

The Predictability of FOMC Decisions:
Evidence from the Volcker and Greenspan Chairmanships

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Abstract

The paper examines whether there is a systematic relationship between FOMC decisions and publicly available data that would potentially allow the public to anticipate FOMC policy changes. We characterize each FOMC decision as a move to tighten, ease, or leave policy unchanged and use ordered probit to estimate models of the probabilities of each change. We find that there is a statistically significant relationship between FOMC decisions and measures of inflation and real activity, but that this relationship does not accurately predict the directions of FOMC decisions. While short-term interest rate changes prior to FOMC meetings have predictive power, suggesting that the financial market can anticipate FOMC decisions somewhat, other financial variables such as stock price movements appear unrelated to FOMC policy changes. Overall, FOMC decisions are not highly predictable using publicly available data and adding the private information contained in the FOMC's Greenbook does not significantly increase the predictive accuracy.

1. Introduction

About every six weeks, the Federal Open Market Committee (FOMC) meets to decide on the short-run course of U.S. monetary policy. Before each meeting the financial press reports extensively on the likely decision and afterwards attempts to explain the reasoning behind the decision.¹ Decisions to ease or tighten monetary policy are usually attributed to recently announced information about the state of the economy, such as the latest indicators of real activity and inflation. Moreover, asset price changes after these economic announcements are often interpreted as reflecting the market's expectation of the Federal Reserve's response to such announcements. This paper examines whether there has been a systematic connection between economic announcements and subsequent FOMC decisions that would potentially allow the public to predict the direction of these decisions. The press coverage given to the FOMC meetings suggests that FOMC decisions are considered important and are not highly predictable.

There has long been a debate about whether policy should be predictable. William Poole (2001) has recently argued that:

The presumption must be that market participants make more efficient decisions – decisions that maximize economic growth by minimizing the wastage of resources from expectational errors – when markets can correctly predict central bank actions.(p.9)

On the other hand, to the extent that the central bank wants to surprise economic agents, as in the models following Barro and Gordon (1983), the central bank would prefer its decisions to be largely unpredictable.² This would require that policy changes be only loosely tied to the information available to the public.

¹ Until 1994, FOMC decisions were not officially disclosed right after the meeting so that the decisions themselves were a source of speculation.

² See Goodfriend (1986) for a discussion of this literature in the context of the Federal Reserve's argument for secrecy in monetary policy.

The goal of our investigation of the predictability of FOMC decisions is more modest than that of the traditional reaction function literature, which requires an accurate measure of the stance of monetary policy. We confine our attention to the decisions made at regular FOMC meetings, knowing that these do not capture all changes in monetary policy.³ Our main question is how well the public might have anticipated FOMC decisions based on information that was available at the time. This question is related to the general issue of transparency in monetary policy. For example, Faust and Svensson (2001, p. 373) measure the degree of transparency by “how easily the public can deduce central-bank goals and intentions from observables.”

For each FOMC meeting we measure, based on summaries of the discussion, directives and transcripts from FOMC meetings, and attempt to explain, intended changes in FOMC policy. We characterize each decision as an easing of policy, a tightening of policy, or a decision to maintain the previous policy. Our unit of observation is the FOMC meeting rather than calendar quarters or months as has been the practice of most other researchers.

While traditional reaction function studies have generally used revised data that were unavailable at the time of FOMC meetings, we are careful to use only real-time data, that is, data that could have been known by the public and the FOMC at the time of the meetings.⁴ If the FOMC reacts to data that are not publicly available, say its private forecasts, then FOMC decisions should be difficult for the public to

³ Monetary policy changes have occurred between FOMC meetings, often after a telephone conference of FOMC members. There have been fewer such changes since 1994.

⁴The use of revised data or data unavailable at the time of the FOMC meeting may give misleading estimates of the relationship between economic conditions and FOMC decisions. For example, Orphanides (1997) and Runkle (1998) report that evaluations of the Taylor (1993) rule for setting the federal funds rate target differ significantly when real-time data are used in place of revised data.

predict.⁵ We examine this issue by investigating the marginal explanatory power from adding the Federal Reserve's internal estimates of current conditions and confidential forecasts to the publicly available information set.

We discuss our characterizations of FOMC decisions in the next section. The third section outlines our modeling strategy for estimating the probability of decisions to ease or tighten policy and the measurement of the variables in the models. The fourth section presents the estimation results. The fifth section explores the value of the Federal Reserve's internal forecasts and a concluding section discusses the implications of our results.

2. Characterizing FOMC Decisions

We employ what has been called the narrative approach in which policy documents are interpreted to gauge the FOMC's policy stance. The advantage of this approach is that it can be used across the different operating target regimes that the Federal Reserve has employed. The drawbacks of this approach are the substantial room for subjectivity in document interpretation and in distinguishing between large and small policy moves.⁶ We limit the subjectivity inherent in the narrative approach by focusing on the intended change in policy and foregoing any attempt to gauge its size. In contrast, authors of earlier studies using the narrative approach characterized monetary policy as expansionary, contractionary or neutral (and, in

⁵ Karamouzis and Lombra (1989, p.5) conclude that "current economic and financial conditions rather than forecasts drive FOMC behavior." Tootell (1997), however, finds evidence that the FOMC considers staff forecasts in making its decisions.

⁶ Romer and Romer (1989) use this approach to identify times when the Fed tightened. Boschen and Mills (1995) review past work on narrative measures of monetary policy and also provide their own measure that defines five possible degrees of monetary policy, from aggressively easy policy to aggressively tight policy. They find considerable agreement on characterizing monetary policy.

Boschen and Mills [1995], to what degree). This is no mean assignment as an attempt to define a “neutral” monetary policy will make clear.⁷ Since the FOMC often uses a phrase similar to “... the Committee seeks to maintain the existing degree of pressure on reserve positions” or “... the Committee seeks to increase slightly the degree of pressure on reserve positions” assessing the intended change in policy from the preceding meeting is more likely to be successful than attempting to determine if policy is easy or tight in an absolute sense and to quantify the scale.⁸

Each FOMC meeting results in a short-run directive for monetary policy that is the basis for any dynamic open market operations between meetings. For each meeting we studied the summary of the discussion and the directive and determined if the FOMC had intended to tighten, loosen, or maintain policy. When available we tried to resolve any ambiguity by consulting the verbatim transcripts of FOMC meetings.⁹

As anyone who has read these documents can attest, the FOMC is not always clear as to its objectives.¹⁰ Thus, ambiguities are unavoidable.¹¹ Sometimes the FOMC directive does not clearly indicate a policy change. If the transcripts did not clarify the FOMC's intention or if they

⁷Blinder (1998) offers a definition of neutral policy in terms of a neutral real rate of interest, which he describes as “difficult to estimate and impossible to know with precision.” (p.33).

⁸ Quotes from the policy directives from the July 7, 1978 and March 29, 1988 meetings, respectively. (*Federal Reserve Bulletin*, October 1987, p. 796 and July 1988, p. 473.)

⁹ FOMC verbatim minutes are available with a lag of five years and currently are not available for 1979-1983.

¹⁰ Goodfriend (1986) notes that one of the Federal Reserve’s arguments for keeping the FOMC directive secret until weeks after the decision was the fear that the financial markets would misinterpret the directive: “the FOMC argues that the Directive is written in ‘terms of art’ that are vague and cannot always be accurately interpreted.” (p. 79)

¹¹ Another ambiguity arises from the FOMC occasional use of wording in the directive that implies a bias towards easing or tightening. Lapp and Pearce (2000) report that these bias statements have predictive power for inter-meeting changes in the funds rate targets. We estimated alternative models that had five policy choices, interpreting a bias towards tightening as intermediate between no change in policy and tightening, and a bias towards easing as intermediate between easing and no change in policy. Results from using this alternative dependent variable were

not qualitatively different and are not reported.

were not available we relied on changes in targets for monetary growth and the federal funds rate. Occasionally the targets announced in the directives appeared to be conflicting, forcing us to choose between the targets. In these instances we relied on the change in the federal funds rate target to define the change in policy.¹²

During the Volcker chairmanship the FOMC held 67 regularly scheduled meetings. The committee voted to ease 14 times, to tighten 13 times, and to leave policy unchanged 40 times, or about sixty percent of the meetings. This percentage rose to almost eighty percent during the Greenspan period. Of the 92 FOMC meetings Greenspan chaired through 1998 there were only 10 votes to ease and 10 votes to tighten. Figure 1 plots the cumulative values of our policy change variable, initialized to zero and coding an easing as -1 and a tightening as +1. The graph indicates the FOMC tightened in the first two years of the Volcker chairmanship but then generally eased afterwards, moving to a tighter policy just before the end of Volcker's tenure. During the Greenspan chairmanship our policy change measure indicates an initial tightening until mid-1989 and then an easing until late 1991. There was no change in policy during 1992 and 1993. The FOMC often voted to tighten policy during 1994 and then voted to ease three times from July 1995 through the first meeting in 1996. With the exception of one vote to tighten in March 1997, FOMC policy remained unchanged from spring 1996 until the two decisions to ease in late 1998. The figure supports the common perception that changes in monetary policy are applied in stages. This pattern is particularly apparent over the last fifteen years, reflecting either a cautious approach to policy or the serial correlation in economic conditions.

¹² We checked our policy change variable with the post-1989 change in the intended (or targeted) federal funds rate as given on the FOMC's web site (www.federalreserve.gov/fomc/fundsrate.htm). Our measure is identical in direction except for the changes in the target that were not made at regularly scheduled FOMC meetings.

3. Models and Data

To assess the relationship between FOMC policy decisions and available economic data we estimate models of the probability of the alternative decisions as a function of recent economic information.

We assume there is an unobservable policy index, IP_t , that depends on a set of observable variables, X_t , and an error term, ε_t , so that $IP_t = X_t \beta + \varepsilon_t$. We assume the FOMC chooses its intended change in policy by comparing IP_t to two threshold values. Values of IP_t below the lower threshold result in a decision to ease policy while values above the upper threshold result in a decision to tighten policy; otherwise the FOMC votes to maintain the previous policy. Because we assume a normal distribution for ε_t , the ordered probit model is an appropriate estimator of β and the threshold values, given the ordered nature of the policy alternatives.¹³ In the ordered probit models the signs of the estimated coefficients give the direction of change in the probability of a decision to tighten. Thus, a positive coefficient on a variable indicates that an increase in that variable raises the probability that the FOMC will decide on a tighter policy. Throughout the following discussion we describe the effects of variables on the probability of a tighter policy. Each description can be reversed for the probability of an easier policy.

Presumably, the FOMC chooses to change policy when it believes the current policy would produce undesirable values of its ultimate goals. This may be indicated by undesirable current values of the goal variables, by values of intermediate targets that diverge from their desired paths, and by values of information, or indicator, variables that imply unacceptable future developments.¹⁴ The goals of U.S.

¹³ See Greene (1997, pp. 926-931) for a discussion of ordered probit. This approach imposes symmetry on the coefficients of the index model, but the marginal effects of the explanatory variables on the probabilities of policy changes vary with the values of the explanatory variables.

¹⁴ Forecasts are clearly another indicator. We examine this issue in section 5.

monetary policy are usually taken to be stable prices, low unemployment, and sustainable economic growth. In addition, the FOMC often mentions the trade balance in its discussions, with large imbalances considered undesirable. Quantitative targets corresponding to the goals are not available and, as a result, we cannot control for variation in desired values of the goals.¹⁵ For variables related to the goals of policy we consider inflation, changes in economic activity, and the trade balance as potential elements of the vector X.

We measure inflation by the annualized percentage rates of change in the CPI, the PPI, and an index of commodity prices.¹⁶ The rate of change of commodity prices is included because it is often mentioned as a useful inflation indicator [see for example Johnson (1988)] and it has played an important role in resolving the “price puzzle” under the assumption that commodity price inflation induces tighter monetary policy.¹⁷ We expect to find that higher inflation, by any of these measures, increases the likelihood of tighter policy. We measure changes in economic activity by the annualized percentage rate of change in the industrial production index and the change in the unemployment rate. We measure international trade imbalances by the monthly goods and services nominal trade balance (the merchandise trade balance prior to 1994) and consider both levels and changes in the trade balance. Because the FOMC may react to the same information on the economy differently during a recession, we also estimated models that included interaction terms with a dummy variable that equals one during an NBER-dated recession.

To consider the role of intermediate money supply targets in shaping decisions to change monetary policy we constructed several measures of money growth. In addition to the annualized percentage growth

¹⁵ Blinder (1997, p.5) decried the “lack of consensus on the ultimate targets for unemployment and inflation” viewing it as “a severe handicap to rational policymaking.”

¹⁶ We also estimated models using the core CPI and PPI, which take out food and energy prices.

¹⁷ Garner (1989) reports that commodity prices have predictive information for general inflation. For a discussion of

in M1 and M2, we also measured the difference between money growth and the mid-point of the announced target ranges for these aggregates.¹⁸

It has often been argued that the FOMC does, or should, use financial market data in its decision-making process.¹⁹ Bernanke and Woodford (1997, p.655) assert that “virtually all central banks pay close attention to financial-market indicators of inflation, such as long-term bond yields” and that it is well-known that “the Fed attempts to use private-sector information implicit in asset prices.”²⁰ We include changes in the long-term interest rate, measured by the 10-year constant maturity U.S. Treasury bond rate, as a measure of changing inflation expectations. We also include changes in the yield curve, measured by the change in the difference between the 10-year Treasury bond rate and the 3-month Treasury bill rate, because several researchers have shown that such changes have predictive power for inflation and economic activity.²¹ Additionally, we consider the change in the 3-month Treasury bill rate as an indicator of changing aggregate spending or as a measure of the market’s anticipation of a change in FOMC policy. An increase in the long-term bond rate, the 3-month bill rate, or an increase in the slope of the yield curve should raise the probability of a shift toward tighter policy if the FOMC interprets these events as evidence

the price puzzle see Christiano, Eichenbaum and Evans (1996).

¹⁸ Announced targets for M1 were dropped after 1986 so we could only use deviations of M2 from its target for the entire period. To check for threshold effects, we also created variables for money growth outside the target range.

¹⁹ Johnson (1988) argues strongly for using such data. Woodford (1994) and Blinder (1997), on the other hand, caution that close attention to financial markets may be inadvisable.

²⁰ Leeper *et al.* (1996) argue that “Federal Reserve behavior could certainly depend on such indicators of the state of the economy” (p.28) and include them in their attempt to identify monetary shocks.

²¹ For example, Frankel and Lown (1994) find that there is significant information about future inflation in the yield curve while Lapp (1997) and Estrella and Mishkin (1998) report that term spreads have predictive power for economic activity.

of more robust future growth or higher future inflation.²² If the FOMC reacts to stock prices or the exchange rate we would expect rising stock prices or a falling dollar to raise the probability of tighter policy. Changes in the exchange rate are measured by annualized percentage changes in the Federal Reserve's trade-weighted exchange rate and changes in stock prices are measured by annualized percentage changes in the S&P 500 index.

Including financial market data in a model of FOMC behavior introduces a potential identification problem. Presumably, market participants use economic data to predict what the FOMC will do. Thus financial markets may move in anticipation of the FOMC's actions. A connection between financial data and FOMC decisions may not reflect the FOMC's reaction to the financial data, but, rather, the success of market participants in anticipating policy decisions. For example, rising stock prices prior to FOMC meetings should increase the likelihood of the FOMC tightening if the FOMC views the stock price increase as reflecting a stronger economy. Stock prices are likely to fall prior to the FOMC meeting, however, if market participants expect a decision to tighten. Being unable to distinguish between the two types of movements in stock prices may result in an estimate of no relationship between stock price movements and FOMC decisions, a point raised in a recent paper by Rigobon and Sack (2001).²³ A similar problem arises for exchange rate movements. Nominal interest rates, however, should increase if market

²² Goodfriend (1993) interprets increases in the long-term interest rate as "inflation scares" that the Fed should deal with aggressively. Roley and Sellon (1995) report that long-term interest rates predict policy changes.

²³ Rigobon and Sack (2001) use daily data and a novel identification method and find that stock price movements are positively related to subsequent short-term interest rates, which they interpret as evidence that the FOMC is responding to such movements. We thank a referee for referring us to this paper.

participants anticipate a tightening and should also be positively correlated with subsequent FOMC tightenings if the FOMC used interest rate changes as indicator variables.²⁴ If the financial data reflect the market's expectation of FOMC policy and if market participants use the available economic data to predict FOMC behavior, adding financial data should make the publicly available data on economic conditions redundant. In addition, if the public uses additional data, which we have ignored, to predict FOMC actions, adding financial data to our models should improve their explanatory power.²⁵

In addition to the possible identification problem, there is uncertainty about the time frame over which changes in the explanatory variables should be measured. To limit the specification search inherent in any investigation like this one, we consider three time spans. We first measure all variables by the most recent observation or change since the last FOMC meeting. For monthly data we use the latest announcement prior to the current FOMC meeting. For daily data we use the change in the variable from the day after the previous FOMC meeting to the day before the current meeting. The alternative time spans are one quarter and one year, so that all variables are measured as changes or averages over the previous three or twelve months.

To assess the potential for predicting FOMC actions it is important to construct all variables using only data that were available both to the FOMC and to the public at the time of each meeting. Simply using the lagged values of monthly data as in earlier papers is insufficient since these lagged values are often not known at the time of the FOMC meetings and are often measured with data that were revised after the

²⁴ The expectations theory of the term structure predicts that the change in the 3-month Treasury bill rate would reflect expected movements in the federal funds rate and Rudebusch (1995) finds evidence of this.

²⁵ Another financial variable that we considered is the futures contract on the federal funds rate. Although Robertson and Thornton (1997) do not find that these data are accurate predictors of FOMC decisions, Poole and Raasche (2000) report that the futures data appear more informative about FOMC decisions since 1994. We have not tried this variable because it exists for only part of our time period.

meeting.²⁶ For variables measured monthly this paper uses the most recent announcements made prior to each meeting. We use the weekly announcements of the money supply to create our money growth measures. Commodity prices, interest rates, stock prices, and exchange rates are known without lags and are generally not revised. Hence we used daily data on these variables to calculate inter-meeting changes from the day after one FOMC meeting to the day before the next.²⁷

Our sample consists of all FOMC meetings held during the Volcker chairmanship and the meetings when Greenspan was chairman through the end of 1998. While the composition of the FOMC changes every year, we assume, following Blinder (1997, p.16) that the “chairman normally dominates the proceedings” of the FOMC meetings. Thus we estimate separate models for the two sub-periods and test for differences across the two sub-periods.

4. Results Using Publicly Available Data

We first estimate models that include only measures of inflation and real activity. We experimented with the three time spans of the variables and with allowing the coefficients to depend on whether the economy was in a recession. We found that the best time span for inflation, in terms of explanatory power, is one year while the best time span for economic activity is the inter-meeting period.

Table 1 reports estimated models for the Volcker and Greenspan periods. Estimates 1.1 and 1.2 show that, for the Volcker period, the probability of tightening was significantly associated with higher

²⁶ For example, at a meeting in the middle of May, FOMC members would not know the CPI for May or April since the CPI announcement for April is made in the latter part of May. The trade balance for a given month comes out a month and a half later.

²⁷ Variables measured over the past year are averages of monthly data or changes from one year prior to the meeting. All data, except for proprietary data on commodity prices, and a data appendix with precise definitions and sources for all variables are available from the authors.

inflation, as measured by the change in the CPI or PPI, except when the economy was in a recession. Using the CPI or PPI core inflation data produced very similar results. Faster growth in industrial production also raised the probability of tightening.²⁸ When the commodity price measure of inflation is used we find that its effect is unchanged during a recession (estimate 1.3) so the interaction term is dropped in subsequent models. These simple models have statistically significant coefficients but correctly assign the highest probabilities to easing or tightening in only about one quarter of the cases. To see if past decisions have predictive content we added two dummy variables that take the value of one if the FOMC eased or tightened at the previous meeting. Estimate 1.4 gives the results for the PPI measure of inflation, which indicate that the dummy variables are insignificant.²⁹

To see if money growth affected FOMC decisions we employed several measures of growth in M1 and M2. For the period from October 1979 through October 1982 the FOMC supposedly emphasized M1 growth targets. Accordingly, we measure M1 growth separately for this period and for the remainder of the Volcker period. Estimates 1.5 and 1.6 show that faster M1 growth since the previous meeting was significantly related to the probability of tightening during the 1979-82 period but not after. Using longer time spans or deviations from targets to

²⁸ We find no evidence of an interaction between the growth rate of industrial production and recessions. Using the change in the unemployment rate produced similar but less significant results. The use of the NBER recession dates assumes that people can recognize when the economy is in a recession. We also investigated whether the change in unemployment had different effects depending on whether the unemployment rate was above or below the natural rate. We found no evidence of different effects.

²⁹ Using a duration model, Rudebusch (1995) found evidence of persistence in the direction of changes in fed funds rate targets, up to about 25 days. We also estimated a model with only the dummy variables for the past decisions. Although the coefficients on the dummies were not jointly equal to zero, the model did not correctly assign the highest probability to any instance of easing or tightening. Moreover, it is unclear that the public knew the past decision at the time of the next meeting prior to 1994.

measure money growth produce similar results. We also added alternative measures of the trade deficit but these variables were never significant and are not reported.

The estimates for the Greenspan period indicated that commodity price inflation was the only inflation measure to have a systematic relationship to FOMC decisions. Alone or combined with an interaction with the recession dummy, CPI and PPI measures of inflation were never significant. Estimate 1.8 illustrates the lack of a relationship for the CPI. Using the core CPI and PPI measures produced very similar results. The only real activity variable that was linked to FOMC decisions was the rate of change in industrial production. While both higher commodity price inflation and faster growth in industrial production are statistically significant (estimate 1.9), these two variables by themselves never correctly predict an easing or tightening decision. As in the Volcker period, adding dummy variables for the last meeting's decision does not significantly increase the explanatory power of the model. None of our measures of money growth, M1 or M2, or the trade deficit are significant in the Greenspan period.³⁰

To obtain quantitative measures of the effects of the variables on the probability of the FOMC tightening or easing, we computed the change in the estimated probabilities for one standard deviation changes in each of the explanatory variables, with the other variables at their sample means. Using estimate 1.5, the estimated probability of the FOMC voting to tighten increases from about 10% to about 33 % for a one standard deviation increase in PPI inflation when the economy is not in recession. An increase in the growth rate of industrial production of one standard deviation increases the probability of tightening to about 26%. A one standard

³⁰ We estimated a basic model with only commodity price inflation and the growth rate of industrial production for both periods and found that, while the model has less explanatory power in the Greenspan period, one cannot reject the hypothesis that the coefficients are equal.

deviation increase in M1 growth for the 1979-82 period raises the estimated probability of tightening to 21%.³¹ For the Greenspan period (estimate 1.9), the probability of tightening rises from 7% to 17% when commodity price inflation rises by one standard deviation, and to 11 % when industrial production growth rises by the same amount.

Table 2 presents estimates of models that include financial variables. For the Volcker period, estimates 2.1 and 2.4 indicate that adding the inter-meeting changes in the exchange rate, the 10-year bond rate, and stock prices increases the explanatory power of the model, but only the change in the 10-year bond rate is individually significant. The positive sign on the bond rate change is consistent with the interpretation that this variable contains information on expected inflation, but is also consistent with the market anticipating the Fed tightening. Adding the change in the 3-month Treasury bill rate (estimates 2.2 and 2.5) greatly increases the fit of the model, makes the bond rate change insignificant, and makes the change in the exchange rate significant.³² Models with the change in the 3-month bill rate included correctly assign the highest probability to easing and tightening more than half the time in the Volcker period. Holding short-term interest rates constant, the estimates suggest that an appreciating currency reduces the probability of tightening. Tests of the joint significance of the money variables and the change in the long bond rate and stock prices indicate that these variables are not significant when the change in the short rate is included and models excluding these variables are presented in estimates 2.3 and 2.6.

³¹ Using estimate 1.6, an increase in commodity price inflation of one standard deviation increases the probability of tightening to 26%. The effects of industrial production growth and money growth were similar to those from estimate 1.5

³² When the change in the yield curve was included, its coefficient was always negative, inconsistent with the view that a steeper yield curve would increase the probability of a tighter policy. This result appears driven by the large positive effect of the 3-month bill rate.

These estimates indicate the effect of exchange rate changes remains negative but imprecisely estimated. If the Treasury bill coefficient reflects the market's expectation of policy changes, the continued significance of inflation and economic growth suggests that the market did not incorporate all publicly available information that influences the FOMC when forming its expectation of FOMC decisions.

For the Greenspan period, we find that only commodity price inflation and the change in the 3-month bill rate have consistently significant effects for FOMC decisions. As estimates 2.8 and 2.9 indicate, even the addition of the inter-meeting change in the 3-month bill rate does not result in estimates that can correctly assign the highest probability to easing and tightening more than about one-quarter of the time. Similar to the findings of Bernanke and Gertler (1999), we find no evidence of a systematic link between stock price movements and FOMC decisions, despite statements by Greenspan that stock price movements concern the Fed.³³ As noted earlier, this may be due to the identification problem raised by Rigobon and Sack (2001).

If the change in the Treasury bill rate increases by one standard deviation in the Volcker period, the probability of tightening rises to 53% for estimate 2.3 and to 49% for estimate 2.6. For the Greenspan period, a one standard deviation increase in the Treasury bill rate only raises the probability of tightening to about 13%.

A basic model for the entire sample period with commodity price inflation, the growth rate of industrial production and the change in the Treasury bill rate as arguments is reported as estimate 2.10.³⁴ While the model is highly significant it correctly assigns the highest probability to policy changes less than

³³ See for example his "irrational exuberance" speech ["The Challenge of Central banking in a Democratic Society", December 5, 1996] and "Monetary Policy Report to Congress," July 21, 1998. We also looked for threshold effects by including only large swings in stock prices but these were also insignificant.

³⁴We cannot reject the hypothesis that the coefficients are equal over the Volcker and Greenspan samples.

one-third of the time. For the Volcker period, the estimated probabilities are often quite high but there are mistakes in both directions. The estimated probabilities for the Greenspan period, while generally higher around policy changes, rarely exceed .4.

The results reported above suggest that there have been systematic connections between publicly available data and FOMC decisions. But the estimated models only assign the highest probability to the actual decision about one-third to one-half of the time. FOMC decisions appear to be difficult to predict, especially during the Greenspan chairmanship. One possible reason for being unable to anticipate FOMC actions is that the FOMC is using its private forecasts of the economy in making its decisions. We investigate this possibility in the next section.

5. Models including FOMC forecasts

Before each regular FOMC meeting the staff prepares and presents forecasts of economic activity, prices and other variables as well as estimates of current values and summaries of the recent historical values of these variables in the Greenbook, which is distributed to FOMC members. If the FOMC reacts to its private estimates and forecasts, which are not publicly available, then a systematic reaction function may exist even if it is not apparent from public data. Romer and Romer (2000) find that the staff forecasts of inflation are superior to commercial forecasts. Moreover, they find that private forecasters revise their forecasts on the basis of FOMC policy decisions implying that policy actions reveal new information. Therefore, we also consider models using estimates and forecasts from the FOMC Greenbooks. Greenbooks are available with a five-year delay and our sample stops with the November 15, 1995 FOMC meeting.

Estimates 3.1 and 3.5 in Table 3 show that for the Volcker sample staff estimates of faster current real GNP growth and a higher expected rate of inflation in the GNP deflator four quarters in the future both raise the probability of tightening. We find similar results if economic activity is measured by the rate of growth of industrial production (but not the unemployment rate) and if the inflation variable is derived from the CPI, the core CPI or a fixed weight price index. Estimated current inflation, the inflation forecast and the combination of current inflation and the forecasted change in inflation over the following four quarters are all significant for the Volcker sample, but none are significant for the Greenspan sample. Nearly all the expected inflation measures have p-values less than .01 for the Volcker sample.³⁵ Estimated current output growth is significant in both samples.³⁶

We considered two important variations on this model.³⁷ First, we added interaction terms with a recession dummy. These interaction terms are significant for the inflation measures in the Volcker sample, but not for the economic activity variables. Estimates 3.2 and 3.3 indicate that, for the Volcker sample, if the economy is in a recession, current inflation has little net effect on policy changes and expected inflation's effect is approximately halved. Including the interaction terms renders economic activity insignificant in estimates for the Volcker sample. None of the interaction terms are significant in the Greenspan sample. Second, we considered the influence of new information that differed from previous estimates or forecasts. The difference between the current estimate of economic activity and the previous estimate for the current

³⁵ Inflation measures based on the CPI generally have higher p-values than the other measures.

³⁶ Forecasts of future growth rates enter these regressions with negative signs that are sometimes significant. This counter-intuitive result probably reflects the fact that forecast growth rates are highest in recession when tightening is most unlikely. Indeed, if a dummy variable for high unemployment ($U > 7$ percent) is included in the specification, the negative signs on economic growth disappear.

³⁷ We are indebted to two referees for suggesting the specifications discussed in this paragraph.

quarter has a positive effect on the probability of tightening policy. This is found for both samples and for economic activity measured by the growth rates of real GNP and industrial production, and by the unemployment rate.³⁸ However, if the inflation – recession interaction term is included in the model, the revision in the estimate of current economic activity is only significant for the Greenspan sample (estimates 3.4 and 3.8).

A comparison of estimates 3.1 – 3.4 with estimates 3.5 – 3.8 makes it clear that the FOMC responded to different influences in these two periods. Not surprisingly, tests of parameter stability for models based on the Greenbook variables decisively reject stability. The estimates in Table 3 suggest that whereas the Volcker FOMC responded to inflation measures, the Greenspan FOMC responded to economic activity. This generalization is robust over the various measures of the variables and combinations of variables in the models.

The Fed's private information is significantly related to FOMC policy decisions, which implies that our inability to account fully for policy changes may be due to the omission of the Fed's private variables. To test this we estimated regressions with Greenbook variables and publicly available variables together.³⁹ With public data on commodity price inflation, the growth rate of industrial production and the change in the Treasury bill rate included in regressions the Greenbook variables are, in general, not significant. The exception to this is that if only the revisions in the estimates of current real GNP growth or industrial production growth are included in the model for the Greenspan sample along with the public variables, they are significant at the .10 and .05 levels, respectively. Experimentation with a number of variables from the

³⁸ We did not find significant results for revisions to inflation estimates or in the change in the previous four-quarter forecasts.

³⁹ Since the restricted availability of the Greenbook results in an abbreviated sample, we re-estimated our models with

Greenbooks (including estimates and forecasts of net exports, the capacity utilization rate, unemployment and the high-employment surplus) failed to find any other variables that are significant in the presence of these public variables. The Greenbook variables do not appear to contain any information relevant for policy decisions beyond what is in publicly available data. However, the public variables retain their joint significance when included in models with the Greenbook variables. We illustrate these results with estimates 3.9 and 3.10.⁴⁰ Estimate 3.9 shows that the specification of estimate 2.10 is valid for the abbreviated sample covered by the Greenbooks. Estimate 3.10 shows we cannot reject the hypothesis that the Greenbook variable coefficients are zero, while the public variables remain collectively significant and are individually significant except for industrial production growth.⁴¹

The Greenbook variables do not improve the model's ability to assign the highest probability correctly. Estimates in Table 3 show that the Greenbook variables rarely assign the highest probability to policy changes correctly. Comparing estimates 3.9 and 3.10 shows that the Greenbook variables have a minimal effect on the model's ability to assign the highest probability correctly.

only publicly available data for the same time period and found results that were qualitatively identical to those reported in Tables 1 and 2.

⁴⁰ Under the null hypothesis that the coefficients on the Greenbook variables are zero we cannot reject parameter stability. Estimates 3.9 and 3.10 report results for the combined sample.

⁴¹ If we allow the coefficients on the Greenbook variables to differ for the two sub-samples these variables continue to be redundant except for the revision in estimates of economic activity in the Greenspan period.

6. Conclusions

We have examined whether there is a systematic relationship between FOMC decisions and publicly available economic data that would potentially allow the public to predict changes in the stance of monetary policy. We find that the FOMC did systematically respond to measures of inflation and economic activity in the sense that estimated probabilities of tightening were higher after announcements indicating higher inflation or faster economic growth and estimated probabilities of easing were higher after announcements indicating lower inflation and slower growth. However, our results indicate that models using public information on inflation and growth rarely produce high predicted probabilities for actual policy changes. Models that include information on money supply growth, trade deficits, exchange rate changes, or stock price changes also failed to predict policy changes accurately.

There was strong evidence that short-term, and to some extent, long-term interest rates generally move prior to FOMC policy changes with rates rising (falling) before the FOMC tightens (eases). While this finding is consistent with financial markets anticipating policy changes, the statistical significance of inflation and real activity measures suggests that the market does not fully incorporate this information in their expectations of FOMC behavior. More importantly, even models that include inter-meeting changes in interest rates do not forecast policy decisions well, particularly during the Greenspan period. While we find evidence that the FOMC reacts to the private information in its Greenbook forecasts, this information is redundant in models that include publicly available information. We conclude that FOMC decisions are not transparent enough for the public to make accurate predictions of policy changes.

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Table 1
Ordered Probit Models of FOMC Decisions Using Inflation, Real Activity Variables, and Money Growth

	Volcker Period (1979-87)						Greenspan Period (1987-1998)				
	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	1.10	1.11
CPI inflation	.181*** (4.12)						-.074 (-.54)	-.089 (-1.02)			
PPI inflation		.149*** (3.76)		.144*** (3.22)	.127** (2.57)						
Commodity price inflation			.043** (2.45)			.045*** (3.10)			.069*** (3.425)	.065*** (3.14)	.067*** (3.28)
(Inflation measure) *(Recession dummy)	-.124*** (-3.50)	-.121*** (-3.12)	.009 (.33)	-.117*** (-2.96)	-.097** (-2.38)						
Growth rate of industrial production	.036** (2.58)	.032** (2.33)	.027** (2.29)	.030* (1.83)	.041** (2.47)	.039** (2.59)	.047** (2.25)	.044** (2.16)	.043** (1.96)	.036 (1.56)	.050* (1.93)
Eased at previous meeting				-.210 (-.54)						-.521 (-1.14)	
Tightened at previous meeting				.036 (.08)						.256 (.46)	
Growth Rate of M1 for 1979-82					.050** (1.97)	.079*** (2.97)					
Growth Rate of M1 for 1982-87					.007 (.24)	.007 (.29)					
Growth Rate of M2											-.022 (-.72)
χ^2	23.08***	23.61***	21.9***	23.93***	26.57***	30.68***	6.01**	6.99**	18.30***	19.94***	18.84***
Fraction of FOMC Decisions for which the models correctly assign the highest probability											
Ease	1/14	2/14	3/14	3/14	2/14	2/14	0/10	1/10	0/10	2/10	1/10
No change	38/40	38/40	36/40	37/40	38/40	38/40	72/72	72/72	70/72	71/72	70/72
Tighten	5/13	5/13	2/13	4/13	6/13	6/13	0/10	0/10	0/10	0/10	0/10

*, **, *** indicate significance at the .1, .05 and .01 levels. t-statistics are in parentheses.

χ^2 is the Chi-square statistic for the test of the joint hypothesis that all slope coefficients are zero.

Table 2
Ordered Probit Models of FOMC Decisions Including Financial Market Information

	Volcker Period (1979-87)						Greenspan Period (1987-98)			1979-98
	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.10
PPI inflation	.106** (1.98)	.187** (2.32)	.138** (2.00)							
Commodity price inflation				.037** (2.38)	.049* (1.71)	.049** (2.11)	.061*** (2.77)	.054** (2.31)	.054*** (2.60)	.052*** (3.93)
(Inflation measure) *(Recession dummy)	-.079 (-1.61)	-.179* (-1.93)	-.001 (-1.05)							
Growth rate of industrial production	.043** (2.09)	.059** (2.30)	.062** (2.36)	.038** (2.13)	.053** (2.11)	.032* (1.96)	.061* (1.93)	.054 (1.59)	.038 (1.42)	.032** (2.45)
Growth rate of M1 for 1979-82	.051 (1.50)	-.032 (-.53)		.075** (2.39)	.027 (.48)					
Growth rate of M1 for 1982-87	.001 (.034)	-.058 (-1.41)		.002 (.07)	-.049 (-1.25)					
Growth rate of M2							-.040 (-1.19)	-.032 (-.85)		
Change in exchange rate	-.005 (-.60)	-.027** (-2.33)	-.018* (-1.88)	-.053 (-.39)	-.022* (-1.71)	-.013 (-1.46)	.011 (1.50)	.011 (1.31)		
Change in 10 year bond rate	.644** (2.24)	-.613 (-1.21)		.565** (1.99)	-.589 (-1.36)		.956 (1.52)	.167 (.23)		
Change in stock prices	-.001 (-.14)	-.008 (-1.37)		-.001 (-.29)	-.007 (-1.07)		-.002 (-.37)	-.004 (-.75)		
Change in Treasury bill rate		1.962*** (3.15)	1.315*** (3.45)		1.632*** (2.61)	1.256*** (3.68)		1.839** (2.24)	1.958*** (2.84)	1.234*** (4.69)
χ^2	34.65***	68.79***	59.44***	36.37***	66.88***	59.84***	28.78**	35.93***	30.98***	91.47***
Fraction of FOMC Decisions for which the models correctly assign the highest probability										
Ease	6/14	8/14	8/14	5/14	9/14	8/14	2/10	1/10	1/10	7/24
No change	35/40	36/40	35/40	32/40	37/40	34/40	70/72	70/72	71/72	105/112
Tighten	5/13	9/13	6/13	5/13	8/13	6/13	0/10	4/10	3/10	7/23

See notes at bottom of Table 1

Table 3
Ordered Probit Models of FOMC Decisions Including Greenbook Information

	Volcker Period (1979-87)				Greenspan Period (1987-95)				(1979-95)	
	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	3.10
Current Inflation (GNP)		.187*** (3.26)				-.043 (-0.29)				
Expected Inflation (GNP)	.260*** (3.60)		.327*** (4.43)	.263*** (2.77)	-.111 (-0.56)		-.158 (-0.79)	-.114 (-0.49)		-0.057 (-0.53)
(Inflation measure) *(Recession dummy)		-.175*** (-3.50)	-.173*** (-2.80)	-.164*** (-2.59)		.149 (0.60)	.168 (0.58)	-.167 (-0.84)		-0.054 (-0.73)
Growth rate of GNP	.125*** (3.18)	.011 (0.21)	.044 (0.86)		.448*** (2.89)	.525** (2.49)	.524** (2.40)			
Growth rate of GNP Revision in Estimate				.125 (1.37)				.446** (2.56)		.137 (1.19)
Commodity price inflation									.057*** (3.35)	.057*** (2.96)
Growth rate of industrial production									.032** (2.33)	.019 (1.23)
Change in Treasury bill rate									1.218*** (4.40)	1.238*** (4.71)
χ^2	12.18***	16.61***	19.46***	20.27***	17.43***	17.85***	18.24***	12.84***	86.58***	90.23***
χ^2 - Greenbook Variables										3.16
χ^2 - Public Variables										24.64***
Fraction of FOMC Decisions for which the models correctly assign the highest probabilities										
Ease	0/14	0/14	2/14	1/14	2/6	2/6	2/6	1/6	7/20	7/20
No change	39/40	38/40	37/40	36/40	48/52	47/52	49/52	50/52	85/92	86/92
Tighten	3/13	3/13	6/13	7/13	0/9	0/9	0/9	0/9	7/22	8/22

See notes at bottom of Table 1

χ^2 - Greenbook Variables is the Chi-square statistic for the joint hypothesis that all coefficients on the Greenbook variables are zero.

χ^2 - Public Variables is the Chi-square statistic for the joint hypothesis that all coefficients on the public variables are zero.

Figure 1
Cumulative Policy Changes
July 1979 - December 1998

