Economic Projections and Rules-of-Thumb for Monetary Policy

Athanasios Orphanides
Central Bank of Cyprus
and
Volker Wieland*
Goethe University Frankfurt

October 2007

Abstract

Monetary policy analysts often rely on rules-of-thumb, such as the Taylor rule, to describe historical monetary policy decisions and to compare current policy to historical norms. Analysis along these lines also permits evaluation of episodes where policy may have deviated from a simple policy rule and examination of the reasons behind such deviations. One interesting question is whether such rules-of-thumb should draw on policymaker forecasts of economic conditions or recent outcomes of key variables such as inflation and unemployment. Importantly, deviations of the policy from the prescriptions of a Taylor rule that relies on outcomes may be due to systematic responses to information that may well be captured in policymaker's own projections. We investigate this proposition in the context of FOMC policy decisions over the past 20 years using publicly available FOMC projections from the biannual monetary policy reports to the Congress (Humphrey-Hawkins reports). Our results indicate that FOMC decisions can indeed be predominantly explained in terms of the FOMC's own projections rather than recent economic outcomes. Thus, a forecast-based rule-of-thumb better characterizes FOMC decision-making. We also confirm that many of the apparent deviations of the federal funds rate from an outcome-based Taylor-style rule may be considered systematic responses to information contained in FOMC projections.

Keywords: Monetary policy, forecasts, FOMC policy rules.

JEL Classification System: E52

*Preliminary and incomplete draft prepared for the 2007 Federal Reserve Bank of St. Louis Policy Conference on "Monetary Policy Under Uncertainty." We are grateful for excellent research assistance by Sebastian Schmidt from Goethe University Frankfurt. The opinions expressed are those of the authors and do not necessarily reflect views of the Central Bank of Cyprus.
Correspondence: Orphanides: Central Bank of Cyprus, 80, Kennedy Avenue, 1076 Nicosia, Cyprus, email: Athanasios.Orphanides@centralbank.gov.cy. Wieland: Goethe University Frankfurt, Frankfurt am Main, Germany. e-mail: wieland@wiwi.uni-frankfurt.de

1 Introduction

William Poole has been a long-time proponent of rules-of-thumb for monetary policy. Nearly four decades ago, as staff economist at the Federal Reserve Board, Poole presented a reactive rule-of-thumb that he argued could serve as a robust guide to policy decisions (Poole, 1971). More recently, as President of the Federal Reserve Bank of St. Louis and a member of the FOMC, he has highlighted how a simple Taylor rule that systematically responds to economic activity and inflation can serve as a useful tool for understanding historical monetary policy decisions (Poole, 2007). In both his recent and earlier work, Poole highlighted the usefulness of rules-of-thumb in the context of the complexity of the macroeconomy and our limited knowledge regarding it. In this light, a policy adviser cannot offer precise guidance about how the monetary authority should respond to every conceivable contingency so as to best achieve these goals. What a policy adviser can do is identify useful rules-of-thumb that can serve as appropriate guides to policy under most circumstances. To the extent policymakers rely on a simple rule-of-thumb as an approximate policy guide, it should be possible to identify this rule and use it to understand historical policy decisions and to improve future policy.

One of the difficulties in identifying a simple rule that can serve as a useful description of policy is that the policy prescriptions relevant for policy advice at any point in time reflect the information available to policymakers at that time. To the extent policy is based on observable macroeconomic variables, a simple rule could be estimated using real-time historical data. However, to the extent policymakers view projections of key macroeconomic variables as more useful summary descriptions of the current state of the economy, estimation of a simple rule based on those same policymaker projections would provide a more promising avenue. Poole (2007) examines FOMC policy decisions over the past 20 years using the simple outcome-based rule proposed by Taylor (1993). This rule uses the current inflation rate and output gap as inputs for federal funds rate decisions. Poole identifies some deviations of policy from the systematic prescriptions suggested by the rule which could, however, reflect a systematic response of the FOMC to its own projections.

Our objective in this paper is to investigate this proposition. To this end we compare estimated policy rules that are based on recent economic outcomes to policy rules based on the economic projections of the FOMC. We investigate whether the federal funds rate target set by the FOMC when these projections are made responds systematically to these projections as opposed to recent economic data.

Our results, which are based on real-time data and projections over the past 20 years, indicate that interest rates respond pre-dominantly to FOMC projections, and thus a forecast-based rule better characterizes FOMC decision-making during this period. Furthermore, we check to what extent deviations from an outcome-based Taylor-rule may be better explained by the information incorporated in FOMC forecasts. Our analysis suggests that distinguishing between forecasts and outcomes can indeed explain a number of deviations of policy from the simple underlying rule though it also identifies episodes where deviations remain. This includes episodes where one would expect systematic policy to deviate from a simple rule-of-thumb, such as the response to financial turbulence experienced in 1998.

Overall, our analysis suggests that FOMC projections used in the context of a rule-of-thumb are quite informative for understanding historical monetary policy while similar analysis based on economic outcomes can often be of much lower value.

2 On rules-of-thumb for monetary policy

Simple estimated policy rules would not be useful devices for understanding historical monetary policy if actual policy was not sufficiently systematic to be captured by such rules. As Poole observed in 1971, however, this could not be the case:

> "Individual policy-makers inevitably use informal rules-of-thumb in making decisions. Like everyone else, policy-makers develop certain standard ways of reacting to standard situations. These standard reactions are not, of course, unchanging over time, but are adjusted and developed according to experience and new theoretical ideas." (p. 151)

Though it did not attract much attention at the time, the particular rule-of-thumb proposed by Poole in 1971 is of interest in that it incorporated both an interest rate reaction to real economic activity (specifically the rate of unemployment deviation from the Federal

Reserve's estimate of the rate corresponding to full employment at the time) as well as a nominal variable in a way that would ensure price stability over the long run. The latter was not based on an interest rate response to inflation, as is commonly specified today. Rather, Poole's rule specified that the money supply be always contained within bounds as a robust means to control inflation, and suggested adjusting the interest rate so as to respond to deviations of unemployment from full employment only when doing so would respect these bounds. In essence, Poole's rule-of-thumb uses money growth to ensure the maintenance of price stability and, subject to that, provided counter-cyclical policy prescriptions. He provided the following summary description:

> "The proposed rule assumes that full employment exists when the unemployment rate is in the 4.0 to 4.4 per cent range. The rule also assumes that at full employment, a growth rate of the money stock of 3 to 5 per cent per annum is consistent with price stability. Therefore, when unemployment is in the full employment range, the rule calls for monetary growth at the 3 to 5 per cent rate.
>
> The rule calls for higher monetary growth when unemployment is higher, and lower monetary growth when unemployment is lower. Furthermore, when unemployment is relatively high the rule calls for a policy of pushing the Treasury bill rate down provided monetary growth is maintained in the specified range; similarly, when unemployment is relatively low the rule calls for a policy of pushing the Treasury bill rate up provided monetary growth is in the specified range. Finally, the rule provides for adjusting the rate of growth of money according to movements in the Treasury bill rate in the recent past." (p. 183)

Poole also explicitly recognized a scope for deviations from his suggested rule-of-thumb, even if policymakers had decided to adopt it in principle. What was more important in Poole's view was transparency in explaining the rationale for such deviations:

> "it is not proposed that this rule-of-thumb or guideline be followed if there is good reason for departure. But departures should be justified by evidence and not be based on vague intuitive feelings of what is needed (since the rule was carefully designed from the theoretical and empirical analysis ..., and from a careful review of post-accord monetary policy.)" (p. 183).

As to whether rules could usefully rely on economic projections, in 1971 Poole argued that an important factor would be the accuracy of the forecasts:

> "Given the accuracy of forecasts at the current state of knowledge, it seems likely that for some time to come forecasts will be used primarily to supplement

> a policy-decision-making process that consists largely of reactions to current developments. Only gradually will policy-makers place greater reliance on formal forecasting models." (p. 152-153)

In 2007, Poole used a version of the classic Taylor (1993) rule to describe Federal Reserve behavior over the past 20 years. As is well known, this rule posits that the systematic component of monetary policy may be described as a notional target for the federal funds rate, $\hat{f}$:

$$\hat{f} = r^* + \pi + 0.5(\pi - \pi^*) + 0.5y \tag{1}$$

where π and y reflect contemporaneous readings of inflation and a measure of the output gap, respectively. Following Taylor, Poole assumed a constant inflation target, π^* and a constant equilibrium real interest rate, r^*. Poole's rendition of the Taylor rule is reproduced in Figure 1.

As in his work 36 years earlier, Poole explained potential sources of deviation from the rule and also the potential use of forecasts:

> "The FOMC, and certainly John Taylor himself, view the Taylor rule as a general guideline. Departures from the rule make good sense when information beyond that incorporated in the rule is available. For example, policy is forward looking; which means that from time to time the economic outlook changes sufficiently that it makes sense for the FOMC to set a funds rate either above or below the level called for in the Taylor rule which relies on observed recent data rather than on economic forecasts of future data. Other circumstances – an obvious example is September 11, 2001 – call for a policy response. These responses can be and generally are understood by the market. Thus, such responses can be every bit as systematic as the responses specified in the Taylor rule." (p. 6)

This last remark suggests that a better rule-of-thumb for understanding the behavior of the Federal Reserve over the past 20 years could be a version of the Taylor rule that is explicitly based on the FOMC's own projections. This is the subject of the investigation that follows.

3 FOMC economic projections and real-time outcomes

The semi-annual monetary policy report to the Congress (the Humphrey-Hawkins report), has presented information on the range and central tendency of annual forecasts of FOMC members since 1979. Following Poole's 2007 analysis, we construct a dataset of FOMC projections and corresponding real-time data that focuses our attention on the past 20 years.[1]

Regarding projections, we take the midpoints of the central tendencies reported in each of the reports starting with February 1988 and ending with July 2007 and use these as proxies for the modal forecasts of FOMC expectations. Our objective using these data is to examine whether deviations from an outcome-based Taylor rule may be explained by the additional information contained in policy makers' forecasts. These include inflation, the rate of unemployment and output growth. Since we could not make approximate inferences of the Committee's forecasts of the output gap from these variables, while we do have the FOMC's unemployment projections, we focus on a version of the Taylor rule that substitutes the unemployment rate for the output gap. Consequently, in our dataset we focus on data and forecasts regarding inflation and unemployment.

Some of the particular measures have been redefined over the years. For inflation, the implicit deflator of the GNP was used through July 1988, thereafter replaced by the CPI. In February 2000, the CPI was replaced by the PCE Deflator measure of inflation 2000, and from July 2004 onwards the Committee decided to focus on the core PCE Deflator that excludes the more volatile food and energy prices. These changes are of particular interest as the alternative measures do not always provide similar summary readings of inflationary pressures and may differ both in level and in their variability over time, especially in small samples, which poses some interpretation challenges.

Figures 2 and 3 provide two recent examples useful for understanding what information on projections is released with the monetary policy reports. Forecasts for 2007 were first reported in July 2006 (not shown). In February 2007, revised forecasts for 2007 and first forecasts for 2008 were reported, as shown in Figure 2. Then, in July, the final updated forecasts for 2007 accompanied updated forecasts for 2008, as shown in Figure 3.

[1] In earlier work—Lindsey, Orphanides and Wieland (1997)—we examined the implications of FOMC projections for understanding policy in the sample prior to 1988 and presented some comparisons with the 1988-1996 period.

Although we have only two observations per year. it is convenient to describe our data set in terms of a quarterly frequency because the FOMC projections report either quarterly data or growth rates over 4 quarters. Denoting time (measured in quarters) with t, we associate the February Humphrey-Hawkins report with the first quarter of the year and the July Humphrey-Hawkins report with the third quarter. We construct a dataset containing two sets of forecasts for each year covering four-quarter intervals that always end three quarters in the future. For any variable x, we let $x_{t+i|t}$ denote the estimated outcome (for $i \leq 0$) or forecast (for $i > 0$) of the value of the variable x at $t + i$ as of time t.[2] Thus, letting u denote the rate of unemployment, $u_{t+3|t}$ would represent the three quarter ahead forecast of the rate of unemployment formed during quarter t, and $u_{t-1|t}$ the estimate, as of quarter t, of what the outcome for the rate of unemployment was in the previous quarter.

As shown on the time chart in Figure 4, using the rate of unemployment as an example, the forecasts reported to the Congress in February have exactly the desired timing. That is, when t is the first quarter, the three-quarter-ahead forecast of unemployment, $u_{t+3|t}$, corresponds to the Humphrey-Hawkins forecast for the rate of unemployment in the fourth quarter of the same year. That is, when t represents the first quarter of a year we have

$$u_{t+3|t} \equiv u^{HH}_{t+3|t}, \tag{2}$$

where we employ the superscript HH to denote the Humphrey-Hawkins forecasts.

Note that in Figure 4 the arrow points to the quarter on the time line for which the unemployment rate is predicted (t+3), while the dotted line points to the quarter in which the forecast is made (t). Similarly, for inflation when t represents the first quarter of a year the three-quarter-ahead forecast corresponds to the rate of growth of prices from the fourth quarter of the previous year to the fourth quarter of the current year, exactly matching the horizon of the Humphrey-Hawkins forecast. Letting π represent the rate of inflation over

[2] Importantly, because of the lags with which information about the past becomes available, we need to keep track not only of revisions of forecasts but also of revisions regarding outcomes when trying to understand the environment in which FOMC decisions were taken. We describe the data we use for outcomes later on.

four quarters, when t is the first quarter of a year we have

$$\pi_{t+3|t} \equiv \pi^{HH}_{t+3|t}, \tag{3}$$

For the July Humphrey Hawkins reports, some additional work is required to obtain 3-quarter ahead projections. We need to estimate the forecast of the unemployment rate for next year's second quarter, and the corresponding forecast of the four-quarter growth rate for prices that ends in the second quarter of next year, by combining available information. The timing of the two Humphrey-Hawkins forecasts and the constructed forecast for three quarters ahead is shown again with respect to the time line in Figure 4. In this case the dashed arrow refers to the three-quarter ahead observation for which an unemployment forecast is needed. We approximate the unemployment forecast in the second quarter of the following year by simply averaging the forecasted levels for the current year's fourth quarter and next year's fourth quarter that are contained in the report. That is, when t represents the third quarter of the year we set

$$u_{t+3|t} = \frac{1}{2}(u^{HH}_{t+1|t} + u^{HH}_{t+5|t}). \tag{4}$$

Other than the rare occurrence of a shock known to have only transitory effects, for a four-quarter interval that starts two quarters later, it is doubtful that FOMC members would have strong views about the likelihood of different changes in the unemployment rate over the two halves of that period. Implicitly, we assume that the changes forecasted in July for the unemployment rate in each half of next year are about the same.

The desired second-quarter-to-second-quarter forecasts of the growth rate of prices is obtained by constructing two forecasted half-year annualized growth rates and then averaging them. In other words, when t represents the third quarter of the year we set

$$\pi_{t+3|t} = \frac{1}{2}(\pi^{S}_{t+1|t} + \pi^{S}_{t+3|t}) \tag{5}$$

where S stands for semi-annual, so that $\pi^{S}_{t+1|t}$ is the inflation forecast for the second half of the current year, and $\pi^{S}_{t+3|t}$ is the forecast for the first half of the following year.

The inflation forecasted for the second half of the current year, $\pi^{S}_{t+1|t}$, can be inferred from the reported inflation forecast for the whole current year from a base of last year's fourth quarter, $\pi^{HH}_{t+1|t}$, and the estimated inflation over the first half of the current year from a fourth quarter of last year base, $\pi^{S}_{t-1|t}$. That is, expressing all terms as annualized growth rates, when t is a third quarter

$$\pi^{S}_{t+1|t} = 2\pi^{HH}_{t+1|t} - \pi^{S}_{t-1|t}. \tag{6}$$

For $\pi^{S}_{t+3|t}$, inflation over the first half of the next year, we simply set it equal to the forecast for all of next year contained in the July Humphrey-Hawkins report. That is, we set

$$\pi^{S}_{t+3|t} = \pi^{HH}_{t+5|t}. \tag{7}$$

The inflation rate estimated for the first half of the current year as of July of the same year, that is $\pi^{S}_{t-1|t}$, is not available in the Humphrey Hawkins report. Thus, instead we make use of alternative real-time data sources which are discussed below.

To allow for a direct comparison of rules based on the forecasts described above to rules based on outcomes of these variables, we construct parallel variables reflecting the latest historical information available to the FOMC at the time of the meetings preceding the two Humphrey-Hawkins reports in every year.

Thus, for the unemployment rate, we create the variable $u_{t-1|t}$ which for the February observation reflects the average level in the fourth quarter of the prior year and for the July observation reflects the average level in the second quarter of the current year. Similarly, for inflation, we create the variable $\pi_{t-1|t}$ which reflects the four-quarter growth rate of prices ending in the fourth quarter of the prior year for the February observation, and ending in the second quarter of the current year for the July observation.

An important aspect of our analysis is to ensure that our definition of outcomes reflects only information available to the FOMC in real time. To that end, we rely only on data which would have been available to the FOMC by early February or early July. This implies that the data we use correspond either to preliminary estimates, first reported quarterly data or estimates based on partial data for the quarter.

To match the timing of this information as closely as possible, for the years 1988 through 2001 inclusive, we use Board-staff estimates of outcomes ending in the prior quarter contained in the Greenbook that is distributed to the FOMC prior to the early February or early July FOMC meetings. Even so, because Greenbook data remain confidential for five years, we cannot rely on that source for the last few years of our sample. Instead, from 2002 to 2007 we use real-time vintage data from the Federal Reserve Bank of St. Louis ALFRED database.[3] For these dates we use the data vintage from ALFRED that was available one week after the respective February and July HH meetings. We choose the timing after the meeting, because FOMC members have the opportunity to revise their projections during a window of a few days following the meeting.

4 Estimated policy rules: FOMC projections versus recent outcomes

4.1 Specification

The interest rate rules we estimate all share the following underlying structure with Taylor's (1993) rule. They posit that the systematic component of monetary policy can be described as a notional target for the federal funds rate, $\hat{f}$, which increases with inflation, π, and real activity.

As already mentioned with regard to projections of real activity, we do not have information about the FOMC's assessment concerning the output gap. Thus, we cannot directly estimate an exact counterpart of the rule proposed by Taylor. Instead, an indirect comparison is feasible, using the unemployment rate, u, as a measure of the level of economic activity.[4]

Following Taylor we restrict attention to a linear specification of the rule and posit that[5]

$$\hat{f} = a_0 + a_\pi \pi + a_u u \tag{8}$$

[3] As a robustness check, we also checked how much the ALFRED-based information differs from Greenbook information in the years sample until 2001 when both are available. Although the data source does influence the data values somewhat, the differences were small.

[4] The difference between the unemployment rate and a constant natural rate (NAIRU) can then be translated into an estimate of the output gap by means of Okun's law.

[5] The linearity assumption is purely for simplicity in the spirit of the Taylor rule. Non-linear reaction functions such as those characterizing "opportunistic disinflation" examined by Orphanides and Wilcox (2002), and Orphanides, Small, Wilcox and Wieland (2006) and those incorporating asymmetric easing near the zero-bound for nominal interest rates as derived by Orphanides and Wieland (2000) would likely be more realistic but more complicated depictions of policy.

We note that we do not have direct information on the policymakers' views regarding the equilibrium interest rate, r^*, the inflation target, π^* or the natural rate of unemployment u^*. If these concepts are roughly constant over the sample period, then they would be subsumed in the estimated intercept, $a_0 = r^* - (a_\pi - 1)\pi^* - a_u u^*$.

In estimating our specification we need to take an explicit stand regarding the explanatory variable as well as regarding the timing of the information about inflation and real activity that the FOMC takes into account in their policy decision.

As to the FOMC's policy instrument, that is the interest rate on the left-hand-side of the rule, we use the Committee's intended level of the federal funds rate as of the close of financial markets on the day after the final day of the February and July FOMC meetings.

Regarding the information on the current or projected future state of the economy, we set

$$\hat{f}_t = a_0 + a_\pi \pi_{\tau|t} + a_u u_{\tau|t} \tag{9}$$

where τ captures the particular timing. The explanatory variables $\pi_{\tau|t}$ and $u_{\tau|t}$, are meant to encompass the information variables to which the FOMC may be reacting. In this specification, $\tau = t - 1$ if the rule-of thumb is outcome-based, while $\tau = t + 3$ if it is based on the 3-quarter ahead projections.[6]

Figure 5 again employs a time line to put the timing of the explanatory variables into perspective, using the unemployment outcomes and forecasts as an example. Again, the arrows point to the quarter to which the forecast or outcome applies, while the dotted line points to the date on which the forecast or the estimate of the outcome are made.

In our estimation, we also allow for the possibility that the FOMC has a preference for policy inertia and perhaps only partially adjusts the intended federal funds rate, f, towards its notional target, $\hat{f}$. We introduce such inertial behavior by allowing the FOMC decision prior to one Humphrey-Hawkins report to be influenced by the level of the intended federal funds decided at the FOMC meeting before the previous Humphrey-Hawkins report. With

[6] A richer but more complicated specification that nests the two cases we estimate as limiting cases is to specify, for each concept, x, $x_{\tau|t} \equiv (1-\phi)x_{t-1|t} + \phi x_{t+3|t}$, that weighs both forecasts and outcomes with the relative weight ϕ. The weight ϕ can then be estimated as explained in Lindsey, Orphanides and Wieland (1997).

our timing convention, this can be written as

$$f_t = (1 - \rho)\hat{f}_t + \rho f_{t-2} \tag{10}$$

where ρ provides a measure of the degree of partial adjustment so that $\rho = 0$ reflects an immediate adjustment of the intended federal funds rate to its notional target.

4.2 Regression estimates: 1988 - 2007

The results from our regression analysis using our sample of Humphrey-Hawkins report from 1988 to the present are summarized in Table 1. The estimates shown are obtained by non-linear least squares regressions applied to the equation:

$$f_t = \rho f_{t-2} + (1 - \rho)(a_0 + a_\pi \pi_{\tau|t} + a_u u_{\tau|t}) \tag{11}$$

In columns (1) and (2) of Table 1 the regressions are based on outcomes $\tau = t - 1$ while in columns (3) and (4) they are based on forecasts with $\tau = t + 3$. Standard errors are shown under the parameter estimates. In columns (1) and (3) $\rho = 0$, is imposed, while in columns (2) and (4) the unrestricted partial adjustment specification is shown.

In all regressions shown in the table we find that the estimated rules-of-thumb suggest a systematic response to inflation and unemployment. The response to inflation is positive and noticeably greater than 1, suggesting all these rules satisfy the Taylor principle. And the response to unemployment is negative and also quite large, suggesting a strong countercyclical stabilization response. These findings are quite robust and hold regardless of whether we employ FOMC projections or recent economic outcomes and regardless of whether we allow for some degree of interest-rate smoothing or not.

However, not all specifications describe policy decisions equally successfully. A comparison of the regressions based on recent outcomes, (1) and (2), to those based on FOMC projections, (3) and (4), reveals that the forecast-based rules describe policy decisions quite a bit better than the corresponding outcome-based rules.[7] Further, the results suggest a

[7] A richer but more complicated specification that nests the two cases we estimate as limiting cases is to specify, for each concept, x, $x_{\tau|t} \equiv (1 - \phi)x_{t-1|t} + \phi x_{t+3|t}$, that weighs both forecasts and outcomes with the relative weight ϕ. Estimates of this specification with ϕ near unity (not shown) confirm the above result.

substantial degree of inertia in setting policy.

We conclude that a rule-of-thumb based on the FOMC's own projections of inflation and unemployment, and allows for inertial behavior can serve as a very good guide for understanding the systematic nature of FOMC decisions over the past twenty years.

The improved fit of the forecast-based rule relative to the outcome-based rule also suggests that at least some of the apparent deviations of actual interest rates from an outcome-based Taylor rule, such as described in Poole (2007), may be easily explained once FOMC forecasts are examined. To explore this question further, in Figure 6 we plot the fitted values of the forecast-based and outcome-based rules estimated in Table 1. The upper panel of the figure contains the rules without interest-rate smoothing corresponding to columns (1) and (3) in Table 1. The black line, denoted by refers to the actual federal funds rate target decided on February and July FOMC meetings from 1988 to 2007. The thin blue line corresponds to the outcome-based rule and the red dashed line to the forecast-based rule.

The figure confirms visually that the forecast-based rule explains the federal funds rate target path better than the outcome-based rule. Of course, the fit is further improved once we allow for interest rate smoothing, in other words, partial adjustment of the funds rate depending on last periods realization. This can be seen from the lower panel in the figure. Again, the blue line corresponds to the outcome-based rule and the red line to the forecast-based rule, but now the fitted path is smoother as it takes into account the estimated degree of partial adjustment.

Based on the figure, we can identify 5 periods where the outcome- and forecast-based rules diverge from each other in an interesting manner and which can improve our understanding of the role of projections for FOMC policy decisions. Two of these episodes, around 1988 and 1994 correspond to periods of rising policy rates. In both of these periods, the FOMC was raising rates preemptively because of concerns regarding the outlook for inflation. Correspondingly, the forecast based rules track policy decisions better, while the outcome-based rules only manage to describe policy with a noticeable lag.

Two other episodes, in 1990-91 and in 2001, correspond to periods of falling policy rates. In both of these periods, the FOMC was easing policy out of concern of a faltering economy, clearly influenced by its projections of relatively weak economic activity. Again, the forecast-based rules track policy decisions better while the outcome-based rules exhibit a noticeable lag.

The last episode is 2002-03, when the forecast-based rule correctly tracked the further policy easing at the early stages of the recovery from the recession, while the outcome-based rule suggested that policy should have been considerably tighter.

Of interest are also two additional episodes when the forecast-based rule-of-thumb did not track the actual policy setting as well but where the resulting deviations can be explained by other factors which are not part of the rule. The first of these is the 1998 policy easing. On that occasion the FOMC was responding to the underlying financial turbulence which intensified that Fall, a factor not well reflected in the rule-of-thumb, even considering its forward looking nature.

The second, and arguably more controversial is the miss reflected in the rule-of-thumb during 2004. This is more controversial because of recent criticisms that policy was much easier than would have been suggested by simple Taylor rules during this episode. This is evident, for example, in Poole's rendition of the classic Taylor rule, reproduced in Figure 1. It is argued that, to the extent this reflected a deviation from systematic policy, it might have been a contributing factor for the subsequent housing boom and associated price adjustments and liquidity difficulties experienced in financial markets this year (Taylor, 2007.) Indeed, as is well known, around 2003-04 the FOMC was particularly concerned with the risks of deflation and perceived an important asymmetry in the costs associated with a possible policy misjudgment. In particular, the costs of policy proving too tight were perceived as considerably exceeding the costs of policy proving to be too easy.[8] Under these circumstances, it should be expected that even a rule-of-thumb that might track policy

[8]The suggested rationale was the uncertainty arising with operating policy near the zero bound. See Orphanides and Wieland (2000) for a model demonstrating the optimality of unusually accommodative policy in light of the asymmetric risks associated with the zero bound on nominal interest rates.

nearly perfectly under normal circumstances would not accurately characterize policy and that policy would be easier than suggested by the rule. Even so, we find that the rule with FOMC projections tracks the federal funds rate target quite well through the first half of 2004, and that the only noticeable deviation is that it would have already called for much more aggressive tightening starting in the second half of 2004 than actually took place.

4.3 Time-variation in natural rates

One might have suspected that the FOMC-projections-based rule-of-thumb presented in Table 1 could have proved too simple to capture the contours of FOMC decisions during the past 20 years. In that light, the explanatory power of the rule shown in Figure 6 may be considered surprisingly good. One reason to suspect that a rule based on the notional target:

$$\hat{f}_t = a_0 + a_\pi \pi_{t|t+3} + a_u u_{t|t+3} \tag{12}$$

might be too simple is the constant intercept. As already mentioned, this would not be of concern if FOMC beliefs regarding its inflation objective, and natural rates of interest and unemployment were roughly constant over the estimation sample. If any of the above exhibited time-variation, however, a better description of FOMC behavior would be in terms of the following similar, but not identical rule:

$$\hat{f}_t = r_t^* + \pi_t^* + a_\pi(\pi_{t|t+3} - \pi_t^*) + a_u(u_{t|t+3} - u_t^*) \tag{13}$$

which suggests a time-varying intercept $a_{0,t} = r_t^* - (a_\pi - 1)\pi_t^* - a_u u_t^*$. Unfortunately, absent the necessary information required to proxy the Committee's real-time assessments of π^*, u^* and r^* in our sample, it is difficult to examine if a version of the rule allowing for such variation could explain the data even better than the rule-of-thumb based on equation (12)

As a simple check in that direction, however, we restimated the rule in a manner that could at least allow for a proxy of the FOMC's likely perceptions of the natural rate of unemployment, u^*. Absent the Committee's own assessment, we relied on the real-time estimates published by the Congressional Budget office over the past 20 years. (This is the same source of real-time estimates used by Poole, 2007, as a proxy for Federal Reserve staff estimates.) The results (not shown) were broadly similar to those presented in Table 1 and Figure 6. As with the baseline specification, the data suggests that the FOMC-projection based rule can describe policy decisions quite well. However, the overall fit of our preferred forecast-based regression does not improve with the inclusion of the real-time CBO estimate of the natural rate of unemployment. Rather, the fit deteriorates slightly. Two possible explanations for this are as follows. First, the CBO estimate may not capture the updating patterns of the FOMC's own real-time estimates of the natural rate. Second, even in the presence of time variation in the natural rate of unemployment, countervailing time variation in the natural rate of interest might keep the intercept in the rule of thumb, $a_{0,t}$ roughly constant. If so, correcting for the time variation in u^* without a parallel correction for the time variation in r^* should result in a deterioration in the fit of the rule.

4.4 Interpreting changes in the FOMC's preferred inflation concept

Another reason one might be concerned that the rule-of-thumb based on equation (12), as estimated in Table 1, might be too simple is that in our baseline estimation the inflation projection employed do not make any adjustments that FOMC members might incorporate in their policy analysis when their preferred measure of inflation changes. (Here, we take it that the decisions of the Committee to change its inflation projections, e.g. from CPI to PCE in 2000 and from PCE to core PCE in 2004 can be read as changes in preference as to the most appropriate concept for the measurement of inflation for monetary policy purposes.)

To gain some insight into the possible implications of the FOMC turning from the overall CPI measure of inflation, to overall PCE and then the core PCE measure excluding the volatile food and energy prices, we compare the three series in Figure 7. The top panel shows the three series (percentage change in the price index relative to four quarters earlier) for the full sample under consideration, 1988 - 2007. The lower panel provides a detailed view of the most recent 10 years, between 1997 and 2007.

As can be seen, from 1990 to 1998 the three alternative inflation series steadily declined more or less in lockstep with each other, the CPI series starting from a higher than the other two measures. The core PCE seems to best capture the downward trend over this period. The comparison suggests that ex post, a policy rule could have delivered fairly similar policy implications regardless of which if these inflation measures was used. (Note however, that these series are compared from the perspective of the July 2007 vintage and not the real-time policymaker perspective.)

But the series also exhibit some noticeable differences. For instance, while all three inflation rates indicate rising inflation in 1999, the inflationary surge seemed much stronger in the overall CPI and PCE measures than in the core PCE. In fact, core PCE inflation stayed largely within the Federal Reserve's so-called "comfort zone" of 1 to 2 percent all the way through 2007. CPI and PCE inflation however surged up two more times, in 2002 and in 2004, with CPI inflation reaching 4 percent in 2006. The overall PCE measure more or less follows the movements of the CPI albeit staying somewhat below all throughout. Clearly, these increases must have been related to the movements of food and energy prices.

These differences pose a challenge in that the different statistical properties of the alternative measures could in principle influence, perhaps in subtle ways, the specification of a rule-of-thumb. One potential result of the switch from CPI to PCE, for instance, could have been a change in the operational definition of price stability embedded in the rule, π^*. Stated in PCE terms, π^* could be 50 or so basis points lower than the corresponding object stated in CPI terms, reflecting recent estimates of the 50 basis points average difference in the two series. On the other hand, given the uncertainty associated with price measurement and the quantitative definition of price stability most appropriate for monetary policy, it is not entirely clear that such a change in the π^* embedded in a rule-of-thumb should be incorporated to the analysis when the FOMC changes its preferred inflation measure.

In light of these uncertainties and the differential movements of core PCE, PCE and CPI inflation—especially from 2000 onwards, we decided to perform two experiments that could help examine potential influences of the changes in the inflation concept on policy.

One way to examine whether the policy rule has changed with the switch of inflation measures is allowing for changes in the intercept and/or slope coefficients in the estimation corresponding to the switches. We did so by introducing the appropriate additive and multiplicative dummy variables in our regression equations and re-estimating over the full sample from 1988 to 2007. We consider possible shifts in 2000:1 (for the switch to PCE) as well as in 2004:3 (for the switch to core PCE). The results (not shown) did not indicate any significant shifts suggesting that changes in the specification of the rule-of-thumb with FOMC projections associated with the changes in the inflation concept were too small to identify with our limited sample.

Another way to examine possible differences since 1999 is to re-estimate the regressions presented in Table 1 using only the sub-sample 1988-1999 to see if excluding the period following the switch to PCE and later to core PCE would materially influence the results.

The regression estimates are reported in Table 2, based on equation (11), as before. The results are presented in identical fashion as in Table 1. Comparing the estimates to those shown in Table 1 shows that the coefficients of the outcome-based rule change quite a bit. This instability reenforces the prior evidence that the outcome-based rules is mispecified as a description of FOMC policy since it does not account properly for forecasts.

The key result in Table 2 is that the estimates corresponding to the forecast-based rule for the subsample ending in 1999 do not materially differ from those corresponding to the full sample. This suggests that the change in inflation concepts may have not resulted in a corresponding change in the rule-of-thumb describing FOMC decisions, or that this corresponding change might have been rather small. Indeed, this is confirmed in Figure 8 where we show the estimated rule over the subsample ending in 1999 and corresponding simulation when using these estimates together with the FOMC projections for subsequent years. Focusing on the results for the forecast-based rule confirms that interest-rate setting in the 2000 to 2006 period seemed in line with a systematic interest rate response to FOMC projections with the same coefficients, despite the change in concepts.

This result could be seen as somewhat puzzling, especially in light of the 50 or so basis points average difference expected in measured inflation in terms of CPI as opposed to

PCE or core PCE. With no adjustment to any parameter, use of the rule with the PCE instead of the CPI, and assuming PCE forecasts would have been lower, on average, than corresponding CPI forecasts, policy could be systematically somewhat easier following the switch to PCE.

To get a sense of the magnitude of this implied difference over time we also simulated the rule estimated over the subsample ending in 1999 using the Bluechip consensus forecasts of CPI inflation since 2000. If the FOMC had continued to forecast CPI inflation and its forecasts were similar to those of the Bluechip consensus, then the resulting simulation since 2000 would have corresponded to the prescriptions from the rule-of-thumb describing its earlier behavior. The results are shown in the lower panel of Figure 9. The simulation confirms a noticeable deviation of actual policy from the rule-of-thumb when using these CPI projections and is suggestive of the hypothesis that FOMC policy might have been systematically tighter over the past several years had the FOMC not switched its focus away from CPI inflation.

5 Conclusion

Many analysts often rely on rules-of-thumb, such as Taylor rules, to describe historical monetary policy decisions and to compare current policy to historical norms. William Poole's (1971) early study, written explicitly to offer advice to the FOMC, serves as an early example of such work. Analyses along these lines also permit evaluation of episodes where policy may have deviated from a simple policy rule and examination of the reasons behind such deviations. But there is disagreement as to whether the canonical rules-of-thumb for such work should draw on forecasts or recent outcomes of key variables such as inflation and unemployment. Poole (2007) points out that deviations of the actual funds rate from the prescriptions of a Taylor rule that relies on current reading of inflation and the output gap may be due to systematic responses of the FOMC to information not contained in these variables. He notes, however, that much of this additional information may be may be captured in economic projections. We investigate this proposition in the context of

FOMC policy decisions over the past 20 years using publicly available FOMC projections from the Humphrey-Hawkins reports that are published twice a year. Our results indicate that FOMC decisions can indeed be predominantly explained in terms of the FOMC's own projections rather than recent economic outcomes. Thus, a forecast-based rule better characterizes FOMC decision-making. We also identify a difficulty associated with the Committee's switches of the inflation concept it has been using to communicate its inflation projections. Finally, we confirm that many of the apparent deviations of the federal funds rate from an outcome-based Taylor-style rule may be viewed as systematic responses to information contained in FOMC projections.

References

Aksoy, Yunus, Athanasios Orphanides, David Small, Volker Wieland and David Wilcox, 2006. A Quantitative Exploration of the Opportunistic Approach to Disinflation, Journal of Monetary Economics , 53 (8), November, 1877-1893.

Lindsey, David, Athanasios Orphanides and Volker Wieland, 1997. Monetary Policy Under Federal Reserve Chairmen Volcker and Greenspan: An Exercise in Description, unpublished manuscript.

McCallum, Bennett, T., 1988. Robustness Properties of a Rule for Monetary Policy. Carnegie-Rochester Conference Series on Public Policy 29, Autumn, 173-203.

Orphanides, Athanasios, and Volker Wieland, 2000. Efficient Monetary Policy Design Near Price Stability , Journal of the Japanese and International Economies , 14, December, 327-365.

Orphanides, Athanasios, and David Wilcox, 2002. The Opportunistic Approach to Disinflation, International Finance, 5 (1), 47-71.

Poole, William, 1971. Rules-of-Thumb for Guiding Monetary Policy, in *Open Market Policies and Operating Procedures—Staff Studies*, Board of Governors of the Federal Reserve System, Washington, DC.

Poole, William, 2007, Understanding the Fed, Federal Reserve Bank of St. Louis Review, January/February 2007, 3-13.

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

Taylor, John, B., 2007. Housing and Monetary Policy, paper presented at the Jackson Hole conference.

Table 1: Policy Reaction to Inflation and Unemployment Rates

Outcomes versus FOMC Forecasts 1988-2007:2

	Regression based on			
	outcomes		forecasts	
	(1)	(2)	(3)	(4)
a_0	8.29	10.50	6.97	8.25
	1.08	3.07	0.69	0.85
a_π	1.54	1.29	2.34	2.48
	0.16	0.43	0.12	0.14
a_u	-1.40	-1.70	-1.53	-1.84
	0.21	0.55	0.14	0.17
ρ	0	0.69	0	0.39
		0.14		0.06
$\bar{R}^2$	0.74	0.84	0.91	0.96
SEE	1.10	0.85	0.64	0.44
DW	1.00	1.03	1.74	1.94

Table 2: Policy Reaction to Inflation and Unemployment Rates

Period with FOMC Forecasts regarding CPI Inflation: 1988-1999

	Regression based on			
	outcomes		forecasts	
	(1)	(2)	(3)	(4)
a_0	9.78	12.73	6.31	7.34
	1.38	4.57	0.99	1.16
a_π	1.11	0.72	2.32	2.54
	0.19	0.62	0.20	0.23
a_u	−1.35	−1.68	−1.41	−1.72
	0.25	0.71	0.17	0.22
ρ	0	0.69	0	0.41
		0.20		0.08
$\bar{R}^2$	0.68	0.78	0.87	0.94
SEE	1.03	0.84	0.64	0.43
DW	0.98	1.18	1.65	1.96

Figure 1: Poole (2007) Version of Taylor's Rule

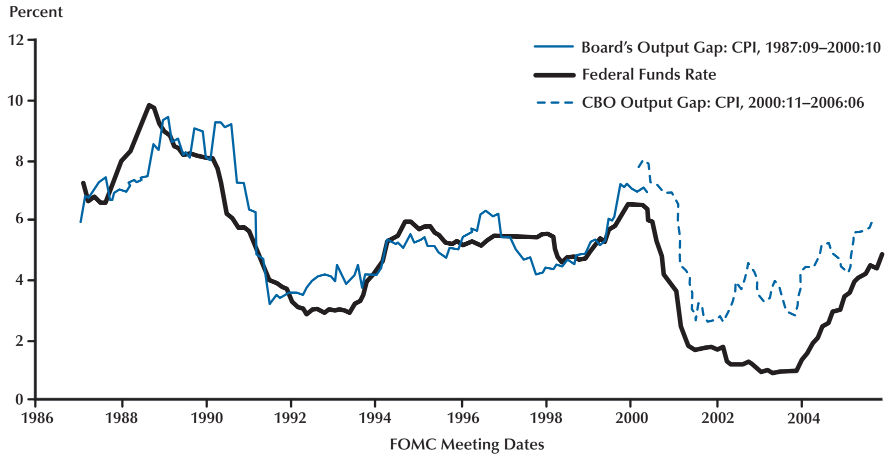


Figure 2: FOMC Forecasts in the Humphrey-Hawkins Report: February 2007

Economic projections of Federal Reserve Governors and Reserve Bank presidents for 2007 and 2008

Percent

Indicator	Memo 2006 actual	2007		2008	
		Range	Central tendency	Range	Central tendency
Change, fourth quarter to fourth quarter[1]					
Nominal GDP	5.9	4¾–5½	5–5½	4¾–5½	4¾–5¼
Real GDP	3.4	2¼–3¼	2½–3	2½–3¼	2¾–3
PCE price index excluding food and energy	2.3	2–2¼	2–2¼	1½–2¼	1¾–2
Average level, fourth quarter					
Civilian unemployment rate	4.5	4½–4¾	4½–4¾	4½–5	4½–4¾

1. Change from average for fourth quarter of previous year to average for fourth quarter of year indicated.

Figure 3: FOMC Forecasts in the Humphrey-Hawkins Report: July 2007

Economic projections for 2007 and 2008

Percent

Indicator	Federal Reserve Governors and Reserve Bank presidents: Range	Federal Reserve Governors and Reserve Bank presidents: Central tendency
	2007	
Change, fourth quarter to fourth quarter[1]		
Nominal GDP	4½–5½	4½–5
Real GDP	2–2¾	2¼–2½
PCE price index excluding food and energy	2–2¼	2–2¼
Average level, fourth quarter		
Civilian unemployment rate	4½–4¾	4½–4¾
	2008	
Change, fourth quarter to fourth quarter[1]		
Nominal GDP	4½–5½	4¾–5
Real GDP	2½–3	2½–2¾
PCE price index excluding food and energy	1¾–2	1¾–2
Average level, fourth quarter		
Civilian unemployment rate	4½–5	About 4¾

1. Change from average for fourth quarter of previous year to average for fourth quarter of year indicated.

Figure 4: The Timing of the Forecasts in the Humphrey-Hawkins Report: Unemployment Rates

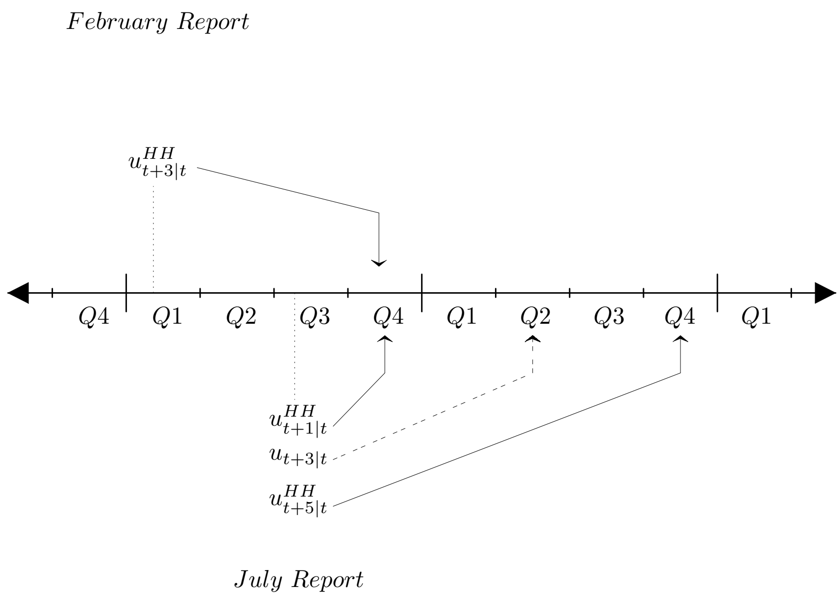


Figure 5: The Timing of the Explanatory Variables: Outcomes and Forecasts of Unemployment

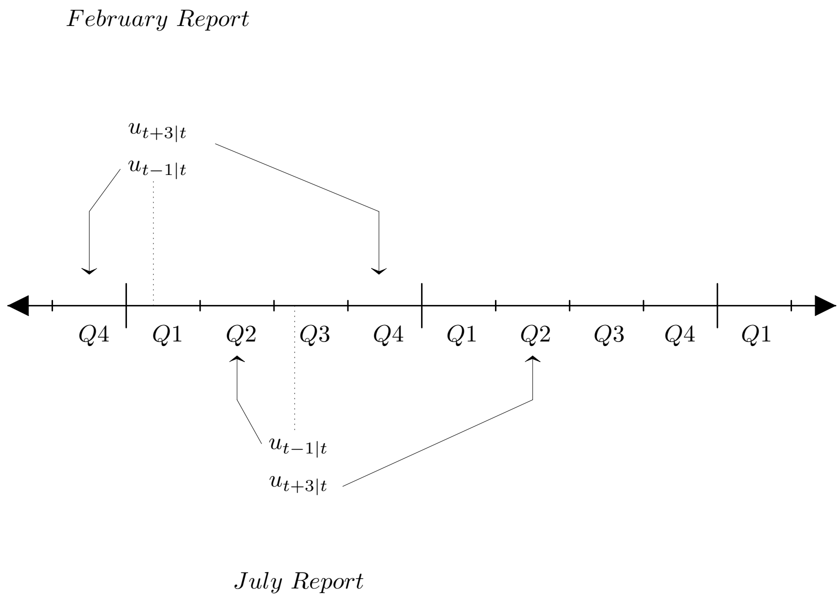
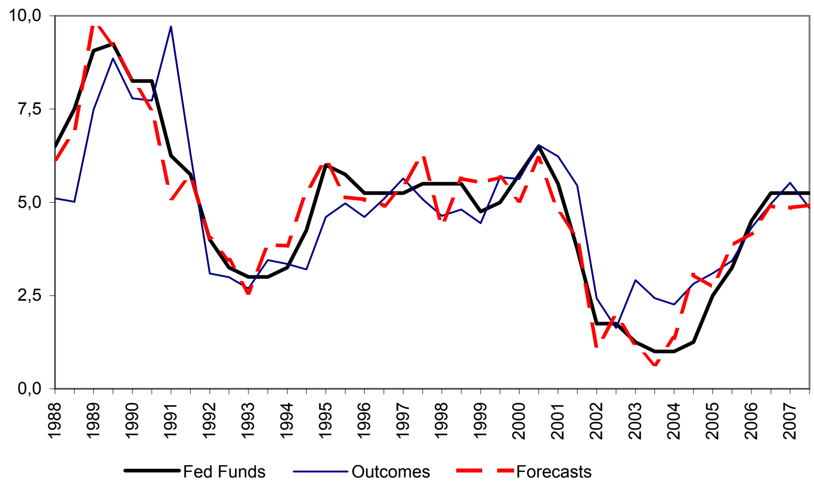


Figure 6: Outcome-based versus Forecast-based Rules 1988 - 2007

No Interest Rate Smoothing



With Interest-Rate Smoothing

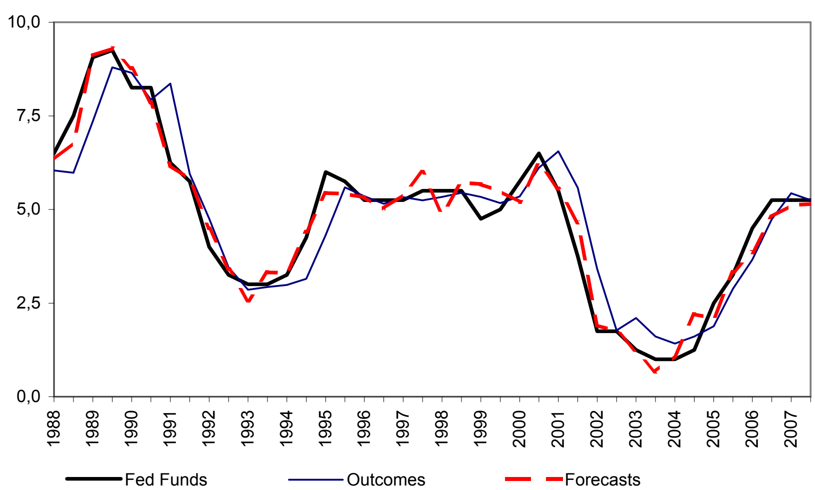
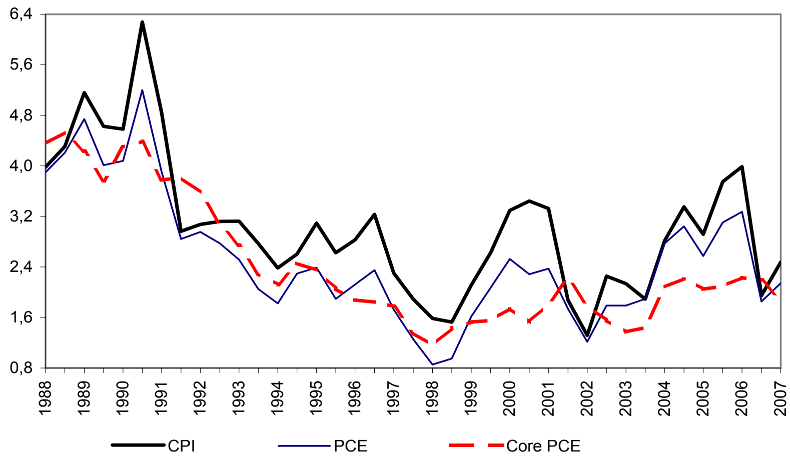


Figure 7: CPI, PCE and core PCE Inflation (vintage July 2007)

1988 - 2007



1997 - 2007

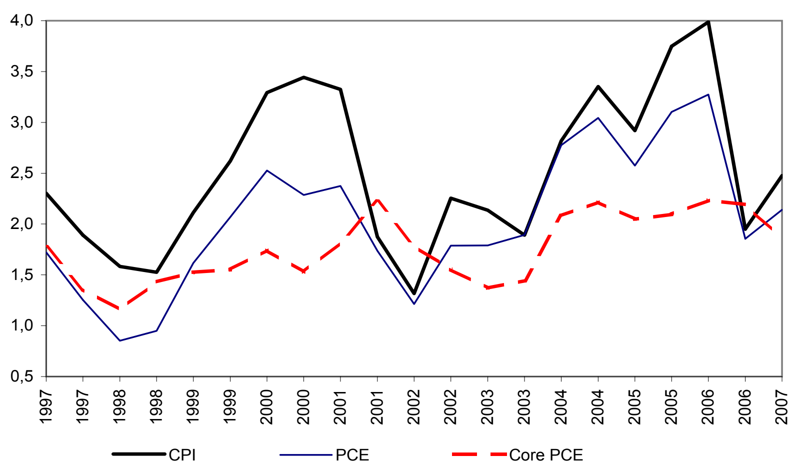
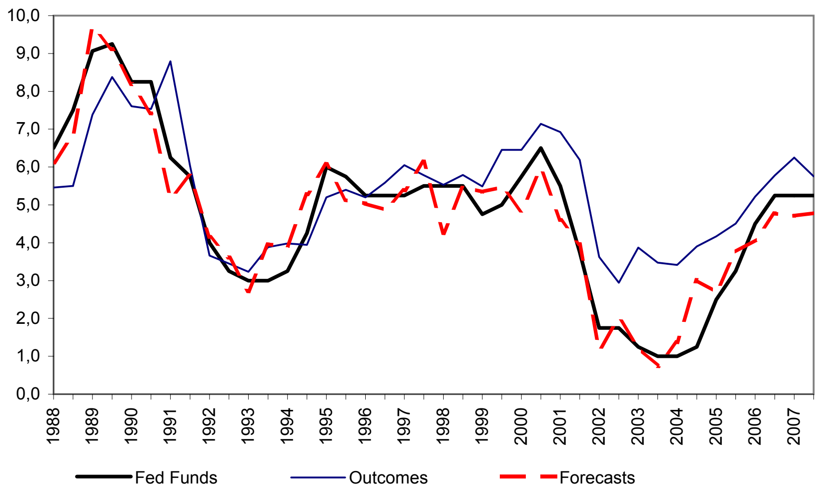


Figure 8: Rules Estimated 1988 - 1999 and Extrapolated to 2007

Extrapolation Using PCE and Core PCE Inflation



Extrapolation Using CPI Outcomes and Bluechip CPI Forecasts