999) present policymaker perspectives in the context of monetary policy in the U.K.

also appears to reflect the characteristics of disciplined discretion.[27] In each case, the policymaker perspective reflects a primary emphasis to price stability as well as the recognition that the complexities and uncertainty regarding the economic environment must be properly incorporated in the decision making process.

The success of monetary policy in the United States over the past two decades indicates that inappropriate activism has been avoided and that the value of disciplined discretion in formulating policy has been properly recognized. In this sense, the overconfidence which appears to have plagued policy decisions during the 1970s has not systematically distorted policy choices during this time. However, were policy to be guided by a fine-tuning objective once again, be it through inappropriately activist discretion or an inappropriately activist policy rule, a return to the economic outcomes of the 1970s might not be far behind. The recent resurrection of interest in policy activism through rules that rely on accurate knowledge of the economy's "full employment" potential must be recognized for the danger it embodies. Much like during the 1970s, insufficient attention appears to have been paid to the informational limitations inherent in such activist policies. The temptation to substitute overconfidence for prudence in guiding policy decisions cannot be viewed as a positive step in tackling the complex realities faced by policymakers.

11 Concluding Remarks

Although economics is often called the dismal science, many macroeconomists appear to be, if anything, overly optimistic and cheerful about the prospects for improving macroeconomic performance. Armed with models we know are imperfect, having to design policies based on data that we know are at best incomplete and at times exceedingly misleading, and lacking the means for controlled experiments, many continue to search for the promise of improved macroeconomic stability. Such efforts are always welcome. Expectations regarding the likely improvement in policy design that might fruitfully result from such efforts, however, must be scaled down. It is all too easy to be drawn back to the promise of excessively activist monetary policy by the siren song of sustained prosperity without inflation. It is all too tempting to dismiss the failed policies of the past as due to faulty analysis and incompetence that we now know how to avoid. But upon closer examination, strategies identified as new and improved guides for activist monetary policy in recent years bear more similarities to the discredited policies of the past than commonly recognized, and too close a

[27] See Duisenberg (1999) for the corresponding policymaker perspective.

resemblance to those policies for comfort.

This is not to deny that activist policies may at times be entirely appropriate and successful. That may be the case if and when a high degree of confidence regarding our understanding of the workings of the economy is warranted. But such times cannot be easily identified ex ante. A willingness to recognize our ignorance and lower our stabilization objectives accordingly may then be the safest defense against destabilizing fine-tuning.

At the deepest level, the failure of the macroeconomic policies of the 1970s and the need for the dislocation of the early 1980s to restore monetary order were due to the hybris that enough was known to perfect the economy's performance. Arthur Burns had already taught us this lesson in 1967 when he perceptively identified the true origins of the Great Inflation:

> "And so we finally come to the agonizing question: why did the nation's policymakers, who for years had succeeded so well in monitoring a business expansion under difficult conditions, finally unleash the forces of inflation? Why did men who showed the ability to profit from experience succumb to one of the oldest weaknesses of government practice? One reason, I think, is that they were misled by the very success that for a time attended their efforts." (p. 30.)

The continuing fallacy is to downplay the degree of our ignorance and at times perhaps mistake the good fortune of the recent past for wisdom. Must we repeat such errors before we learn to respect the limits of stabilization?

References

Abramovitz, Moses (1956), "Resource and Output Trends in the United States since 1870," *American Economic Review*, 46(2), May, 5-23.

Angeloni, Ignazio, Vitor Gaspar, and Oreste Tristani (1999), "The Monetary Policy Strategy of the ECB," European Central Bank, Manuscript, February.

Baily, Martin Neal (1978), "Stabilization Policy and Private Economic Behavior," *Brookings Papers on Economic Activity* 1, 1-50.

Ball, Laurence (1997), "Efficient Rules for Monetary Policy," NBER Working Paper No. 5952, March.

Barsky, Robert and Lutz Kilian (1998), "Money, Stagflation, and Oil prices: A Re-Interpretation," Manuscript, November.

Bernanke, Ben S., and Ilian Mihov (1998), "Measuring Monetary Policy," *Quarterly Journal of Economics* 113(3), 869–902, August.

Bernanke, Ben S., and Frederic S. Mishkin (1997), "Inflation Targeting: A New Framework for Monetary Policy?" *Journal of Economic Perspectives*, 11(2), 97-116.

Bernanke, Ben, Thomas Laubach, Frederic Mishkin and Adam Posen (1998), *Inflation Targeting: Lessons from the International Experience*, Princeton: Princeton University Press.

Black, Stanley, and Robert Russell (1969), "An Alternative Estimate of Potential GNP," *The Review of Economics and Statistics*, 51(1), 70-76, February.

Blinder, Alan (1996), "On the Conceptual Basis of Monetary Policy," Remarks at the Senior Executives Conference of the Mortgage Bankers Association, New York, January 10.

Brunner, Karl (1985), "Monetary Policy and Monetary Order," in *Monetary Policy and Monetary Regimes*, Center for Research in Government Policy and Business, Number CS-17, Rochester, N.Y.: Graduate School of Management, University of Rochester.

Bryant, Ralph C., Peter Hooper and Catherine Mann eds. (1993), *Evaluating Policy Regimes: New Research in Empirical Macroeconomics*, Washington DC: Brookings.

Burns, Arthur (1936), "The Brookings Inquiry into Income Distribution and Progress," *Quarterly Journal of economics,* 50(3), 476-523, May.

Burns, Arthur (1957), *Prosperity Without Inflation*, New York: Fordham University.

Burns, Arthur (1966), "Aggregate or Structural Approaches to Achieving Employment Act Objectives," in *Twentieth Anniversary of the Employment Act of 1946,* Hearings Before the Joint Economic Committee, Congress of the United States, United States Printing Office, Washington, DC.

Burns, Arthur (1967), "First Lecture," in Burns and Samuelson (1967).

Burns, Arthur (1971), Statement before the Joint Economic Committee, July 23. (Reprinted in *Federal Reserve Bulletin*, August 1971, 655-662.)

Burns, Arthur (1979), *The Anguish of Central Banking*, The 1979 Per Jacobsson Lecture, Belgrade, Yugoslavia, September 30.

Burns, Arthur (1981), "Regaining a Stable Price Level," The Founder's Day Address, Xavier University, Cincinnati, Ohio, May 7. (AEI Reprint No. 124, August, 1981.)

Burns, Arthur and Paul Samuelson (1967), *Full Employment, Guideposts and Economic Stability*, American Enterprise Institute, Washington, D.C.

Clarida, Richard, Jordi Gali, and Mark Gertler (1998), "Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory," NBER Working Paper, No, 6442, March.

Clarida, Richard, Jordi Gali, and Mark Gertler (1999), "The Science of Monetary Policy," Manuscript, January.

Clark, Peter K. (1977), "A New Estimate of Potential GNP," in *The 1977 Economic Report of the President*, Hearings before the Joint Economic Committee, Congress of the United States, U.S. Government Printing Office, Washington, D.C.

Council of Economic Advisers (Various Years), *Economic Report of the President*, U.S. Government Printing Office, Washington, D.C.

De Long, Bradford (1997), "America's Only Peacetime Inflation: The 1970's," in Romer and Romer, eds, (1997).

Duisenberg, Willem (1999), "Monetary Policy in the Euro Area," Speech at the Chamber of Commerce and Industry, Frankfurt am Main, January 25.

Estrella, Arturo, and Frederic Mishkin (1998), "Rethinking the Role of NAIRU in Monetary Policy: Implications of Model Formulation and Uncertainty," NBER Working Paper, No. 6518, April.

Federal Open Market Committee (Various Years), *Memorandum of Discussion*, Federal Reserve Board, Washington, D.C.

Fischer, Stanley (1990), "Rules Versus Discretion in Monetary Policy," in B. Friedman and F. Hahn (eds.), *Handbook of Monetary Economics,* North-Holland, Amsterdam.

Friedman, Milton (1947), "Lerner on the Economics of Control," in Friedman (1953).

Friedman, Milton (1953), *Essays in Positive Economics*, Chicago: University of Chicago.

Friedman, Milton (1969), *The Optimum Quantity of Money and Other Essays*, Chicago: University of Chicago.

Gordon, Robert (1997), "The Time-Varying NAIRU and its Implications for Economic Policy," *Journal of Economic Perspectives*, 11(1), 11-32, Winter.

Greenspan, Alan (1997), "Remarks at the 15th Anniversary Conference of the Center for Economic Policy Research at Stanford University," September 5.

Hall, Robert and N. Gregory Mankiw (1994), "Nominal Income Targeting," in Mankiw (1994).

Heller, Walter, Kermit Gordon, and James Tobin (1961), "The American Economy in 1961: Problems and Policies," in *January 1961 Economic Report of the President and the Economic Situation and Outlook*, Hearings before the Joint Economic Committee, Congress of the United States, U.S. Government Printing Office, Washington, D.C.

Hetzel, Robert (1998), "Arthur Burns and Inflation," *Federal Reserve Bank of Richmond Economic Quarterly*, 84(1), 21-44, Winter.

Judd, John and Glenn Rudebusch (1998), "Taylor's Rule and the Fed: 1970-1997," *Economic Review, Federal Reserve Bank of San Francisco*, 1998, Number 3, 3-16.

King, Mervyn (1997), "The Inflation Target Five Years On," Lecture delivered at the London School of Economics, October 29.

King, Robert and Mark Watson (1994), "The Post-War U.S. Phillips Curve: A Revisionist Econometric History," Carnegie-Rochester Conference Series on Public Policy, 41, 157-219.

Laxton, Douglas, David Rose and Demosthenes Tambakis (1999), "The U.S. Phillips Curve: The Case for Asymmetry," *Journal of Economic Dynamics and Control* (forthcoming.)

Lengwiler, Yvan, and Athanasios Orphanides (1998), "Optimal Discretion," Manuscript, November.

Levin Andrew, Volker Wieland and John Williams (1998), "Robustness of Simple Policy Rules Under Model Uncertainty," NBER Working Paper, No. 6570, May.

Maisel, Sherman J. (1973) *Managing the Dollar*, W. W. Norton, New York.

Mankiw, N. Gregory (1994), *Monetary Policy*, Chicago: University of Chicago.

Mauskopf, Eileen (1995), "The Monetary Transmission Mechanism in the United States: Simulations Using the Federal Reserve Board's MPS Model," *Financial Structure and the Monetary Policy Transmission Mechanism*, Basle, Switzerland: Bank for International Settlements.

Mayer, Thomas (1999), *Monetary policy and the Great Inflation in the United States: The Federal Reserve and the Failure of Macroeconomic Policy, 1965-1979,* Edward Elgar, Cheltenham.

McCallum, Bennett T. (1985), "On Consequences and Criticisms of Monetary Targeting," *Journal of Money, Credit and Banking*, 17(4), Part 2, November, 570-597.

McCallum, Bennett T. (1987), "Robustness Properties of a Rule for Monetary

Policy," Carnegie-Rochester Conference Series on Public Policy, Volume 29, 175-203.

McCallum, Bennett T. (1998), "Issues in the Design of Monetary Policy Rules," working paper.

McCallum, Bennett T. and Edward Nelson (1998), "Performance of Operational Policy Rules in An Estimated Semi-Classical Structural Model," NBER Working Paper, No. 6599, June.

Meltzer, Allan H. (1987), "Limits of Short-Run Stabilization Policy," *Economic Inquiry*, 25, 1-14.

Meyer, Laurence (1998), "The Strategy of Monetary Policy," The Alan R. Holmes Lecture, Middlebury College, Middlebury, Vermont, March 16.

Okun, Arthur (1962), "Potential Output: Its Measurement and Significance," in *American Statistical Association 1962 Proceedings of the Business and Economic Section*, Washington, D.C.: American Statistical Association.

Okun, Arthur (1970), *The Political Economy of Prosperity*, Brookings, Washington D.C.

Okun, Arthur (1981), *Prices and Quantities: A Macroeconomic Analysis*, Brookings, Washington D.C.

Onatski, Alexei, and James Stock (1999), "Robust Monetary Policy Under Model Uncertainty in a Small Model of the U.S. economy," Manuscript, February.

Orphanides, Athanasios (1997), "Monetary Policy Rules Based on Real-Time Data," Finance and Economics Discussion Series, 1998-03, Federal Reserve Board, December.

Orphanides, Athanasios (1998), "Monetary Policy Evaluation With Noisy Information," Finance and Economics Discussion Series, 1998-50, Federal Reserve Board, October.

Orphanides, Athanasios, and Robert M. Solow (1990), "Money, Inflation, and Growth," in *Handbook of Monetary Economics,* edited by Benjamin M. Friedman, and Frank H. Hahn. Amsterdam: North Holland.

Orphanides, Athanasios, and David Wilcox (1996), "The Opportunistic Approach to Disinflation," Finance and Economics Discussion Series, 96-24, Board of Governors of the Federal Reserve System, May.

Orphanides, Athanasios, and Simon van Norden (1999), "The Reliability of Output Gap Estimates in Real Time." Manuscript, May.

Perry, George (1977), "Potential Output and Productivity," *Brookings Papers on Economic Activity*, 1, 11-47.

Rasche, Robert and John Tatom (1977), "Energy Resources and Potential GNP," *Federal Reserve Bank of St Louis Review*, 59(6), 10-23, June.

Reifschneider, David, Robert Tetlow and John Wiliams (1999), "Aggregate Disturbances, Monetary Policy, and the Macroeconomy: The FRB/US Perspective,"

Federal Reserve Bulletin, 85(1) January, 1-19.

Romer, Christina and David Romer (1997), *Reducing Inflation: Motivation and Strategy*, Chicago: University of Chicago.

Rotemberg, Julio and Michael Woodford (1998), "Interest-Rate Rules in an Estimated Sticky Price Model." NBER Working Paper, No. 6618, June.

Rudebusch, Glenn and Lars Svensson (1998), "Policy Rules for Inflation Targeting." NBER Working Paper, No. 6512, April.

Sack, Brian (1988), "Does the Fed Act Gradually? A VAR Analysis," Finance and Economics Discussion Series, 98-17, Board of Governors of the Federal Reserve System, March.

Sargent, Thomas (1999), *The Conquest of American Inflation*, Princeton: Princeton University Press.

Sims, Christopher (1998), "The Role of Interest Rate Policy in the Generation and Propagation of Business Cycles: What has Changed Since the '30s?" in *Beyond Shocks: What Causes Business Cycles?*, edited by Jeffrey Fuhrer and Scott Schuh, Boston, Federal Reserve Bank of Boston.

Smets, Frank (1998), "Output Gap Uncertainty: Does it Matter for the Taylor Rule?" BIS Working Paper No. 60, November.

Solomom, Robert (1962), "The Full Employment Budget Surplus as an Analytical Concept," in *American Statistical Association 1962 Proceedings of the Business and Economic Section*, Washington, D.C.: American Statistical Association.

Solow, Robert (1957), "Technical Change and the Aggregate Production Function," *Review of Economics and Statistics*, 39(3), 312-20, August.

Staiger, Doug, James Stock and Mark Watson (1997) "How Precise are Estimates of the Natural Rate of Unemployment," in Romer and Romer eds. (1997).

Stein, Herbert (1984), *Presidential Economics*, New York: Simon and Schuster.

Svensson, Lars E. O. (1997), "Inflation Forecast Targeting: Implementing and Monitoring Inflation Targets," *European Economic Review*, 41(6), June, 1111-1146.

Svensson, Lars E. O. (1998), "Inflation Targeting as a Monetary Policy Rule," working paper, August.

Taylor, John B. (1985), "What Would Nominal GNP Targeting do to the Business Cycle?" Carnegie-Rochester Conference Series on Public Policy, Volume 22, 61-84.

Taylor, John B. (1993), "Discretion versus Policy Rules in Practice," Carnegie-Rochester Conference Series on Public Policy, 39, December, 195-214.

Taylor, John B. (1998a),"The Robustness and Efficiency of Monetary Policy Rules as Guidelines for Interest Rate Setting by the European Central Bank," May.

Taylor, John B. (1998b), "An Historical Analysis of Monetary Policy Rules," NBER Working Paper 6768, October.

Taylor, John B., ed., (1999), *Monetary Policy Rules*, Chicago: University of Chicago (forthcoming).

Thurow, Lester, and Lance Taylor (1966), "The Interaction Between the Actual and the Potential Rates of Growth," *The Review of Economics and Statistics*, 47(4), 351-360, November.

Tobin, James (1985), "Comment on On Consequences and Criticisms of Monetary Targeting, or Monetary Targeting: Dead at Last," *Journal of Money, Credit and Banking*, 17(4), Part 2, November, 605-609.

United States Department of Commerce (1977), *Gross National Producet Data Improvement Report*, Report of the Advisory Committee on Gross National Product Data Improvement, U.S. Government Printing Office, Washington, D.C.

Vickers, John (1998), "Inflation Targeting in Practice: The UK Experience," Bank of England Quarterly Bulletin, November, 368-375.

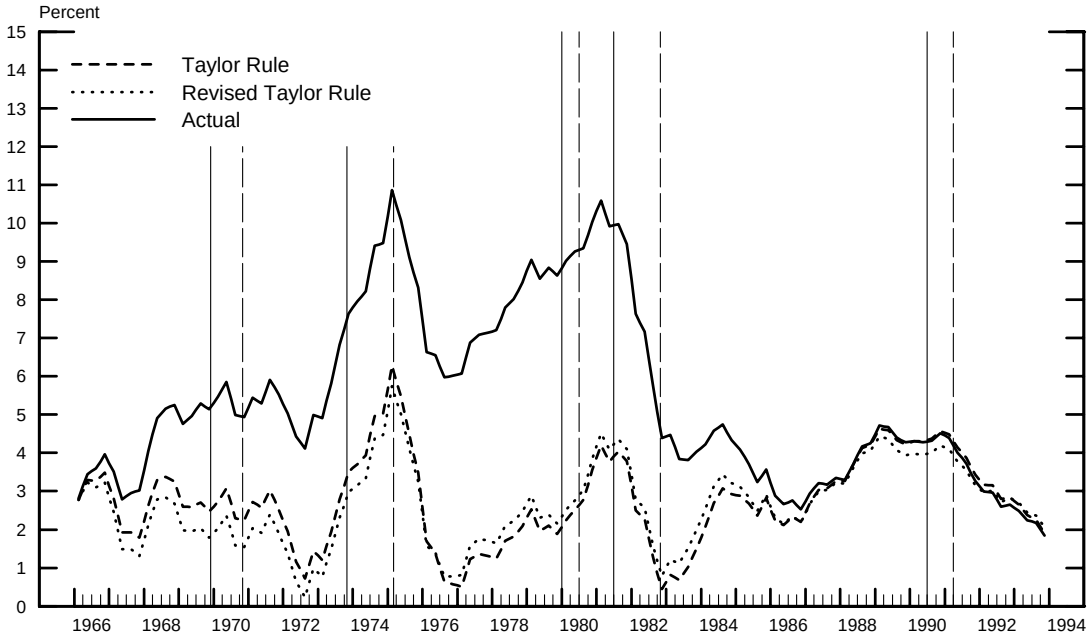
Williams, John C. (1999), "Simple Rules for Monetary Policy," Finance and Economics Discussion Series, 99-12, Board of Governors of the Federal Reserve System, February.

Woodford, Michael (1999) "Optimal Monetary Policy Inertia," Manuscript, January.

Yellen, Janet (1996), "Monetary Policy: Goals and Strategy," *Business Economics*, 31(3), July, 40-44.

Figure 1

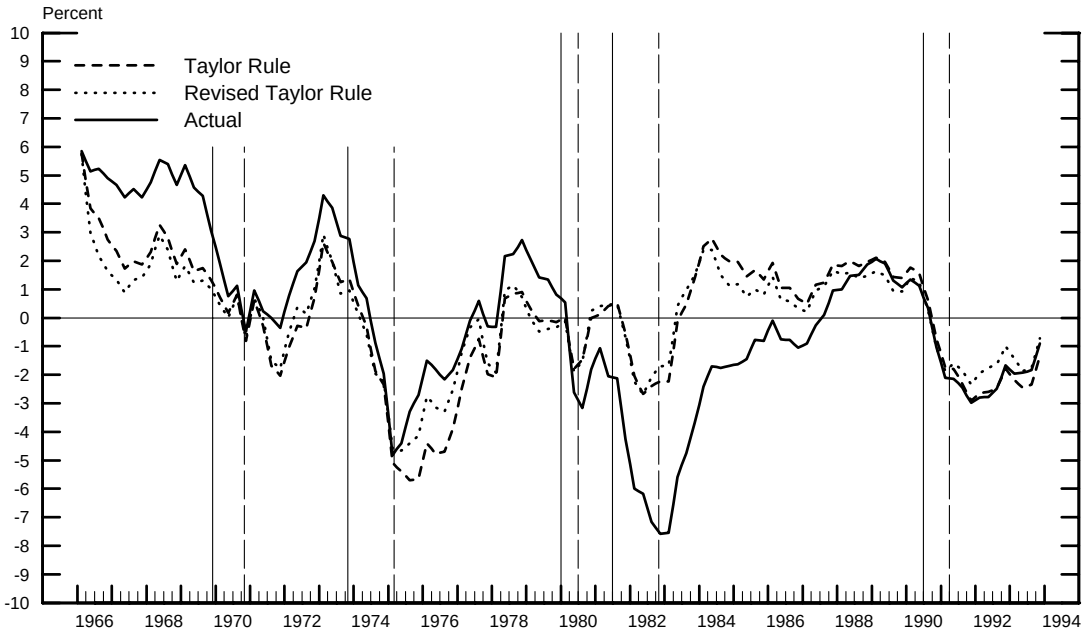
The Promise of Activist Rules: Inflation Dynamic Simulations without Noise



Notes: Inflation is constructed as the rate of change in the implicit output deflator over four quarters. Actual data reflect historical information with data available at the end of 1994. The solid and dashed vertical lines denote NBER business cycle peaks and troughs, respectively.

Figure 2

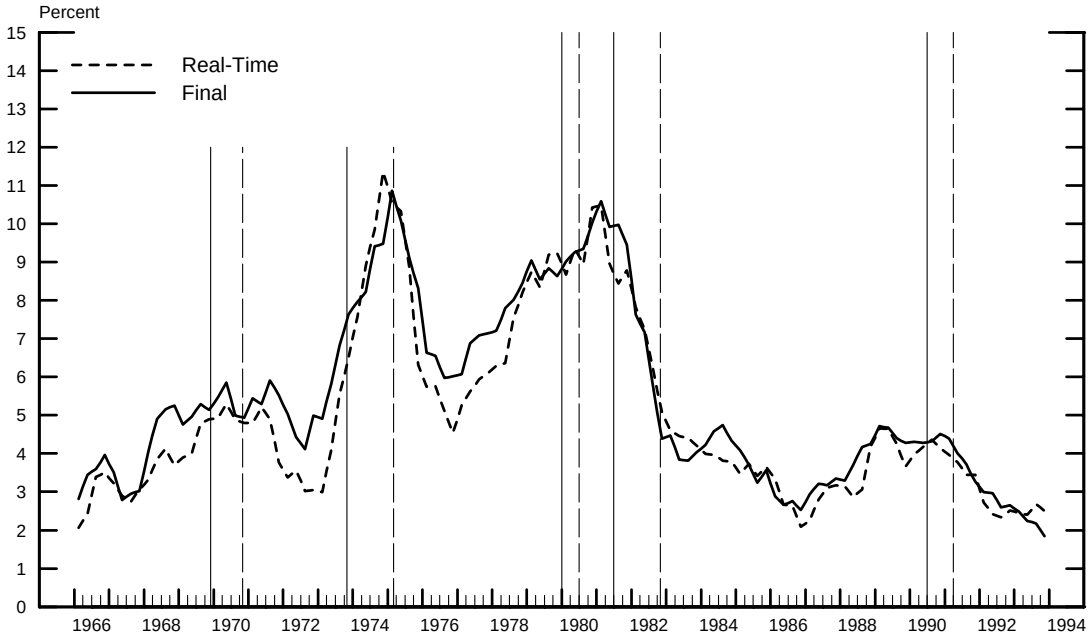
The Promise of Activist Rules: Output Dynamic Simulations without Noise



Notes: The output gap is the difference between real output and potential output, measured as a fraction of potential output using seasonally adjusted quarterly data. Actual data reflect historical information with data available at the end of 1994. The solid and dashed vertical lines denote NBER business cycle peaks and troughs, respectively.

Figure 3

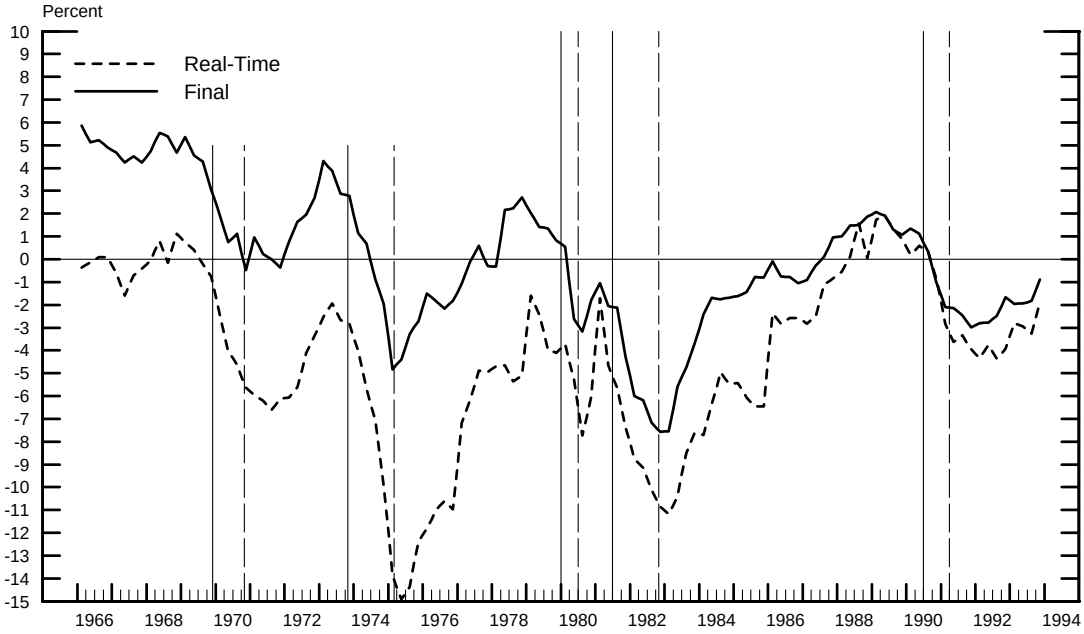
Inflation in Real-Time and Final Data



Notes: Inflation is constructed as the rate of change in the implicit output deflator over four quarters. Real-time data reflect information as of the middle of the quarter shown. Final data reflect historical information with data available at the end of 1994. The solid and dashed vertical lines denote NBER business cycle peaks and troughs, respectively.

Figure 4

The Output Gap in Real-Time and Final Data



Notes: The output gap is the difference between real output and potential output, measured as a fraction of potential output using seasonally adjusted quarterly data. Real-time data reflect information as of the middle of the quarter shown. Final data reflect historical information with data available at the end of 1994. The solid and dashed vertical lines denote NBER business cycle peaks and troughs, respectively.

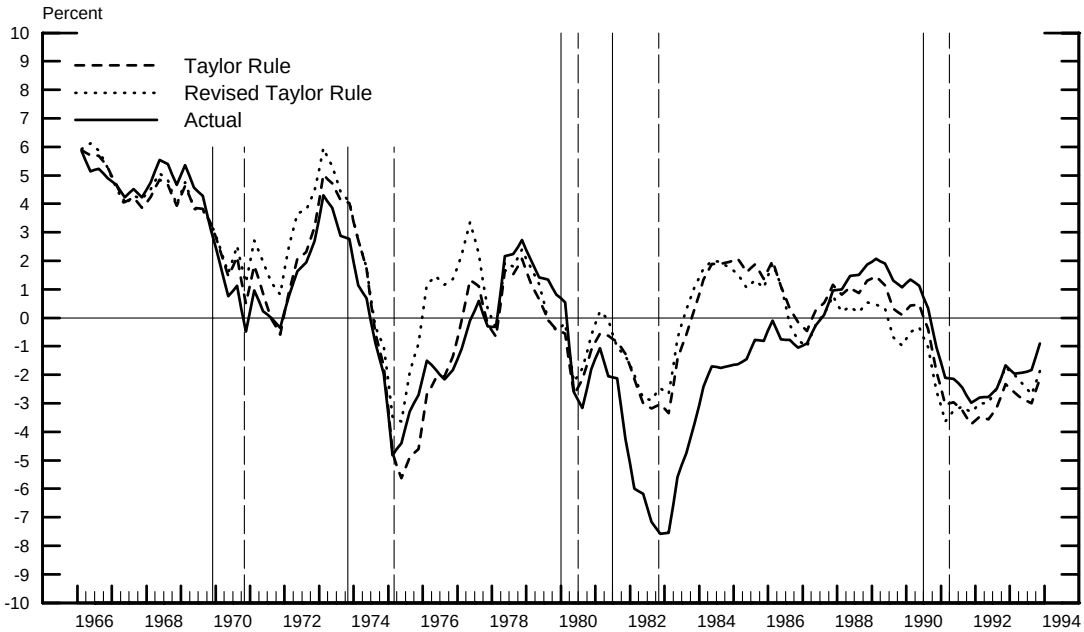
Figure 5

The Reality of Activist Rules: Inflation Dynamic Simulations with Noise

Notes: The solid and dashed vertical lines denote NBER business cycle peaks and troughs, respectively. See also notes to figure 1.

Figure 6

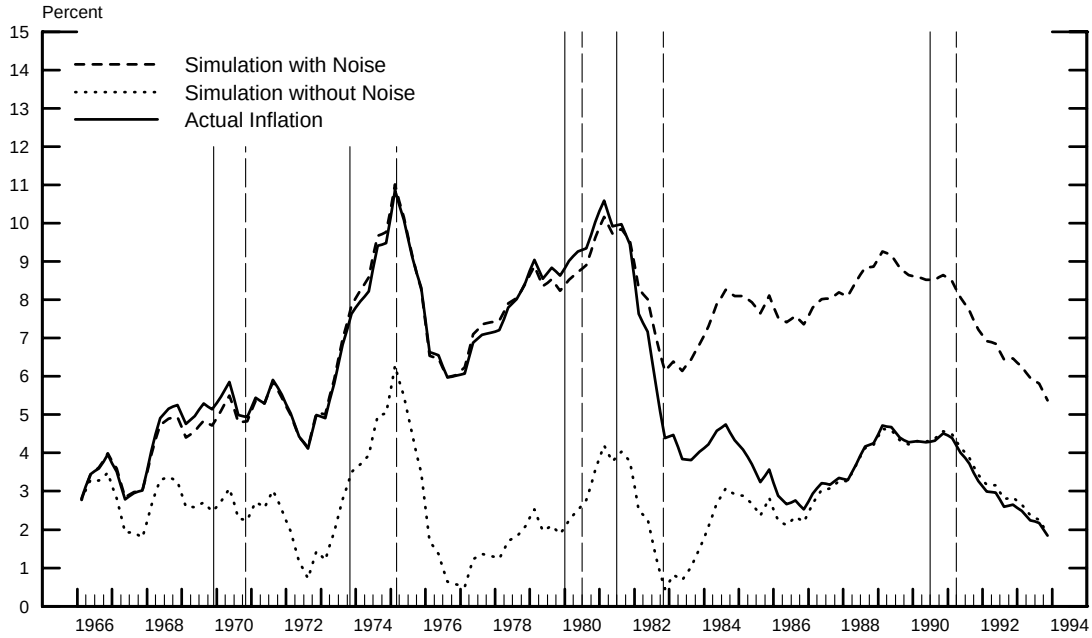
The Reality of Activist Rules: Output Dynamic Simulations with Noise



Notes: The solid and dashed vertical lines denote NBER business cycle peaks and troughs, respectively. See also notes to figure 2.

Figure 7

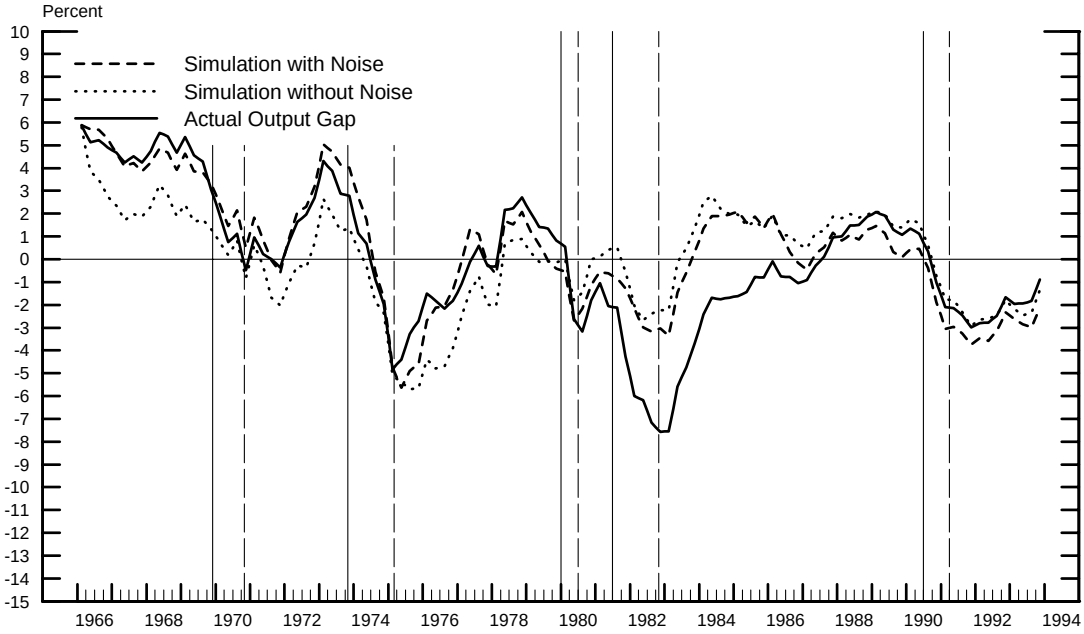
Inflation with Taylor Rule



Notes: The solid and dashed vertical lines denote NBER business cycle peaks and troughs, respectively. See also notes to figure 1.

Figure 8

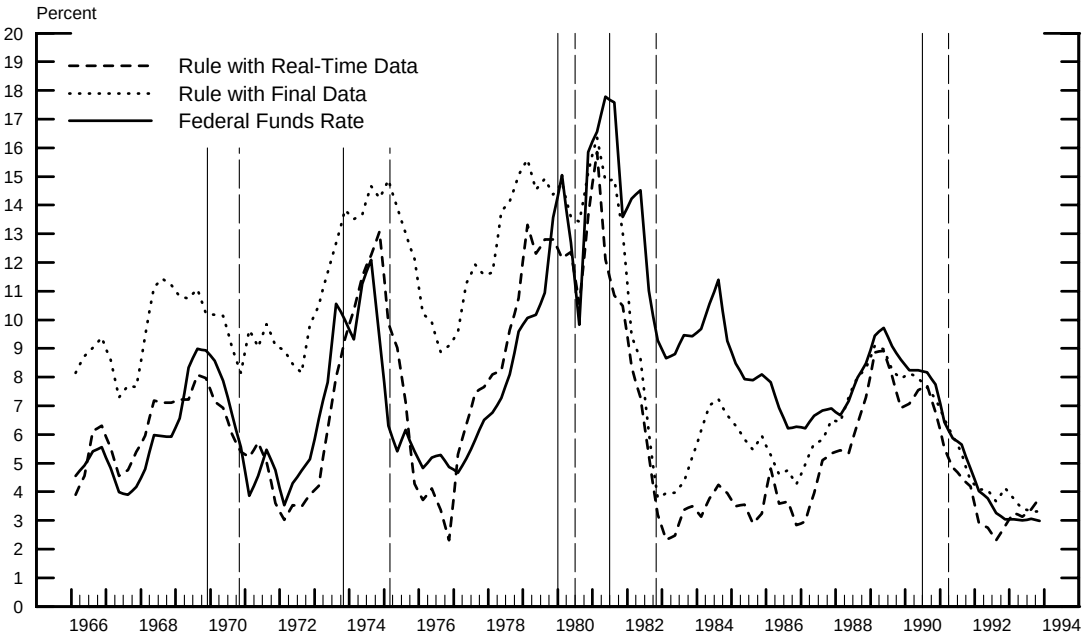
Output Gap with Taylor Rule



Notes: The solid and dashed vertical lines denote NBER business cycle peaks and troughs, respectively. See also notes to figure 2.

Figure 9

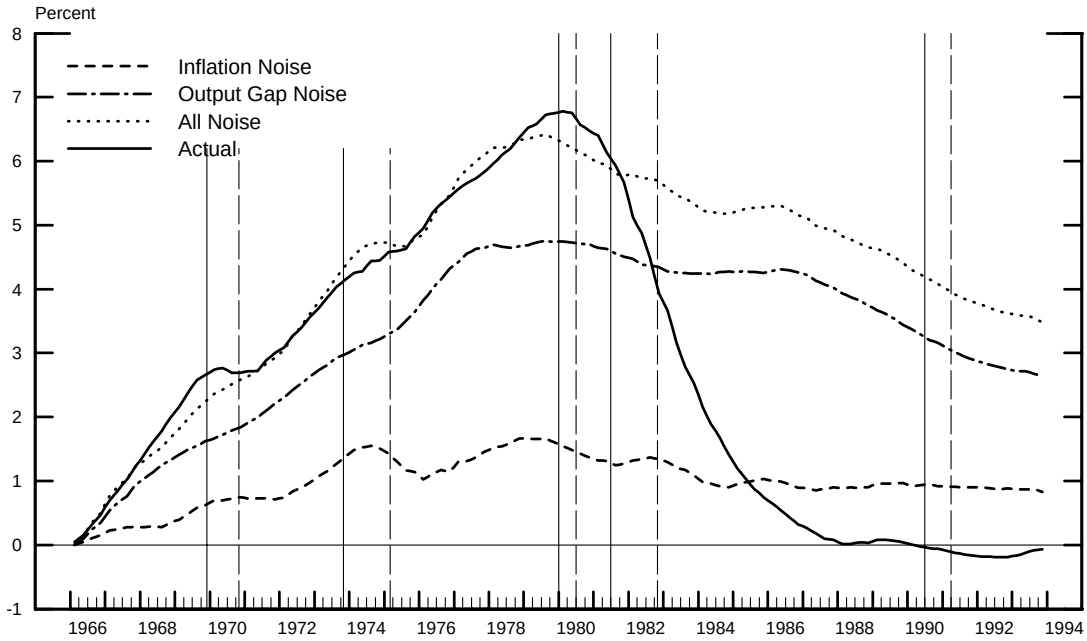
Then and Now
Taylor Rule with Final and Real-Time Data



Notes: For each quarter, the dashed line shows the Taylor rule prescription based on data available in real-time. The dotted line shows the corresponding prescriptions with data available at the end of 1994. The solid line reflects the actual federal funds rate. The solid and dashed vertical lines denote NBER business cycle peaks and troughs, respectively.

Figure 10

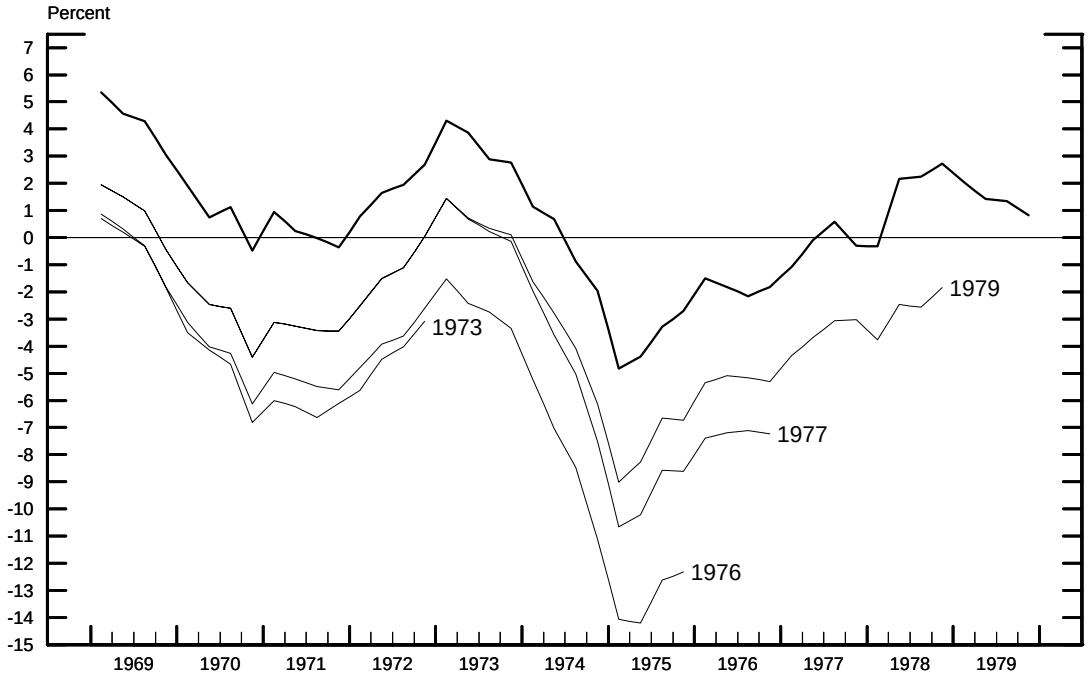
Decomposition of Simulated Differences in Inflation
Dynamic Simulations Based on Taylor Rule



Notes: The solid line indicates the difference between actual inflation and the dynamic simulation based on the Taylor rule without noise. Each of the remaining lines indicates the difference between the path of inflation from a simulation with noise and the simulation without noise. The dotted line reflects both inflation and output noise. The other two lines reflect just inflation or just output noise, respectively. The solid and dashed vertical lines denote NBER business cycle peaks and troughs, respectively.

Figure 11

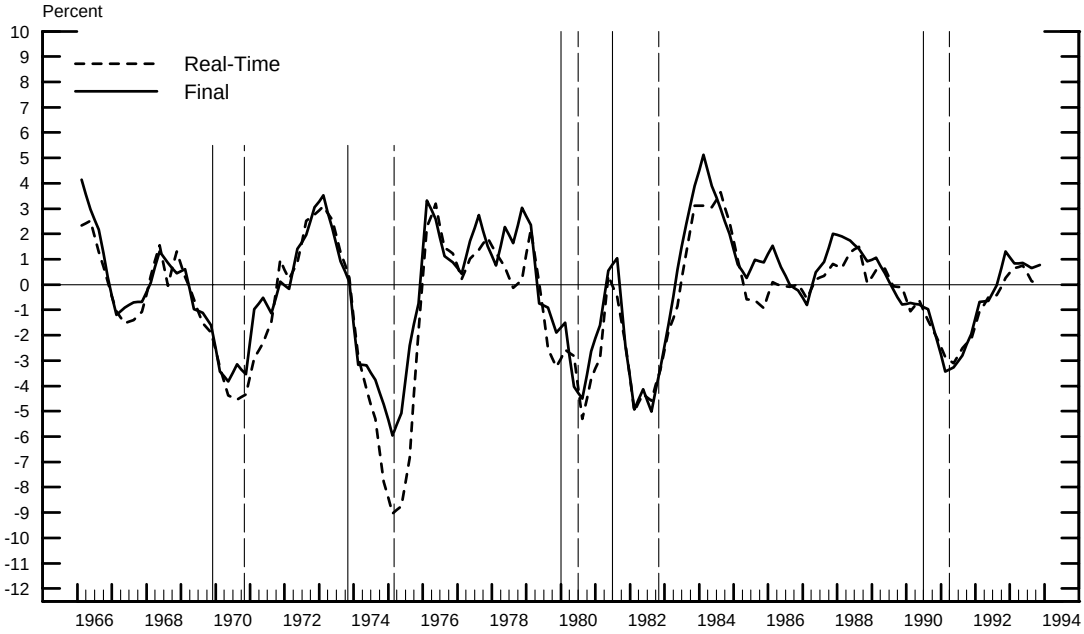
The Evolution of History During the 1970s
Output Gap Measurement



Notes: The dark solid line indicates the final historical series for the output gap with data available at the end of 1994. Each of the thin solid lines shows the historical series for the output gap based on data available in the first quarter of the year shown.

Figure 12

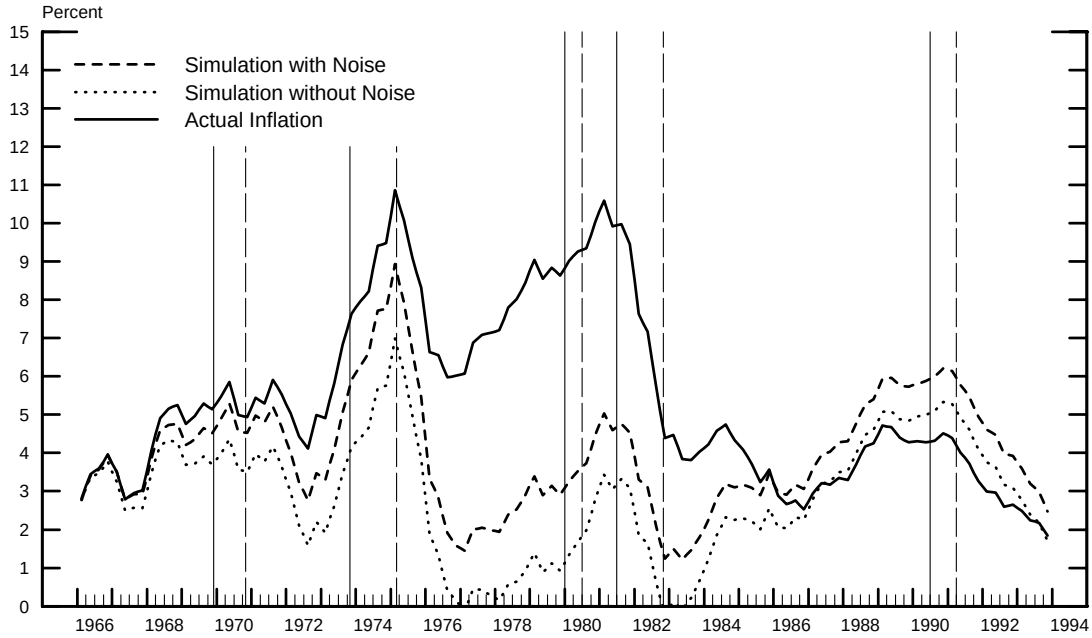
Output Gap Changes in Real-Time and Final Data



Notes: The solid and dashed vertical lines denote NBER business cycle peaks and troughs, respectively. See also notes to figure 4.

Figure 13

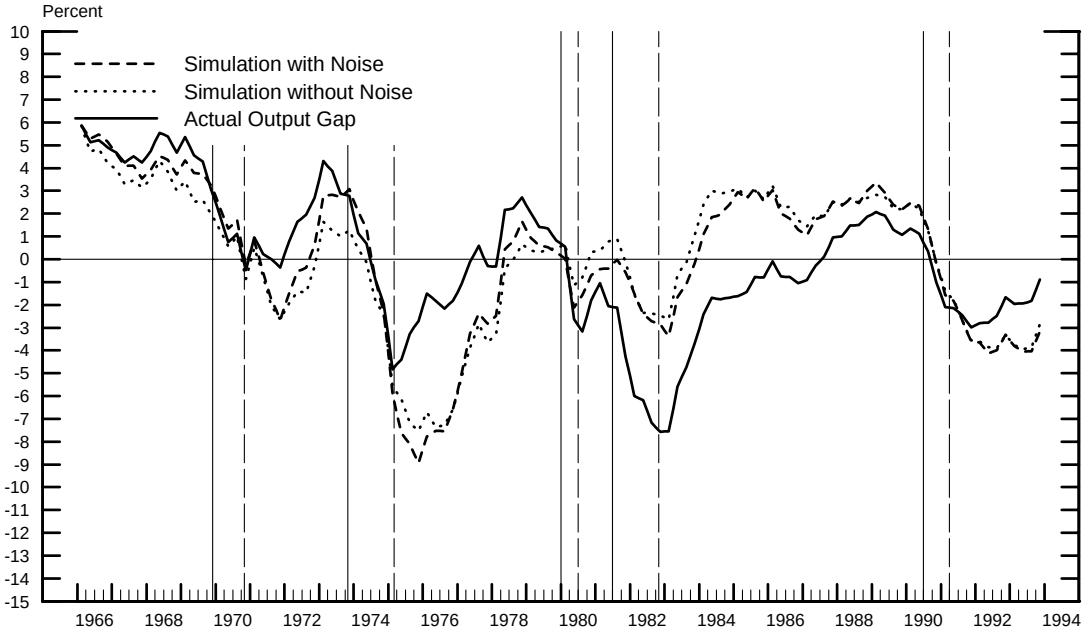
Inflation with Inflation Targeting



Notes: The solid and dashed vertical lines denote NBER business cycle peaks and troughs, respectively. See also notes to figure 1.

Figure 14

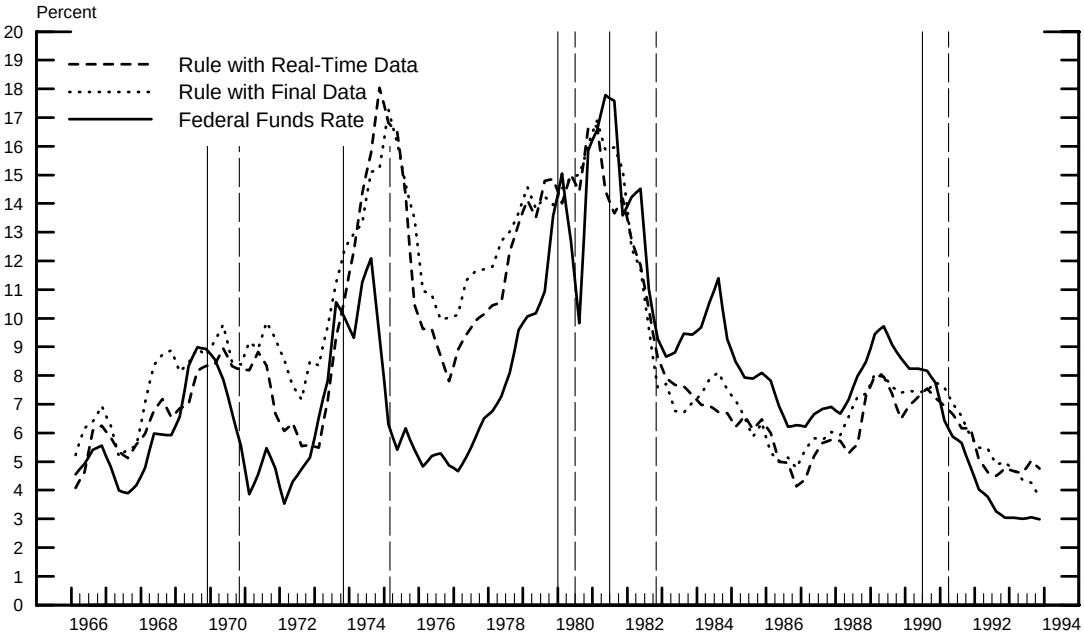
Output Gap with Inflation Targeting



Notes: The solid and dashed vertical lines denote NBER business cycle peaks and troughs, respectively. See also notes to figure 2.

Figure 15

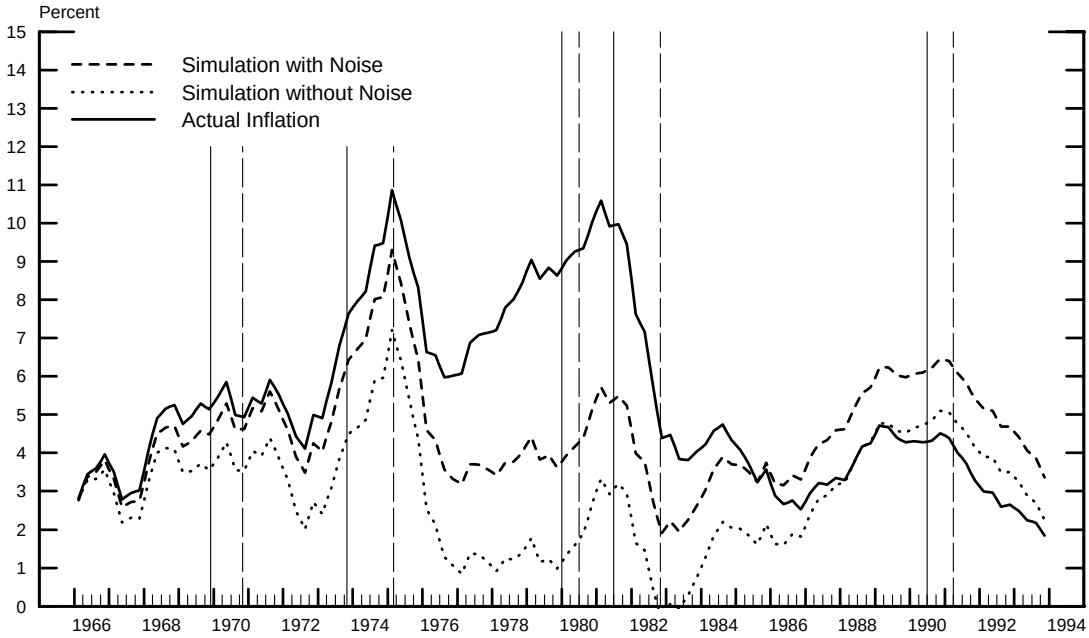
Inflation Targeting Rule and Federal Funds Rate



Notes: For each quarter, the dashed line shows the inflation targeting rule prescription based on data available in real-time. The dotted line shows the corresponding prescriptions with data available at the end of 1994. The solid line reflects the actual federal funds rate. The solid and dashed vertical lines denote NBER business cycle peaks and troughs, respectively.

Figure 16

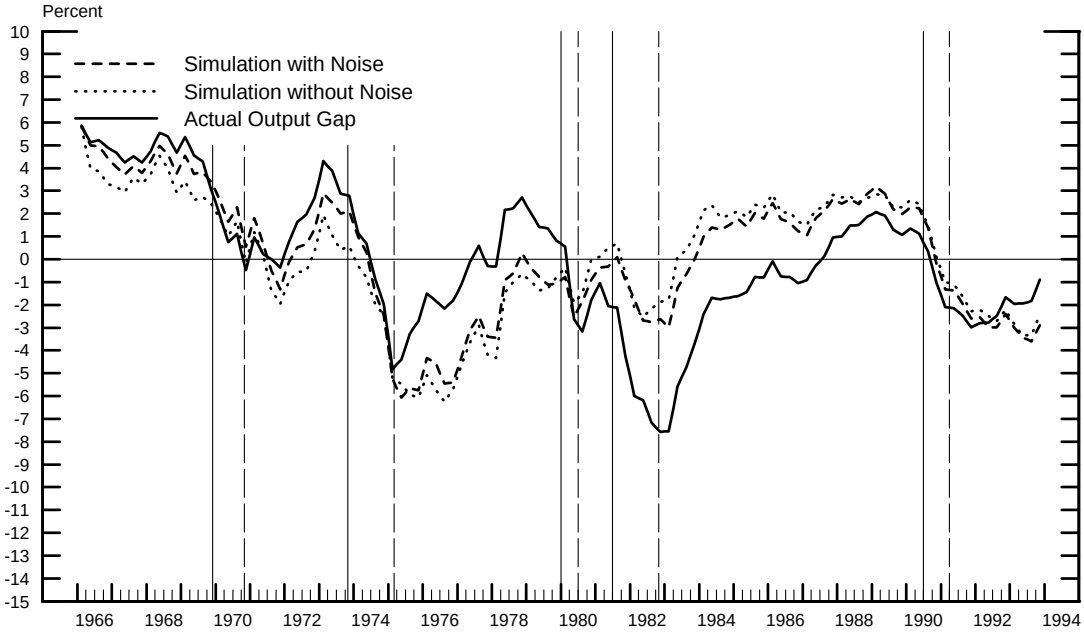
Inflation with Natural Growth Targeting



Notes: The solid and dashed vertical lines denote NBER business cycle peaks and troughs, respectively. See also notes to figure 1.

Figure 17

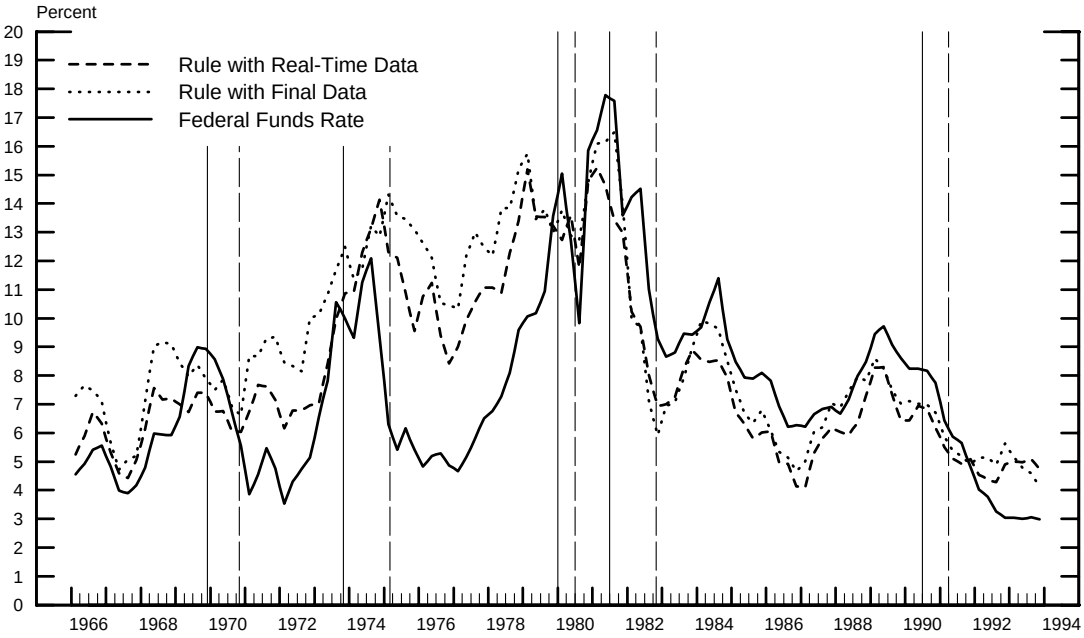
Output Gap with Natural Growth Targeting



Notes: The solid and dashed vertical lines denote NBER business cycle peaks and troughs, respectively. See also notes to figure 2.

Figure 18

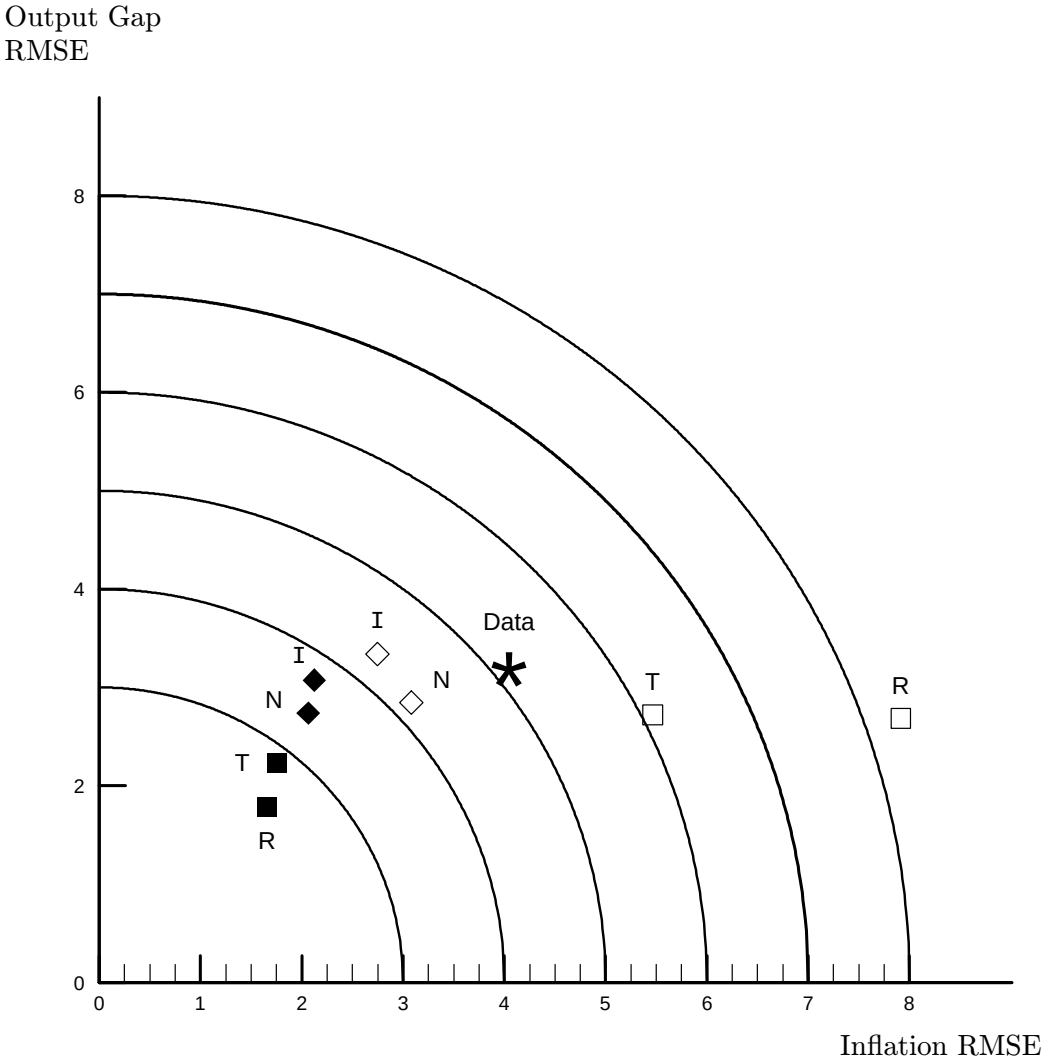
Natural Growth Targeting Rule and Federal Funds Rate



Notes: For each quarter, the dashed line shows the natural growth targeting rule prescription based on data available in real-time. The dotted line shows the corresponding prescriptions with data available at the end of 1994. The solid line reflects the actual federal funds rate. The solid and dashed vertical lines denote NBER business cycle peaks and troughs, respectively.

Figure 19

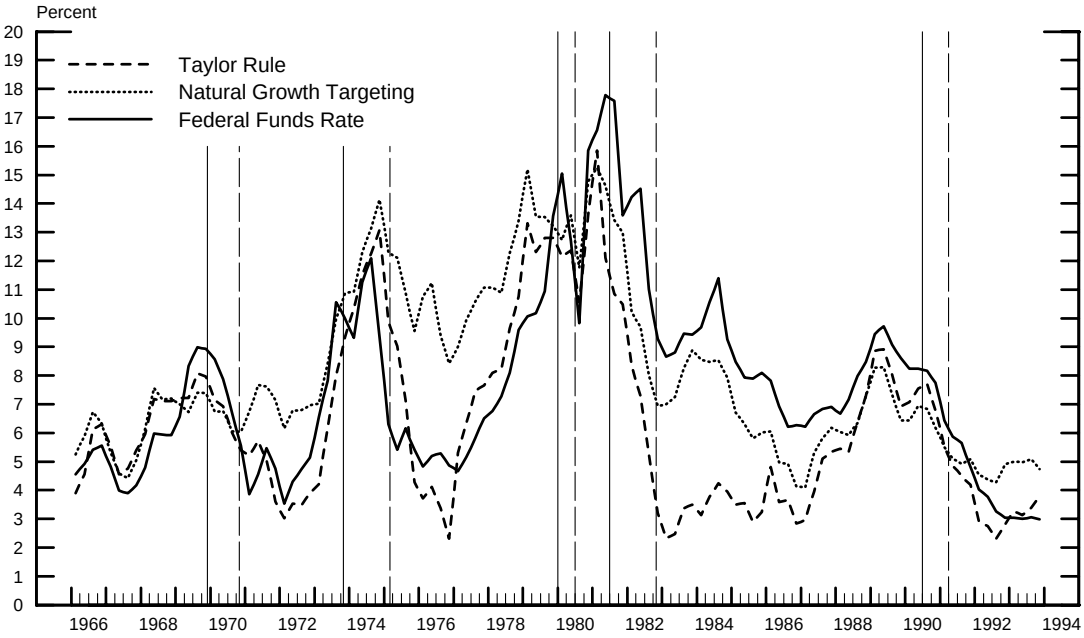
The Performance of Alternative Policies
1966:1 to 1993:4



Notes: T and R denote the original and revised Taylor rules, respectively. I denotes inflation targeting and N natural growth targeting. The solid squares and diamonds indicate infeasible outcomes from simulations assuming perfect information. The blank squares and diamonds indicate the realistic outcomes from simulations reflecting the actual information that would be available when policy decisions were made. The star indicates the actual performance of the economy over the simulation period.

Figure 20

Natural Growth Targeting and Taylor Rule in Real Time



Notes: For each quarter, the dotted and dashed lines show the natural growth targeting rule and Taylor rule prescriptions, respectively, based on data available in real-time. The solid line reflects the actual federal funds rate. The solid and dashed vertical lines denote NBER business cycle peaks and troughs, respectively.

European Central Bank Working Paper Series

1 "A global hazard index for the world foreign exchange markets" by V. Brousseau and F. Scacciavillani, May 1999.

2 "What does the single monetary policy do? A SVAR benchmark for the European Central Bank" by C. Monticelli and O. Tristani, May 1999.

3 "Fiscal policy effectiveness and neutrality results in a non-Ricardian world" by C. Detken, May 1999.

4 "From the ERM to the euro: new evidence on economic and policy convergence among EU countries" by I. Angeloni and L. Dedola, May 1999.

5 "Core inflation: a review of some conceptual issues" by M. Wynne, May 1999.

6 "The demand for M3 in the euro area" by G. Coenen and J.-L. Vega, September 1999.

7 "A cross-country comparison of market structures in European banking" by O. de Bandt and E. P. Davis, September 1999.

8 "Inflation zone targeting" by A. Orphanides and V. Wieland, October 1999.

9 "Asymptotic confidence bands for the estimated autocovariance and autocorrelation functions of vector autoregressive models" by G. Coenen, January 2000.

10 "On the effectiveness of sterilized foreign exchange intervention" by R. Fatum, February 2000.

11 "Is the yield curve a useful information variable for the Eurosystem?" by J. M. Berk and P. van Bergeijk, February 2000.

12 "Indicator variables for optimal policy" by L. E. O. Svensson and M. Woodford, February 2000.

13 "Monetary policy with uncertain parameters" by U. Söderström, February 2000.

14 "Assessing nominal income rules for monetary policy with model and data uncertainty" by G. D. Rudebusch, February 2000.

15 "The quest for prosperity without inflation" by Athanasios Orphanides, March 2000