Federal Reserve Information and the Behavior of Interest Rates

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This paper tests for the existence of asymmetric information between the Federal Reserve and the public by examining Federal Reserve and commercial inflation forecasts. It demonstrates that the Federal Reserve has considerable information about inflation beyond what is known to commercial forecasters. It also shows that monetary-policy actions provide signals of the Federal Reserve's information and that commercial forecasters modify their forecasts in response to those signals. These findings may explain why long-term interest rates typically rise in response to shifts to tighter monetary policy. (*JEL* E52, E43, D82)

Asymmetric information between the Federal Reserve and the public is a phenomenon that is often posited but rarely tested. Numerous models of central-bank behavior, for example, show that the existence of asymmetric information has important implications for the effectiveness of policy and the consequences of dynamic inconsistency.[1] Yet, there is little evidence concerning whether the Federal Reserve does indeed possess information about the state of the economy that is not known by the public.

Asymmetric information between the Federal Reserve and the public is also often mentioned as a possible explanation for a puzzling empirical phenomenon: the response of long-term interest rates to monetary-policy actions. Standard theories of the effects of monetary policy imply that an exogenous shift to tighter policy raises short-term interest rates temporarily by raising real rates, but lowers them in the long run by reducing inflation. When these theories are coupled with the expectations theory of the term structure, they predict that a shift to tighter policy lowers interest rates on bonds of sufficiently long maturities. In fact, however, when the Federal Reserve undertakes contractionary open-market operations, interest rates for securities of all maturities typically rise (Timothy Cook and Thomas Hahn, 1989a). These increases occur on the day of the action and occur even when the actions are planned in advance; thus they must represent responses to the actions themselves. A common explanation of the increases is that when the Federal Reserve tightens policy, market participants infer that it has unfavorable information about the likely behavior of inflation, and they therefore revise their expectations of inflation upward. It is this upward revision in inflation expectations caused by the revelation of Federal Reserve information that causes long-term interest rates to rise.

In this paper we use Federal Reserve and commercial forecasts to test whether the central bank actually does possess additional information about the current and future states of the economy. The key idea is that information the Federal Reserve has about the economy that is not known to market participants is likely to be reflected in the Federal Reserve's internal forecasts. Because the Federal Reserve makes its forecasts public only after five years, the forecasts can contain information that is not known contemporaneously by market participants. In this analysis we look primarily at the Federal Reserve's knowledge about inflation, because

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[1] See, for example, Thomas J. Sargent and Neil Wallace (1975), Robert J. Barro (1976), Barro and David B. Gordon (1983), Matthew B. Canzoneri (1985), and Alex Cukierman and Allan H. Meltzer (1986).

we then use the results to test the asymmetric-information explanation of the response of interest rates to monetary actions. However, to check the robustness of our results, we also look for asymmetric information about the path of real output.

This analysis of asymmetric information and its implications for the behavior of interest rates proceeds in several steps. Section I describes the forecast data that we use. It also presents preliminary diagnostic tests of the rationality of the various forecasts.

Section II then investigates whether the Federal Reserve has information about inflation beyond what is known by market participants. Specifically, we ask whether, given commercial forecasts of inflation, the Federal Reserve forecasts are useful in predicting inflation. To analyze this question, we examine regressions of inflation on commercial and Federal Reserve forecasts. We find that the Federal Reserve possesses statistically significant and quantitatively important additional information. In a typical regression, the coefficient on the commercial forecast is small and insignificant while that on the Federal Reserve forecast is substantial and highly significant. This suggests that the optimal forecasting strategy of someone with access to both forecasts would be to put essentially no weight on the commercial forecast. These findings are robust across forecasting horizons, commercial forecasters, and sample periods. We also find that the Federal Reserve possesses equally important additional information about the path of future output. We argue that the Federal Reserve's information advantage stems not from early access to government statistics or inside information about monetary policy, but rather from the vast resources it devotes to forecasting.

Section III turns to the link between Federal Reserve information and the behavior of interest rates. For the asymmetric-information hypothesis to explain why long-term rates rise following a monetary contraction, it is not enough that the Federal Reserve possesses useful information about future inflation. It is also necessary that monetary actions provide signals of this information and that market participants respond to these signals. And these effects must be large enough to explain the anomalous movements in interest rates that we observe.

To address the signaling issue, we ask whether it is rational for market participants to make inferences about the Federal Reserve's inflation forecasts from its policy actions. Specifically, we regress the Federal Reserve forecast on the contemporaneous commercial forecast and an indicator of Federal Reserve actions. The results of these tests, although not as strong as the results concerning the existence of asymmetric information, support the hypothesis that the Federal Reserve's actions signal its information.

To address the response issue, we examine whether Federal Reserve actions actually affect market participants' forecasts of inflation. Specifically, we regress the commercial forecasters' next forecast of inflation on an indicator of monetary actions and their current forecast, controlling for the arrival of other information about inflation between the two forecast dates. The results of these regressions are broadly similar to those concerning the information content of the Federal Reserve's actions. The estimates suggest that commercial forecasters raise their expectations of inflation in response to contractionary Federal Reserve actions, but that they do so by slightly less than one would expect given the earlier results.

We then use the quantitative estimates from these tests to see if the effects are large enough to explain the observed response of interest rates at different horizons to monetary-policy actions. We find that between a fifth and a half of the rise in short-term rates following a contractionary action can be accounted for by changes in expected inflation caused by the revelation of Federal Reserve information. Simple simulations suggest that the effects of information revelation may be even more important at longer horizons. We find that between half and all of the rise in long-term rates in response to monetary contractions may be due to the revelation of Federal Reserve information.

I. Data

We use inflation forecasts from both the Federal Reserve and commercial forecasters. We view the commercial forecasts as being the expectations of market participants, or at least a key input into their expectation formation. This view is consistent with the fact that some of the commercial forecasts we consider are created by firms managing large portfolios; thus, they *are* the forecasts of market participants. It is also consistent with the fact that market participants pay for the commercial forecasts, suggesting that they view information processing as difficult and commercial forecasts as valuable. Given this, it is plausible that market participants will just adopt the commercial forecasts as their own or use them as a key starting point in their analysis.[2]

An alternative view that is also consistent with our focus on commercial forecasts is that commercial forecasts are representative of market participants. In this view, the commercial forecasts are merely a well-documented example of the expectation-formation process of market participants. In either view, one can use an analysis of the relationship between commercial forecasts and the Federal Reserve forecasts to see if the Federal Reserve has information about future inflation that is not known to market participants.

A. *Forecasts*

We consider forecasts from the Federal Reserve and three commercial forecasters. The particular inflation forecasts we analyze are those for the GNP deflator.[3] We also consider forecasts for real GNP in a robustness check on the inflation results. This section therefore describes the sources of the Federal Reserve and commercial forecasts. It also discusses issues of consistency and timing related to these data.

The Federal Reserve forecasts are contained in the "Green Book" prepared by the staff of the Board of Governors before each meeting of the Federal Open Market Committee (FOMC). These forecasts are available for the period 1965:11–1991:11.[4] The Green Book typically forecasts inflation and real GNP growth for five or six quarters into the future, though the horizon of the forecast varies over time and with the date of the FOMC meeting.

Because the Federal Reserve forecasts are tied to FOMC meetings, there are no forecasts in months when the FOMC does not meet. In the late 1960's and 1970's, there are forecasts almost every month; in the 1980's, there are typically eight forecasts per year. The time of the month when the forecast is made also varies, because the date of the FOMC meeting varies. FOMC meetings more often occur during the first half of the month, but the pattern is not regular.[5]

The first set of commercial forecasts is from Blue Chip Economic Indicators.[6] Around the fifth of each month, Blue Chip surveys economic forecasters at approximately 50 banks, corporations, and consulting firms. It then produces a consensus forecast (which is the median

[2] As David S. Scharfstein and Jeremy C. Stein (1990), Owen Lamont (1995), Tilman Ehrbeck and Robert Waldmann (1996), and others point out, there may be agency problems between commercial forecasters and their clients that cause forecasters not to report their true expectations of inflation. This is unlikely to be a problem for our investigation, however. To begin with, simple models of agency problems imply that forecasters are concerned about the accuracy of their forecasts and about their forecasts relative to others' forecasts. As a result, the models imply that forecasters' predictions are centered around their true expectations, and thus that median forecasts, which are what we mainly consider, reflect forecasters' true expectations (Lamont, 1995). More importantly, the hypothesis that the Federal Reserve's apparent additional information is in fact known to market participants requires that the market participants pay for forecasts that they know to be biased, despite the fact that they possess enough information to produce forecasts incorporating all of the information contained in the forecasts of a large organization (the Federal Reserve) that devotes vast resources to forecasting. Finally, Ehrbeck and Waldmann (1996) find that agency models' predictions are rejected in the data.

[3] The obvious alternative is the Consumer Price Index (CPI). We use the GNP deflator for two reasons. First, forecasts for the GNP deflator are available for a much longer sample period. Second, interest rates were included in the CPI until 1983. This greatly complicates the analysis of the link between inflation forecasts and monetary policy.

[4] The end date is determined primarily by the Federal Reserve's policy of releasing information with a five-year lag. However, we choose to stop the sample in 1991:11 to avoid the awkwardness of the switch from GNP to GDP in the government statistics. Dean Croushore of the Federal Reserve Bank of Philadelphia provided a machine-readable version of the Green Book forecasts for the GNP deflator. We updated and revised his series using a hard copy provided by the Board of Governors. The real GNP forecasts were obtained from the same documents provided by the Board of Governors.

[5] Occasionally, there are two or more Federal Reserve forecasts in a single month. This is especially common in the late 1960's and 1970's. In our analysis, we use either the first or last forecast in a given month, depending on whether the particular application calls for a forecast that is early or late in the month.

[6] The historical Blue Chip Economic Indicators were purchased from Capitol Publications, Inc.

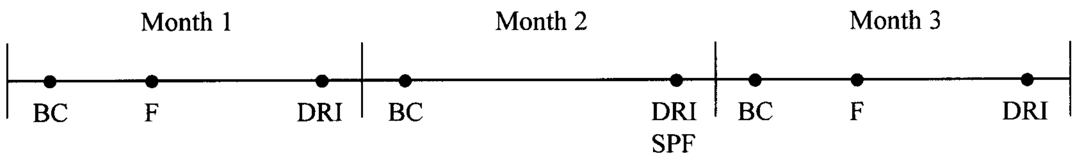

FIGURE 1. TIMING OF FORECASTS IN A TYPICAL QUARTER

Note: BC is the abbreviation for Blue Chip Economic Indicators, F is for the Federal Reserve, DRI is for Data Resources, Inc., and SPF is for the Survey of Professional Forecasters.

of the individual forecasts) for the percentage change in the GNP deflator and real GNP over each of the next six or seven quarters. The Blue Chip forecasts are available starting in 1980:1.

The second set of commercial forecasts is prepared by Data Resources, Inc. (DRI).[7] DRI produces three forecasts each quarter; one early, one late, and one in the middle of the quarter. For comparability with monthly forecasts from other sources, we assign the early forecast to the first month in the quarter, the middle forecast to the second month, and the late forecast to the third month. The early and late forecasts are available starting in the third quarter of 1970, so the monthly start date is 1970:7. Because the middle forecast is not available until the first quarter of 1980, there are many missing observations for the first decade. Each forecast is made relatively late in the month. The forecast horizon is typically seven quarters.

The third set of commercial forecasts is from the Survey of Professional Forecasters (SPF), currently conducted by the Federal Reserve Bank of Philadelphia. This survey continues the American Statistical Association/National Bureau of Economic Research Economic Outlook Survey. Like the Blue Chip Economic Indicators, the Survey of Professional Forecasters is based on many commercial forecasts. We again use the median forecast. The SPF is conducted near the end of the second month of each quarter. For comparison with our other forecasts, which are monthly, we treat the Survey of Professional Forecasters as a monthly series available only in February, May, August, and November. Since the SPF forecasts for the GNP deflator begin in the fourth quarter of 1968, the first observation on a monthly basis is 1968:11. Likewise, since the SPF forecasts for real GNP growth begin in the third quarter of 1981, the first monthly observation is 1981:8.[8] The forecast horizon for both inflation and real growth is four quarters.

Figure 1 summarizes the timing of the various forecasts for a typical quarter. It shows that the Blue Chip surveys occur early in each month, the DRI forecasts occur late in each month, and the Survey of Professional Forecasters occurs at the end of the middle month of the quarter. We have placed the timing of the Federal Reserve's forecast slightly before the middle of the month to reflect the average date of these forecasts; however, the actual date of the forecasts varies from month to month. Likewise, we have shown a Federal Reserve forecast in the first and third months of the quarter to reflect the fact that Federal Reserve forecasts are made roughly two months out of three. Again, the actual months in which forecasts are made vary from quarter to quarter.

The time line also helps clarify the time-series nature of our data. We have monthly observations of forecasts of inflation various numbers of quarters in the future. For example, we have monthly predictions of inflation two quarters ahead for each forecaster. Our subse-

[7] The DRI forecasts were collated and provided by Stephen K. McNees of the Federal Reserve Bank of Boston. They are used with permission from DRI. The forecasts are for the level of the GNP deflator and real GNP. Forecasts for inflation and real growth are calculated as quarterly percentage changes at an annual rate.

[8] We use a version of the forecasts compiled by Dean Croushore of the Federal Reserve Bank of Philadelphia. Like DRI, the SPF forecasts the level of the GNP deflator and real GNP. Forecasts for inflation and real growth are again calculated as quarterly percentage changes at an annual rate.

quent regressions will analyze the behavior of the forecasts for a given horizon made in a certain month by each forecaster.

B. *Data on Actual Inflation and Output*

One data issue involves the appropriate actual series to use for comparison with the various forecasts. Because the U.S. Commerce Department data on the GNP deflator and real GNP are continually revised, a choice has to be made about which revision to use. GNP statistics for a quarter are first released toward the end of the first month following the quarter. Because some component series are not available, these initial estimates are subject to a substantial margin of error. They are revised at the end of the second month following the quarter, and again at the end of the third month as more data become available. There is a comprehensive annual revision each July and a rebenchmarking and conceptual reworking roughly every five years.

We use the second revision (done at the end of the subsequent quarter) in our analysis. The data are collected from the June, September, December, and March issues of the *Survey of Current Business.* To ensure consistency in the calculation of growth rates, the current and previous quarter data are always taken from the same issue of the *Survey.*

We feel that the second revision is the appropriate series to use because it is based on relatively complete data, but is still roughly contemporaneous with the forecasts we are analyzing. This series does not include the rebenchmarking and definitional changes that occur in the annual and quinquennial revisions. As a result, it should be conceptually similar to the series being forecast. At the same time, it does not have the errors associated with the incomplete initial estimates.[9]

[9] Redoing our tests using the most recently available data has little effect on the results. It is perhaps interesting to note that the award given by the Blue Chip Economic Indicators to the forecaster with the best record is based on a comparison of forecasts over the past four years with the most revised data available. Thus, at least for this one highly publicized award, forecasters are judged on their ability to predict the government's best estimate of GNP (and three other series) rather than the initial estimates.

C. *Serial Correlation*

In regressions comparing forecasts and actual data, there is inevitably the problem that forecast errors are serially correlated and that the serial correlation increases as the horizon for the forecasts becomes longer. To see this, consider the implication of an unexpected rise in inflation in the fourth quarter of 1990 for forecasts of inflation three quarters ahead. This would clearly cause positive forecast errors for the January, February, and March 1990 forecasts, since in all three cases forecasters are predicting inflation in the fourth quarter of 1990. But the fact that inflation is serially correlated also means that the forecast errors would tend to be positive for the forecasts of inflation three quarters ahead made in April through December 1990—that is, until forecasters could incorporate the rise in inflation in the fourth quarter of 1990 into their forecasts.

To deal with this potential problem, we calculate robust standard errors for all of our regressions. Specifically, when we consider forecasts for inflation h quarters ahead, the standard errors are computed correcting for heteroskedasticity and for serial correlation over $h + 1$ quarters [that is, over $3(h + 1)$ months]. For example, when we consider the Blue Chip forecast (which is available every month) for three quarters ahead, the standard errors allow for heteroskedasticity and for 12th-order serial correlation. We follow Lars P. Hansen and Robert J. Hodrick (1980) in putting full weight on the serial correlation over all $h + 1$ quarters, rather than using the Bartlett window approach of Whitney K. Newey and Kenneth D. West (1987).[10]

D. *Forecast Rationality*

Before testing for asymmetric information, it is useful to examine the rationality of the forecasts. The view that market participants take a commercial forecast as their baseline or as a key input into their expectation-formation process makes sense only if the forecasts are not grossly

[10] The Hansen-Hodrick procedure occasionally yields negative variances and, thus, undefined standard errors. In such cases, we report Newey-West standard errors instead. These cases are noted in the tables.

TABLE 1—RATIONALITY TESTS FOR INFLATION FORECASTS
$\pi_{ht} = \alpha + \beta\hat{\pi}_{ht} + \epsilon_{ht}$

Forecast horizon (Quarters)	α	β	p-value	R^2	N
Blue Chip					
0	−0.41 (0.36)	1.02 (0.08)	0.082	0.76	143
1	−0.67 (0.42)	1.02 (0.09)	0.004	0.69	143
2	−0.71 (0.75)	0.98 (0.17)	0.001	0.62	143
3	−0.52 (1.07)	0.90 (0.23)	0.001	0.53	143
4	0.58 (0.76)	0.63 (0.13)	0.000	0.31	138
5	1.05 (1.10)	0.48 (0.19)	0.000	0.22	102
6	1.46 (0.92)	0.33 (0.13)	0.000	0.19	66
DRI					
0	0.26 (0.27)	0.97 (0.06)	0.559	0.76	219
1	0.91 (0.37)	0.87 (0.07)	0.052	0.56	219
2	0.80 (0.46)	0.88 (0.09)	0.228	0.47	219
3	1.27 (0.89)	0.76 (0.17)	0.342	0.35	219
4	1.88 (1.25)	0.63 (0.23)	0.263	0.23	219
5	2.43 (1.49)	0.52 (0.27)	0.202	0.15	219
6	3.16 (1.87)	0.37 (0.32)	0.144	0.07	219
7	3.53 (1.99)	0.28 (0.34)	0.089	0.04	217
SPF					
0	−0.12 (0.41)	1.05 (0.08)	0.569	0.71	93
1	0.42 (0.50)	0.97 (0.10)	0.275	0.50	93
2	0.88 (0.83)	0.89 (0.16)	0.442	0.33	93
3	1.76 (1.06)	0.71 (0.19)	0.253	0.20	93
4	2.08 (1.19)	0.65 (0.22)	0.217	0.16	88
Federal Reserve					
0	0.03 (0.33)	1.03 (0.07)	0.479	0.78	251
1	0.34 (0.47)	1.00 (0.11)	0.280	0.60	242
2	0.74 (0.58)	0.95 (0.12)	0.275	0.44	224
3	0.34 (0.72)	1.03 (0.13)	0.534	0.43	207
4	0.12 (0.99)	1.05 (0.17)	0.656	0.38	177
5	−0.16 (1.15)	1.06 (0.22)	0.922	0.34	118
6	−0.80 (1.14)	1.09 (0.28)	0.312	0.47	61
7	−1.19 (1.43)	1.03 (0.36)	0.000	0.53	38

Notes: π denotes inflation, and $\hat{\pi}$ denotes the inflation forecast; h and t index the horizon and date of the forecast. The sample periods are 1980:1–1991:11 for Blue Chip; 1970:7–1991:11 for DRI; 1968:11–1991:11 for SPF; and 1965:11–1991:11 for the Federal Reserve. Numbers in parentheses are robust standard errors. The p-value is for the test of the null hypothesis $\alpha = 0$, $\beta = 1$.

irrational. Therefore, we present a simple test of the rationality of the forecasts.

Let π_{ht} denote actual inflation in the quarter h quarters after month t. For example, if $t =$ January 1990 and $h = 3$, then π_{ht} is actual inflation in the fourth quarter of 1990 (that is, the percentage change in the price level at an annual rate from the third to the fourth quarter of 1990). Similarly, let $\hat{\pi}_{ht}$ denote a forecast of π_{ht} that is made in month t. To test for forecast rationality, we estimate regressions of the form:

$$\pi_{ht} = \alpha + \beta\hat{\pi}_{ht} + \epsilon_{ht}, \tag{1}$$

and test the implication of rationality that $\alpha = 0$ and $\beta = 1$. The standard errors are corrected for serial correlation and heteroskedasticity as described above. For completeness, we analyze the rationality of each of the commercial forecasts and of the Federal Reserve forecasts.

Table 1 reports the results. The null hypothesis of rationality is almost never rejected at conventional significance levels for the DRI, Survey of Professional Forecasters, or Federal Reserve forecasts. It is, however, consistently rejected for the Blue Chip forecasts.

Further investigation shows that these rejections are due to the large weight of the Volcker disinflation in the Blue Chip sample, which does not begin until 1980. When the other forecasts are restricted to the same start date, they too fail the rationality test. And when the forecasts are restricted to the period after the disinflation, none consistently fail the test. The failure of the forecasts to satisfy the usual criteria for rationality during a large regime shift is not surprising.

Table 1 also shows that essentially all of the forecasts contain important information about inflation. The estimates of β, although often less than one, are almost all above one-half and significantly greater than zero. This further suggests that starting with such forecasts as a baseline is a sensible strategy.[11]

II. Does the Federal Reserve Have Additional Information?

This section compares commercial forecasts of inflation with those of the Federal Reserve. Our method of comparison reflects the question we are asking. Our main interest is in whether the Federal Reserve's forecasts contain information that would be useful to market participants. Therefore, we focus on the issue of whether individuals who know the commercial forecasts could make better forecasts if they also knew the Federal Reserve's.

A. *Specification*

As before, let π_{ht} denote actual inflation h quarters after month t. Let $\hat{\pi}^C_{ht}$ and $\hat{\pi}^F_{ht}$ denote the commercial and Federal Reserve forecasts of π_{ht} in month t. Suppose that market participants are using the commercial forecast as their baseline forecast or forming expectations by making linear projections of inflation on the forecast information they have. If the Federal Reserve forecast becomes available, market participants could use this information by making a linear projection of actual inflation on the commercial and Federal Reserve forecasts. That is, their forecasts would be the fitted values of

$$\pi_{ht} = \delta + \gamma_C \hat{\pi}^C_{ht} + \gamma_F \hat{\pi}^F_{ht} + \nu_{ht}. \tag{2}$$

In this regression, the Federal Reserve forecast is useful in predicting inflation if and only if γ_F differs from zero. Thus, testing whether the Federal Reserve forecast contains valuable information requires estimating regressions like (2) and testing whether γ_F differs from zero.

In our basic regressions, we consider forecasts for each quarter separately. An alternative is to examine forecasts of average inflation over various horizons. That is, one can estimate equations of the form:

$$\bar{\pi}_{ht} = \delta + \gamma_C \hat{\bar{\pi}}^C_{ht} + \gamma_F \hat{\bar{\pi}}^F_{ht} + \bar{\nu}_{ht}, \tag{3}$$

where $\bar{\pi}_{ht}$ is average inflation up to horizon h and $\hat{\bar{\pi}}^C_{ht}$ and $\hat{\bar{\pi}}^F_{ht}$ are the commercial and Federal Reserve forecasts of $\bar{\pi}_{ht}$.[12] The regressions using averages provide useful summaries of the overall relationship between inflation and the forecasts. They also provide a check that the relationship is systematic rather than the result of quarter-to-quarter noise.

B. *Basic Results*

The results of estimating equation (2) for each commercial forecaster and each forecast horizon are presented in Table 2. Our main interest is in γ_F, the coefficient on the Federal Reserve forecast. The estimates indicate overwhelmingly that the Federal Reserve possesses valuable information not contained in the

[11] We have also estimated versions of equation (1) that include lagged inflation and the forecaster's previous forecast error as right-hand-side variables. We choose the timing of these variables so as to ensure that they were available at the time of the forecasts. The results again support the rationality of the forecasts. Lagged inflation and the lagged forecast error have no consistent predictive power for inflation given the forecasts, and including these variables has little impact on the p-values for the test of the hypothesis that $\beta = 1$ and that the other coefficients are all zero.

[12] For example, $\bar{\pi}_{4t}$ is the average of π_{0t}, π_{1t}, π_{2t}, π_{3t}, and π_{4t}; $\hat{\bar{\pi}}^C_{4t}$ is the average of $\hat{\pi}^C_{0t}$, $\hat{\pi}^C_{1t}$, $\hat{\pi}^C_{2t}$, $\hat{\pi}^C_{3t}$, and $\hat{\pi}^C_{4t}$.

TABLE 2—TESTS OF FEDERAL RESERVE ADDITIONAL INFORMATION FOR INFLATION

$$\pi_{ht} = \delta + \gamma_C \hat{\pi}^C_{ht} + \gamma_F \hat{\pi}^F_{ht} + \nu_{ht}$$

Forecast horizon (Quarters)	δ	γ_C	γ_F	R^2	N
Blue Chip					
0	−0.06 (0.40)	0.35 (0.23)	0.64 (0.18)	0.83	97
1	0.49 (0.52)	−0.35 (0.27)	1.21 (0.20)	0.81	97
2	0.56 (0.45)	−0.30 (0.25)	1.12 (0.22)	0.70	97
3	0.22 (0.60)	−0.34 (0.32)	1.23 (0.25)	0.71	97
4	0.18 (0.68)	−0.31 (0.32)	1.19 (0.37)	0.54	93
5	0.64 (1.17)	−0.23 (0.41)	0.93 (0.49)	0.37	69
6	1.30 (0.77)	0.55 (0.18)	−0.20 (0.18)	0.27	38
μ (0–4)	0.50 (0.36)	−0.28 (0.21)	1.11 (0.21)	0.91	93
DRI					
0	−0.17 (0.34)	0.39 (0.16)	0.66 (0.18)	0.80	170
1	0.10 (0.43)	−0.03 (0.21)	1.04 (0.23)	0.62	170
2	0.27 (0.50)	−0.19 (0.20)	1.18 (0.18)	0.49	168
3	−0.16 (0.57)	−0.24 (0.30)	1.32 (0.29)	0.48	161
4	−0.51 (0.65)	−0.65 (0.38)	1.80 (0.41)	0.46	146
5	−0.67 (0.85)	−0.72 (0.49)	1.87 (0.53)	0.41	105
6	−0.81 (1.05)	−0.33 (0.43)	1.45 (0.55)	0.45	60
7	−1.51 (1.49)	−0.30 (0.38)	1.42 (0.66)	0.54	38
μ (0–4)	−0.15 (0.41)	−0.53 (0.36)	1.57 (0.38)	0.74	146
SPF					
0	−0.00 (0.38)	0.15 (0.19)	0.88 (0.18)	0.76	79
1	0.46 (0.47)	−0.47 (0.21)	1.45 (0.21)	0.64	79
2	1.55 (0.77)	−0.78 (0.44)	1.57 (0.38)	0.49	78
3	1.27 (0.83)	−0.83 (0.33)	1.70 (0.32)	0.46	73
4	0.72 (0.81)	−0.93 (0.36)	1.89 (0.34)	0.48	64
μ (0–4)	1.09 (0.53)	−1.08 (0.38)	1.93 (0.35)	0.75	64

Notes: π denotes inflation, and $\hat{\pi}^C$ and $\hat{\pi}^F$ denote commercial and Federal Reserve inflation forecasts; h and t index the horizon and date of the forecasts. The sample periods are 1980:1–1991:11 for Blue Chip; 1970:7–1991:11 for DRI; and 1968:11–1991:11 for SPF. Numbers in parentheses are robust standard errors. The forecast horizon μ (0−4) refers to the average of 0 to 4 quarters ahead.

commercial forecasts. For horizons farther ahead than the current quarter, the point estimates of γ_F are typically between 1.0 and 1.5. For the current quarter, they are smaller, but still over 0.5. Most of the estimates are highly significant, and all but two are significant at the 5-percent level.

In addition, the estimates of γ_C, the coefficient on the commercial forecast, are typically small. In fact, most of the point estimates are negative, though not statistically significant at conventional levels. In only two cases is the estimate significantly larger than zero at even the 10-percent level. Thus, an individual with access to both forecasts would want to put little weight on the commercial forecast. And since the estimates of γ_F are generally close to one, simply using the Federal Reserve forecast is close to the optimal way of combining the two forecasts.

Table 2 also reports the results of using the average forecasts up to four quarters ahead (the longest horizon for which all of the commercial forecasts are available); that is, it reports estimates of equation (3) with $h = 4$. The estimates of γ_F, the optimal weight on the Federal Reserve forecast, are large and highly significant. Thus, it does not appear that quarter-to-quarter noise is driving our finding of substantial Federal Reserve additional information.[13]

C. *Sources of the Federal Reserve's Information Advantage*

Given our findings, it is natural to consider the source of the Federal Reserve's information advantage. In this regard, it is easier to identify factors that are not important than those that are. First, the Federal Reserve's additional information is probably not due to inside information about monetary policy. Monetary policy appears to have little impact on output and the price level for at least three to four quarters (see, for example, Robert J. Gordon, 1993; and Romer and Romer, 1994). Yet, the Federal Reserve forecast is valuable in predicting inflation just one or two quarters ahead. The fact that the Federal Reserve forecasts continue to have value at fairly distant horizons could indicate that staff members have inside information about the FOMC's commitment to a given policy. However, evidence presented in the next section contradicts this interpretation.

The advantage is also almost surely not due to the Federal Reserve gaining access to official data earlier than commercial forecasters. The Chairman of the Federal Reserve receives data on economic variables such as unemployment and inflation only the night before they are released to the public, and access to these advance data is tightly restricted within the Federal Reserve. Even if the advance data were available to Federal Reserve forecasters, a day's lead time would not give them a net advantage over the Survey of Professional Forecasters and DRI, since the Federal Reserve forecast is typically made well before these commercial forecasts. Furthermore, the Federal Reserve forecast is valuable in predicting inflation many quarters ahead. One would expect a data advantage to be of most use at very short horizons.

It is possible that the Federal Reserve receives unofficial information from business leaders and bankers. Whether such potentially unrepresentative reports could consistently improve its forecasts is highly questionable. Furthermore, even if such reports were the source of the Federal Reserve's advantage, it does not follow that this information is not available to commercial forecasters. We suspect that the Federal Reserve receives such reports for the most part not because of its official status, but simply because it has an enormous network of regional employees.

More generally, we believe that the most likely explanation for the Federal Reserve's additional information is that the Federal Reserve commits far more resources to forecasting than even the largest commercial forecasters. As a result, it is able to produce superior forecasts from publicly available information. Under this interpretation, the Federal Reserve has no inherent forecasting advantage. It has the same "technology" as commercial forecasters for converting labor and data into forecasts. It simply chooses to use more of these inputs than any commercial forecasters find profitable, and so obtains forecasts that have value beyond the information contained in commercial forecasts.

D. *Robustness*

Outliers.—One way that we check the robustness of our results is to examine the contribution of outliers. Figure 2 is a scatterplot for a typical regression of the component of inflation orthogonal to the commercial forecast against the component of the Federal Reserve forecast orthogonal to the commercial forecast; it is this partial association that underlies the estimate of γ_F in equation (2). The particular commercial forecast series and horizon represented are the three-quarter-ahead forecast from DRI. However, the plots for other forecasters and other horizons are similar.

The scatterplot makes it clear that the explanatory power of the Federal Reserve forecast for inflation is not the result of outliers: there is a consistent positive relationship between the two series. Times when the Federal Reserve forecast is unusually high given the commercial forecast are generally times when inflation is unusually high given the commercial forecast, and the reverse pattern holds in times when the Federal Reserve forecast is unusually low given the commercial forecast.

Timing Disadvantage.—We next test the robustness of the results to a different specification of the relative timing of the Federal

[13] Looking at the average forecasts over other horizons yields similar results.

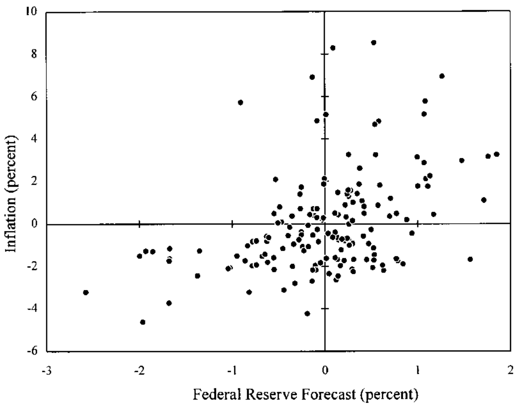

FIGURE 2. PARTIAL ASSOCIATION OF INFLATION AND FEDERAL RESERVE FORECAST

Note: The figure shows the components of actual inflation and of the Federal Reserve forecast that are orthogonal to the DRI forecast. The forecast horizon is three quarters.

Reserve and commercial forecasts. In the basic specification, we use forecasts made in the same month. Because the Blue Chip surveys are done at the beginning of the month while the Federal Reserve forecasts are done throughout the month, this specification gives the Federal Reserve a potential advantage simply because it has more data. And if some Blue Chip participants report forecasts made a week or two before the date of the survey, the advantage is even greater.[14] For the DRI and SPF forecasts, which are done late in the month, our specification puts the Federal Reserve at a disadvantage, except to the extent that some participants in the SPF report out-of-date forecasts.

To ensure that any possible advantage that our basic specification gives the Federal Reserve does not account for our results, we do the experiment of putting the Federal Reserve at a deliberate timing disadvantage. We reestimate equation (2) replacing $\hat{\pi}^F_{ht}$, the Federal Reserve's forecast in month t of inflation h quarters later, with its forecast in month $t - 1$ of inflation h quarters after month t. This specification puts the Federal Reserve at a clear disadvantage relative to all three commercial forecasters. Table 3 shows that when we do this, the Federal Reserve forecast remains a powerful predictor of inflation. Indeed, neither the sizes of the coefficients nor the t-statistics are substantially reduced by this change.

Multiple Forecasts.—In a third test of the robustness of the results, we examine whether the Federal Reserve's inflation forecast contains useful information beyond that contained in two or more commercial forecasts. Since many market participants presumably do not have access to multiple commercial forecasts, this test is likely to understate the value of the Federal Reserve's information.

We have multiple commercial forecasts for the same month starting only in 1980. This is true because Blue Chip forecasts do not begin until 1980 and DRI forecasts are not available in the middle month of the quarter (which is when the SPF forecast is available) before 1980. Our analysis of multiple forecasts is therefore limited to the period 1980–1991. For this period we consider two combinations of commercial forecasts: Blue Chip and DRI forecasts (for which we have observations every month), and Blue Chip, DRI, and SPF forecasts (for which we are limited to one observation per quarter). We regress actual inflation on the Federal Reserve forecast and either the Blue Chip and DRI forecasts or all three commercial forecasts.

The results of this exercise are reported in Table 4. They are only slightly weaker than when individual commercial forecasts are considered. For the current quarter in both specifications and for the six-quarter horizon using Blue Chip and DRI, the Federal Reserve forecast is of little value in predicting inflation. But in every other case, the estimated weight on the Federal Reserve forecast is close to one, usually with a t-statistic over three.

Overall Forecast Accuracy.—Our results suggest that someone with access to both the Federal Reserve and commercial forecasts should not just put positive weight on the Federal Reserve forecast, but put little weight on the commercial one. This suggests that the Federal Reserve may be forecasting inflation more accurately than the commercial forecasters are. Specifically, one can show that if the Federal Reserve and commercial forecasts are unbiased (or equally biased) and forecasters' errors are uncorrelated with their fore-

[14] If, however, one thinks of the survey as an input into market participants' expectations formation rather than as a proxy for their expectations, the relevant date is when the survey is published, not when the forecasts are made.

TABLE 3—TESTS OF FEDERAL RESERVE ADDITIONAL INFORMATION FOR INFLATION WITH FEDERAL RESERVE AT A TIMING DISADVANTAGE

$$\pi_{ht} = \delta + \gamma_C \hat{\pi}^C_{ht} + \gamma_F \hat{\pi}^F_{h,t-1} + \nu_{ht}$$

Forecast horizon (Quarters)	δ	γ_C	γ_F	R^2	N
Blue Chip					
0	0.04 (0.46)	0.28 (0.26)	0.67 (0.18)	0.81	97
1	0.23 (0.47)	−0.19 (0.27)	1.09 (0.21)	0.78	97
2	0.18 (0.45)	−0.25 (0.26)	1.13 (0.22)	0.72	97
3	0.03 (0.62)	−0.20 (0.28)	1.10 (0.21)	0.67	97
4	0.59 (0.67)	−0.31 (0.32)	1.06 (0.34)	0.48	87
5	0.79 (0.93)	−0.06 (0.33)	0.69 (0.44)	0.34	61
6	1.24 (0.75)	0.59 (0.21)	−0.26 (0.25)	0.24	37
μ (0–4)	0.39 (0.40)	−0.25 (0.25)	1.09 (0.24)	0.90	87
DRI					
0	0.05 (0.32)	0.56 (0.13)	0.45 (0.15)	0.76	170
1	0.17 (0.41)	0.12 (0.21)	0.89 (0.21)	0.58	169
2	0.21 (0.49)	0.19 (0.25)	0.82 (0.20)	0.49	168
3	−0.07 (0.64)	−0.13 (0.23)	1.19 (0.21)	0.45	160
4	−0.08 (0.71)	−0.41 (0.29)	1.46 (0.31)	0.39	134
5	−0.45 (0.80)	−0.45 (0.40)	1.55 (0.44)	0.35	89
6	−0.88 (1.27)	0.10 (0.27)	0.90 (0.48)	0.56	51
7	−0.04 (1.27)	0.14 (0.09)	0.51 (0.32)	0.43	24
μ (0–4)	−0.02 (0.39)	−0.19 (0.28)	1.20 (0.29)	0.71	134
SPF					
0	−0.11 (0.44)	0.51 (0.18)	0.57 (0.17)	0.75	65
1	0.79 (0.57)	0.39 (0.42)	0.57 (0.38)	0.50	65
2	1.48 (0.63)	−0.48 (0.33)	1.33 (0.29)	0.44	64
3	1.21 (0.74)	−0.65 (0.31)	1.55 (0.29)	0.45	56
4	1.83 (1.20)	−0.72 (0.36)	1.53 (0.32)	0.32	44
μ (0–4)	1.57 (0.73)	−1.30 (0.59)	2.12 (0.53)	0.66	44

Notes: π denotes inflation, and $\hat{\pi}^C$ and $\hat{\pi}^F$ denote commercial and Federal Reserve inflation forecasts; h and t index the horizon and date of the forecasts. To make the commercial and Federal Reserve forecasts comparable, the Federal Reserve forecast in $t-1$ is of inflation h quarters after t, not after $t-1$. The sample periods are 1980:1–1991:11 for Blue Chip; 1970:7–1991:11 for DRI; and 1968:11–1991:11 for SPF. Numbers in parentheses are robust standard errors. The forecast horizon μ (0–4) refers to the average of 0 to 4 quarters ahead.

casts, the Federal Reserve's mean squared error (MSE) is less than the commercial forecaster's if and only if γ_F, the coefficient on the Federal Reserve forecast in (2), exceeds γ_C, the coefficient on the commercial forecast. If, however, the forecasts are biased by different amounts or forecast errors are correlated with forecasts, there is no necessary connection between the relative sizes of the coefficients on the two forecasts in our earlier regressions and the forecasts' relative accuracy.

Since the results thus far are suggestive about the relative accuracy of the forecasts, here we briefly present some direct evidence on this issue. Table 5 compares the MSEs of the Federal Reserve and commercial forecasts at each horizon. Each comparison is done using the observations for which both forecasts are available; as a result, the MSEs reported for the Federal Reserve for a given horizon vary according to the commercial forecaster with which the Federal Reserve is being compared. The fourth column of the table reports the p-value for the test of the null hypothesis that the Federal Reserve and commercial MSEs are equal.[15]

[15] To calculate p-values, we estimate: $(\pi_{ht} - \hat{\pi}^C_{ht})^2 - (\pi_{ht} - \hat{\pi}^F_{ht})^2 = c + u_{ht}$. Since the dependent variable

TABLE 4—TESTS OF FEDERAL RESERVE ADDITIONAL INFORMATION FOR INFLATION WITH MULTIPLE COMMERCIAL FORECASTS

$$\pi_{ht} = \delta + \gamma_{BC}\hat{\pi}_{ht}^{BC} + \gamma_{DRI}\hat{\pi}_{ht}^{DRI} + \gamma_{SPF}\hat{\pi}_{ht}^{SPF} + \gamma_F\hat{\pi}_{ht}^{F} + \nu_{ht}$$

Forecast horizon (Quarters)	δ	γ_{BC}	γ_{DRI}	γ_{SPF}	γ_F	R^2	N
Blue Chip and DRI							
0	0.12	0.10	0.60		0.26	0.86	97
	(0.36)	(0.22)	(0.19)		(0.18)		
1	1.15	−0.82	0.46		1.13	0.82	97
	(0.65)	(0.43)	(0.26)		(0.16)		
2	0.97	−0.57	0.30		1.04	0.70	97
	(0.52)	(0.29)	(0.12)		(0.20)		
3	1.46	−1.05	0.70		1.02	0.75	97
	(0.50)	(0.31)	(0.21)		(0.23)		
4	1.17	−0.80	0.49		1.01	0.56	93
	(0.43)	(0.34)	(0.23)		(0.27)		
5	2.66	−1.43	1.02		0.76	0.45	69
	(1.40)	(0.71)	(0.31)		(0.38)		
6	1.24	0.59	−0.04		−0.21	0.27	38
	(0.99)	(0.48)	(0.29)		(0.19)		
μ (0–4)	1.38	−0.89	0.63		0.96	0.92	93
	(0.37)	(0.13)	(0.16)		(0.16)		
Blue Chip, DRI, and SPF							
0	0.19	0.26	0.67	−0.27	0.28	0.84	36
	(0.51)	(0.49)	(0.21)	(0.61)	(0.23)		
1	0.83	−0.97	0.65	0.07	1.11	0.84	36
	(0.91)	(0.76)	(0.32)	(0.47)	(0.25)		
2	0.48	−0.73	0.09	0.37	1.12	0.69	36
	(1.09)	(0.66)	(0.54)	(0.62)	(0.29)		
3	2.74	−1.29	1.34	−0.36	0.75	0.68	36
	(0.76)	(0.45)	(0.37)	(0.40)	(0.19)		
4	1.64	−0.86	0.84	−0.39	1.02	0.60	35
	(1.15)	(0.63)	(0.40)	(0.44)	(0.34)		
μ (0–4)	1.93	−1.02	1.19	−0.48	0.92	0.93	35
	(0.40)	(0.28)	(0.21)	(0.23)	(0.21)		

Notes: π denotes inflation, and $\hat{\pi}^{BC}$, $\hat{\pi}^{DRI}$, $\hat{\pi}^{SPF}$, and $\hat{\pi}^{F}$ denote Blue Chip, Data Resources, Inc., Survey of Professional Forecasters, and Federal Reserve inflation forecasts; h and t index the horizon and date of the forecasts. The sample period is 1980:1–1991:11. Numbers in parentheses are robust standard errors. The forecast horizon μ (0–4) refers to the average of 0 to 4 quarters ahead.

The results show that the Federal Reserve's inflation forecasts have indeed been more accurate than commercial forecasters'. In every case, the MSE of the Federal Reserve forecast is lower than the commercial forecaster's; typically it is about 25 percent lower. Further, in a large majority of cases, the null hypothesis of equal forecast accuracy is rejected at the 5-percent level or below.

These findings are consistent with the results of our tests for the information value of the Federal Reserve forecasts. In our basic regressions (Table 2), the coefficient on the Federal Reserve forecast almost always exceeds the coefficient on the commercial forecast. The null hypothesis that $\gamma_C = \gamma_F$ is rejected at the 5-percent level or below in about two-thirds of the cases, usually with a t-statistic between 2.0 and 3.5.

is the difference in the squared errors of the two forecasts for a given observation, the estimate of c is just the difference between the commercial forecaster's and the Federal Reserve's MSEs. The p-value reported in the table is therefore the p-value for the test of the null hypothesis that $c = 0$. The standard error of c is corrected for heteroskedasticity and for serial correlation over $h + 1$ quarters.

TABLE 5—OVERALL ACCURACY OF INFLATION FORECASTS

Forecast horizon (Quarters)	Mean squared error: Commercial forecaster	Mean squared error: Federal Reserve	p-value	N
	(Percentage points)			
Blue Chip				
0	1.46	1.23	0.321	97
1	2.15	1.37	0.000	97
2	2.64	1.72	0.005	97
3	3.12	1.68	0.006	97
4	3.69	1.99	0.003	93
5	5.09	2.81	0.010	69
6	4.89	2.69	0.002	38
μ (0–4)	1.22	0.50	0.011	93
DRI				
0	1.93	1.71	0.390	170
1	3.98	3.13	0.034	170
2	4.91	4.03	0.001	168
3	5.44	4.37	0.061	161
4	6.34	4.65	0.033	146
5	7.51	5.50	0.077	105
6	5.91	4.06	0.118	60
7	6.59	4.06	0.145	38
μ (0–4)	2.28	1.61	0.015	146
SPF				
0	2.33	1.75	0.025	79
1	4.06	2.95	0.000	79
2	5.73	4.39	0.012	78
3	6.24	4.63	0.000	73
4	7.01	5.01	0.002	64
μ (0–4)	2.51	1.70	0.001	64

Notes: The mean squared error is calculated as the average squared difference between forecasted and actual inflation. The sample periods are 1980:1–1991:11 for Blue Chip; 1970:7–1991:11 for DRI; and 1968:11–1991:11 for SPF. The p-value is for the test of the null hypothesis that the Federal Reserve and commercial mean squared errors are equal. The forecast horizon μ (0–4) refers to the average of 0 to 4 quarters ahead.

Real GNP.—Our final, and perhaps most important, robustness check is to see if the Federal Reserve's information advantage for inflation extends to real GNP. Since inflation and real output are simultaneously determined, it would be puzzling if the Federal Reserve had useful information about one and not the other.

To see if the Federal Reserve possesses additional information about real output, we rerun our basic regressions using real GNP growth in place of inflation. The results are reported in Table 6. The table shows that the Federal Reserve certainly possesses information about the course of real output that commercial forecasters would like to have. The coefficient on the Federal Reserve forecast is always positive, almost always large, and usually statistically significant.

There are, however, two differences between the results for output and those for inflation. First, the coefficient estimates are more varied for output. For inflation, the typical estimate of γ_F is close to one and the typical estimate of γ_C is close to zero, which implies that someone with access to both forecasts should discard the commercial one. For output, a moderate number of the estimated γ_F's are well below one and a moderate number of the estimated γ_C's are well above zero, suggesting that the optimal weight on the commercial forecast is positive.

The other substantial difference is that the Federal Reserve's additional information at short horizons is more pronounced for output than for inflation. For the contemporaneous quarter, the Federal Reserve appears to have a large forecasting advantage over both Blue Chip and SPF. One possible explanation for this advantage is that the Federal Reserve collects and processes the index of industrial production. Therefore, at very short horizons it may actually have more data about the state of the economy, rather than just be better at processing widely available information.[16]

The fact that the Federal Reserve has a definite forecasting advantage for real GNP (which may derive from a genuine data advantage at short horizons) raises the possibility that the Federal Reserve's forecasting advantage for inflation could be driven by its real-side advantage. In particular, perhaps the Federal Reserve's superior

[16] In a related exercise, we look at the Federal Reserve and commercial forecasts of CPI inflation. Despite the fact that the sample sizes in these regressions are substantially smaller than those for the GNP deflator because of data limitations, the results are very similar: the Federal Reserve appears to have significant additional information about this alternative measure of inflation. This information advantage is particularly striking at longer horizons. For example, the coefficient on the Federal Reserve forecast in equation (2) is larger than 0.8 for every forecast of inflation four or more quarters ahead for each of the three commercial forecasters we consider, and is almost always significant. For forecasts for shorter horizons, the estimates of γ_F are all positive, but only a few of them are significant.

TABLE 6—TESTS OF FEDERAL RESERVE ADDITIONAL INFORMATION FOR REAL GNP GROWTH
$$y_{ht} = \delta + \gamma_C \hat{y}^C_{ht} + \gamma_F \hat{y}^F_{ht} + \nu_{ht}$$

Forecast horizon (Quarters)	δ	γ_C	γ_F	R^2	N
Blue Chip					
0	1.00 (0.52)	−0.82 (0.25)	1.47 (0.14)	0.61	97
1	0.32 (0.97)	0.55 (0.59)	0.26 (0.59)	0.19	97
2	1.20 (1.87)	0.05 (0.87)	0.48 (0.54)	0.08	97
3	1.78 (2.24)	−0.00 (0.74)	0.22 (0.55)	0.01	97
4	−1.02 (0.84)	−0.57 (0.16)	1.96 (0.27)	0.38	93
5	−0.64 (1.36)	−0.20 (0.29)	1.32 (0.48[a])	0.17	69
6	−1.06 (1.82)	0.09 (0.43)	1.24 (0.35)	0.39	38
μ (0–4)	−1.12 (1.04)	0.49 (0.53)	0.87 (0.36)	0.56	93
DRI					
0	0.07 (0.39)	0.71 (0.22)	0.32 (0.24)	0.71	169
1	−0.14 (0.91)	0.55 (0.22)	0.42 (0.33)	0.37	169
2	0.14 (1.09)	0.14 (0.29)	0.73 (0.39)	0.20	167
3	−0.04 (0.91)	0.18 (0.29)	0.65 (0.45)	0.12	160
4	−0.34 (0.71)	−0.00 (0.21)	0.99 (0.33)	0.17	145
5	−1.72 (0.74)	−0.03 (0.23)	1.38 (0.29)	0.22	104
6	−0.99 (1.21)	−0.17 (0.27)	1.39 (0.48)	0.30	59
7	−0.76 (1.72)	−0.23 (0.72)	1.32 (0.29)	0.24	37
μ (0–4)	−0.10 (0.61)	0.29 (0.38)	0.65 (0.38)	0.49	145
SPF					
0	0.48 (0.29)	−1.02 (0.47)	1.75 (0.40)	0.69	32
1	−1.44 (0.61)	0.56 (0.53)	0.81 (0.52)	0.39	32
2	−2.17 (1.11)	0.66 (0.53)	1.07 (0.66)	0.30	32
3	−1.15 (1.50)	0.40 (0.28)	0.99 (0.44)	0.21	32
4	−0.17 (1.01)	−1.07 (0.55)	2.33 (0.46)	0.38	32
μ (0–4)	−1.75 (0.65)	0.42 (0.59)	1.20 (0.48)	0.64	32

Notes: y is the percentage change in real GNP, and $\hat{y}^C$ and $\hat{y}^F$ denote commercial and Federal Reserve forecasts of real GNP growth; h and t index the horizon and date of the forecasts. The sample periods are 1980:1–1991:11 for Blue Chip; 1970:7–1991:11 for DRI; and 1981:08–1991:11 for SPF. Numbers in parentheses are robust standard errors. The forecast horizon μ (0–4) refers to the average of 0 to 4 quarters ahead.

[a] Standard error calculated using Newey-West procedure because the Hansen-Hodrick standard error cannot be computed.

inflation forecasts are simply derived from a Phillips curve that uses as inputs the superior real GNP forecasts.

To see if this is the case, we consider the following simple extension of our regression in equation (2). We regress actual inflation at various horizons not only on the commercial and Federal Reserve forecasts of inflation at the same horizon, but also on the contemporaneous and one-quarter-ahead commercial and Federal Reserve forecasts of real output growth. If the Federal Reserve's forecasting advantage for inflation is working through its near-term, potentially data-driven output forecasts, the Federal Reserve inflation forecast should no longer be a significant predictor of actual inflation. The results of this extension are that the near-term output growth forecasts have little predictive power for inflation and virtually no impact on the significance of the Federal Reserve inflation forecast. This suggests that the Federal Reserve has a forecasting advantage for inflation relative to commercial forecasters that is separate from its advantage in forecasting real output.

III. Implications for the Behavior of Interest Rates

We now turn to the implications of Federal Reserve information for the behavior of interest rates. For asymmetric information to explain why interest rates at all horizons rise in response to a monetary contraction, it must be the case that some of the Federal Reserve's additional information is revealed by its actions and that market participants respond to this information revelation by changing their forecasts of future inflation. Furthermore, these effects must be large relative to the observed movements in interest rates.

A. *Indicators of Federal Reserve Actions*

The first step in this analysis is to derive an indicator of Federal Reserve actions. We consider two variants. The first is a simple dummy variable derived from the *Wall Street Journal.* Cook and Hahn (1989a and 1989b) catalog the dates from September 1974 to September 1979 when the *Journal* reports that the Federal Reserve deliberately moved the federal funds rate. From this catalog, we construct a dummy variable that is -1 in the months when the Federal Reserve loosened, $+1$ in months when it tightened, and 0 in all other months.

We extend the sample period by replicating Cook and Hahn's procedures for the months between March 1984 and December 1991. (We skip the years surrounding the Volcker disinflation because the Federal Reserve did not target the funds rate in this period.) To identify funds-rate changes, we check the front page of each issue of the *Wall Street Journal* for some mention of Federal Reserve action or interest-rate change. Occasionally, there was more than one funds-rate change in a month. However, only in October 1987 was there both a tightening and a loosening in the same month. Therefore, in all but this one month, assigning the dummy variable is straightforward. We deal with October 1987 by excluding it from the sample.

This simple dummy variable may be a particularly useful indicator of monetary actions. It is possible that action of any sort is what reveals information. Thus, having an indicator that does not distinguish between large and small changes could be desirable. Furthermore, because the dates of actions are derived from the press, we are certain that this is information that commercial forecasters and other agents in the economy actually possessed.

An alternative indicator of policy actions that we consider is the change in the Federal Reserve's actual federal funds-rate target. These data are available for 1974:9–1979:9 and from 1984:3 through the end of our sample period. We use the funds-rate target in effect at the end of the month as the monthly observation.[17] The change in the target, therefore, reflects the change from the end of the previous month to the end of the current month.

The target series could be useful because it calibrates the size of monetary actions. If commercial forecasters respond differently to changes in the funds rate of different magnitudes, then it is useful to know the size of the changes. The target series is also a useful complement to the dummy variable derived from the *Wall Street Journal* because it reflects what the Federal Reserve was actually doing. Cook and Hahn (1989b) show that while the *Journal* identifies most changes in the target, it misses some and misjudges the magnitude of others. Particularly in analyzing the information revealed by Federal Reserve actions, it is therefore desirable to work with the Federal Reserve's own target information. At the same time, since most of the target information is revealed in the press, the Federal Reserve series provides a good proxy for what market participants actually knew about the timing and magnitude of target changes.[18]

B. *Information Revelation*

The Federal Reserve's information cannot matter for the effects of policy actions on interest rates unless the actions reveal some of that information. To investigate this issue, we consider the problem of market participants attempting to infer the information that the

[17] The funds-rate target series is available in Glenn D. Rudebusch (1995). We construct observations for the end of 1974:08 and 1984:02 (to be used in calculating changes over the next month) by combining the earliest observation of the funds-rate target in 1974:09 and 1984:03 and the reported change in the target.

[18] For the 1980's, it is quite difficult to derive a synthetic target series from the *Wall Street Journal.* In many instances, the *Journal* is confident that the Federal Reserve has moved, but it is unsure where the funds rate will come to rest. Furthermore, the *Journal* often reports the funds rate in comparison to a year ago, so it is unclear how large a short-run change the newspaper observes.

Federal Reserve possesses that they do not. As with our examination of the existence of asymmetric information, we focus on information about inflation. Also as before, we use the commercial forecasts as our indicator of market participants' expectations.

Specification.—To see if market participants could learn something about the Federal Reserve's additional information from monetary actions, we regress the Federal Reserve forecast for a particular horizon on a measure of Federal Reserve actions and the contemporaneous commercial forecast for the same horizon. That is, we estimate equations of the form:

$$\hat{\pi}_{ht}^{F} = \psi + \theta M_t + \phi \hat{\pi}_{ht}^{C} + \omega_{ht}, \tag{4}$$

where $\hat{\pi}_{ht}^{F}$ and $\hat{\pi}_{ht}^{C}$ are again the Federal Reserve and commercial forecasts of inflation h quarters ahead, and M_t is the Federal Reserve's monetary-policy action in month t (measured either by our dummy variable or by the change in the funds-rate target). In this specification, the coefficient θ shows whether, and by how much, monetary actions reveal that the Federal Reserve forecast is systematically different from what one would predict based on the commercial forecast. For example, a coefficient that is large and positive would indicate that contractionary monetary-policy actions provide information that the Federal Reserve inflation forecast is higher than usual relative to the commercial forecast. Because any information that is publicly available at time t should be incorporated in both the Federal Reserve and commercial forecasts, it is not necessary to include any control variables in the regression.

The main issue that arises in the specification is the relative timing of the inflation forecasts and Federal Reserve actions. Ideally, one would like to have Federal Reserve and commercial forecasts that were exactly contemporaneous and that were made just before monetary actions. As described in Section I, however, this is not feasible: Federal Reserve and commercial forecasts are not made simultaneously, and they are not made just before Federal Reserve actions.

Our best approximation to this ideal is the following. We choose the timing of the commercial forecasts so that they are before the monetary-action variable for each observation. The monetary-action variable refers to policy changes in month t. For the DRI and SPF forecasts, which are made late in the month, we therefore use the forecast in month $t - 1$ as the control variable. For the Blue Chip forecast, which is made at the beginning of the month, we use the forecast in month t as the control variable.

For the Federal Reserve forecast, we choose the timing so that it is slightly after the commercial forecast used as the control variable. As described in Section I, although the Federal Reserve forecasts are made at different times of the month, the majority of them are made in the first half of the month. This suggests that when either the DRI or SPF forecast in $t - 1$ is used as the control variable, the Federal Reserve forecast in t is the appropriate dependent variable. When the Blue Chip forecast in t is used as the control variable, the Federal Reserve forecast in t is the appropriate dependent variable.

We use the Federal Reserve forecast slightly after the commercial forecasts to counteract a likely bias against finding signal revelation. Because both the commercial and Federal Reserve forecasts are often made weeks before the monetary actions, the Federal Reserve may base its actions on information not contained in its last official forecast. Therefore, an action may signal that the Federal Reserve forecast is even more different from that predicted based on the commercial forecast than the analysis of published forecasts would suggest.[19] Taking the Federal Reserve forecast just slightly after the

[19] Because the commercial forecast is also before the monetary action, it is possible that the commercial forecasters also receive additional information that causes them to revise their forecasts. In this case, our focus on published forecasts could cause a bias toward finding signal revelation. However, the Federal Reserve presumably bases its actions mainly on its own forecasts rather than those of commercial forecasters. Thus, times when its estimates of inflation increase after its last published forecast but commercial forecasters' do not are more likely to be followed by tightening than times exhibiting the reverse pattern. To the extent that this occurs, the actions are signaling a deviation in the usual relationship between Federal Reserve and commercial estimates of inflation; but our tests, which are based on the published forecasts, will not capture this. As a result, if the Federal Reserve and commercial forecasts were made at the same time, but both preceded the Federal Reserve's actions, the tests would be biased against finding information revelation.

commercial forecast can help to counteract this problem.[20]

Results.—Table 7 reports the results. In Panel A, policy actions are measured using the dummy variable; in Panel B, they are measured using the change in the funds-rate target. As before, the standard errors are computed allowing for heteroskedasticity and for serial correlation over $h + 1$ quarters. The sample periods used are determined by the availability of the data.

The results support the hypothesis that shifts to tighter policy signal that the Federal Reserve forecasts of inflation are unusually high given the commercial forecasts. Almost all of the estimates of θ are positive, and a substantial number are significantly greater than zero at conventional levels. None of the estimates are significantly less than zero.

As before, a convenient way of summarizing the evidence from the different quarters is to consider forecasts of average inflation over the next h quarters.[21] Table 7 therefore also reports the results using average forecasts up to four quarters ahead, the longest horizon for which all three commercial forecasts are available. In all six variants considered, the estimated relationship is positive. The t-statistic on the measure of policy actions ranges from 1.5 to 2.9. The results also suggest that the magnitude of the association is substantial. When we use the dummy variable as the indicator of monetary policy, the average point estimate of θ for this one-year horizon is 0.16. Thus, the estimates suggest that a typical move to tighter policy indicates that the Federal Reserve forecast of inflation over the coming year is between one- and two-tenths of a percentage point higher than one would expect given the commercial forecast. When we use the change in the funds-rate target as a monetary indicator, the corresponding figure is 0.27: an increase in the funds-rate target of one percentage point signals a gap of about a quarter of a percentage point between the Federal Reserve inflation forecast and what one would expect given the commercial forecast. Thus, Federal Reserve actions appear to be important signals of its additional information.

These results shed further light on the source of the Federal Reserve's information advantage. As described in the previous section, one possible reason that the Federal Reserve could have useful information about inflation is that it has superior information about future monetary policy. As discussed there, the fact that the Federal Reserve has useful information about inflation just one or two quarters ahead already casts strong doubt on this hypothesis. The direction of the relationship between the Federal Reserve's information and its actions provides a further piece of evidence. If the Federal Reserve has additional information about future inflation because it knows more about its likely policy actions, then times when its inflation forecasts are unusually high should on average be followed by moves to looser policy. However, such times are in fact followed by moves to tighter policy. This is consistent with the view that the Federal Reserve has additional information about the economy not stemming from its knowledge about future policy. Times when the Federal Reserve's inflation forecasts are unusually high are on average times when it has received news that inflation will be higher than expected, and when it is therefore about to tighten to dampen rises in inflation.

C. *Expectations Response*

The previous analysis shows that monetary actions reveal some of the Federal Reserve's information about future inflation. For this to explain the response of interest rates to monetary actions, market participants must revise

[20] For completeness, we have also examined the case where the Federal Reserve forecast usually precedes the commercial forecast. For DRI and SPF, this means that we consider the Federal Reserve forecast in the same month as the commercial forecast; for Blue Chip, it means that we consider the Federal Reserve forecast in the preceding month. Our analysis implies that this specification is unambiguously biased against finding a signaling effect of policy actions. Consistent with this analysis, for DRI and SPF—where the Federal Reserve forecasts typically precede the commercial forecasts by several weeks and the policy actions by over a month—we obtain results that are qualitatively similar to those from our main specification, but considerably weaker. For Blue Chip—where the Federal Reserve forecasts usually precede the commercial forecasts by almost a month and the policy actions by more than a month—we find no consistent relationship between policy actions and the Federal Reserve forecasts, controlling for the commercial forecasts.

[21] Thus, we estimate regressions of the form $\hat{\bar{\pi}}^F_{ht} = \psi + \theta M_t + \phi \hat{\bar{\pi}}^C_{ht} + \bar{\omega}_{ht}$, where bars over the variables indicate averages up to horizon h. The results reported are for $h = 4$, but they are similar for other horizons.

TABLE 7—ESTIMATES OF REVELATION OF INFORMATION ABOUT INFLATION

$$\hat{\pi}^F_{ht} = \psi + \theta M_t + \phi \hat{\pi}^C_{ht} + \omega_{ht}$$

Forecast horizon (Quarters)	ψ	θ	ϕ	R^2	N
		A. Dummy Variable			
Blue Chip					
0	−0.71 (0.71)	0.21 (0.12)	1.13 (0.18)	0.59	61
1	−0.45 (0.47)	−0.13 (0.14)	1.01 (0.11)	0.60	61
2	−0.07 (0.63)	0.02 (0.10)	0.93 (0.16)	0.54	61
3	0.55 (0.90)	0.13 (0.08)	0.78 (0.20)	0.48	61
4	0.48 (0.66)	0.16 (0.05)	0.79 (0.14)	0.57	61
5	0.24 (0.44)	0.10 (0.05)	0.84 (0.09)	0.68	47
6	−0.49 (0.61)	−0.10 (0.07)	1.01 (0.14)	0.74	27
μ (0–4)	−0.43 (0.63)	0.07 (0.04)	1.02 (0.16)	0.76	61
DRI					
0	0.63 (0.29)	0.17 (0.14)	0.91 (0.07)	0.85	100
1	0.86 (0.33)	0.29 (0.15)	0.87 (0.07)	0.84	100
2	0.81 (0.34)	0.29 (0.12)	0.87 (0.07)	0.85	100
3	1.01 (0.31)	0.25 (0.11)	0.82 (0.08)	0.84	100
4	0.86 (0.38)	0.15 (0.11)	0.84 (0.09)	0.81	100
5	0.67 (0.29)	0.18 (0.07)	0.90 (0.07)	0.89	85
6	0.50 (0.35)	0.08 (0.12)	0.92 (0.08)	0.87	52
7	1.50 (0.64)	0.47 (0.22)	0.66 (0.18)	0.80	28
μ (0–4)	0.54 (0.32)	0.19 (0.13)	0.92 (0.07)	0.93	100
SPF					
0	−0.57 (0.41)	0.13 (0.19)	1.13 (0.08)	0.88	47
1	−0.52 (0.38)	0.12 (0.18)	1.09 (0.08)	0.86	47
2	−0.42 (0.44)	0.29 (0.17)	1.08 (0.09)	0.80	47
3	−0.47 (0.40)	0.20 (0.09)	1.06 (0.07)	0.86	47
4	0.36 (0.36)	0.27 (0.09)	0.92 (0.08)	0.81	46
μ (0–4)	−0.49 (0.26)	0.22 (0.10)	1.09 (0.05)	0.94	46
		B. Change in Funds-Rate Target			
Blue Chip					
0	−0.69 (0.72)	0.31 (0.20)	1.11 (0.18)	0.57	62
1	−0.48 (0.45)	−0.29 (0.22)	1.02 (0.11)	0.60	62
2	−0.02 (0.59)	0.18 (0.16)	0.92 (0.14)	0.55	62
3	0.54 (0.82)	0.33 (0.09)	0.78 (0.19)	0.49	62
4	0.48 (0.62)	0.44 (0.09)	0.79 (0.13)	0.60	62
5	0.36 (0.46)	0.34 (0.11)	0.81 (0.09)	0.69	47
6	−0.39 (0.60)	−0.02 (0.17)	0.98 (0.13)	0.73	27
μ (0–4)	−0.41 (0.60)	0.17 (0.06)	1.01 (0.15)	0.76	62
DRI					
0	0.55 (0.27)	0.05 (0.32)	0.93 (0.07)	0.85	101
1	0.72 (0.30)	0.54 (0.22)	0.90 (0.06)	0.83	101
2	0.68 (0.29)	0.60 (0.21)	0.90 (0.06)	0.85	101
3	0.88 (0.29)	0.42 (0.22)	0.85 (0.07)	0.84	101
4	0.77 (0.38)	0.16 (0.17)	0.86 (0.10)	0.80	101
5	0.60 (0.27)	0.36 (0.10)	0.92 (0.06)	0.90	86
6	0.47 (0.27)	0.32 (0.19)	0.92 (0.07)	0.87	52
7	1.11 (0.67)	0.71 (0.47)	0.74 (0.19)	0.77	28
μ (0–4)	0.44 (0.28)	0.35 (0.18)	0.95 (0.07)	0.92	101
SPF					
0	−0.61 (0.38)	0.04 (0.30)	1.13 (0.08)	0.88	47
1	−0.56 (0.36)	0.05 (0.30)	1.10 (0.08)	0.86	47
2	−0.62 (0.40)	0.53 (0.32)	1.12 (0.09)	0.80	47
3	−0.59 (0.39)	0.29 (0.17)	1.08 (0.07)	0.85	47
4	0.22 (0.37)	0.21 (0.10)	0.95 (0.08)	0.79	46
μ (0–4)	−0.62 (0.23)	0.32 (0.12)	1.11 (0.05)	0.93	46

Notes: $\hat{\pi}^F$ and $\hat{\pi}^C$ denote Federal Reserve and commercial inflation forecasts; h and t index the horizon and date of the forecasts. M is the indicator of monetary-policy actions. The sample periods are 1984:2–1991:11 for Blue Chip; and 1974:8–1979:8 and 1984:2–1991:11 for DRI and SPF. Numbers in parentheses are robust standard errors. The forecast horizon μ (0–4) refers to the average of 0 to 4 quarters ahead.

their expectations of inflation to reflect the information revealed by the actions. Since we view commercial forecasts as a proxy for or a key input into market expectations, this means that commercial forecasters must raise their expectations of inflation when the Federal Reserve tightens, rather than lower them as more conventional models of the effects of monetary policy would lead one to predict. In this section we investigate whether this is the case.

Specification.—A straightforward way to analyze how forecasters respond to Federal Reserve actions is to regress the next commercial forecast on an indicator of Federal Reserve actions and the last commercial forecast before the action. A positive coefficient on the action would indicate that the forecasters raise their inflation forecasts in response to a monetary tightening, controlling for their initial prediction.

The obvious complication is that the current commercial forecast is not the only other relevant predictor of the next forecast. In particular, both the monetary action and the next forecast could be the result of information received after the current forecast was made. For example, suppose that there is unfavorable news about inflation. Then commercial forecasters may raise their inflation forecasts in response to this news, and the Federal Reserve may tighten. The rise in the forecasts, however, would not be a response to the tightening. Thus, in the absence of controls, the coefficient estimate could be biased upward.

To address this possibility, we include as an additional control variable the change in the Federal Reserve's inflation forecast in the interval between the current and subsequent commercial forecasts. The change in the Federal Reserve forecast should reflect general information that becomes available during the period between the two forecasts.[22] Therefore, we estimate regressions of the form:

$$\hat{\pi}^C_{h,t+1} = \eta + \lambda M_t + \kappa \hat{\pi}^C_{ht} + \rho(\hat{\pi}^F_{h,t+1} - \hat{\pi}^F_{ht}) + \upsilon_{h,t+1}, \tag{5}$$

where M_t is again an indicator of Federal Reserve actions. A positive value of λ would indicate that inflation expectations respond to monetary actions in a way consistent with the existence and revelation of Federal Reserve additional information.

Timing is again very important. We need to ensure that the revision in the Federal Reserve forecast included as a control variable corresponds to the interval between the current and subsequent commercial forecasts. Similarly, we need to ensure that the current and subsequent commercial forecasts that we examine bracket the monetary action. Because the various forecasts differ in when they are made during the month, taking account of timing involves making minor adjustments in the time subscripts given in equation (5).[23]

The timing depicted in equation (5) is most accurate for the regressions using the Blue Chip forecasts. Because these forecasts are made at the beginning of the month, $\hat{\pi}^C_{h,t+1}$ will be a forecast made soon after a monetary action in month t and $\hat{\pi}^C_{ht}$ will be made before the action. Similarly, since the Federal Reserve forecasts tend to be made in the first half of the month, the revision between t and $t + 1$ should reflect new general information received by the commercial forecaster between forecasts.

Because the DRI forecasts are done at the end of each month, the forecasts for month $t + 1$

[22] The change in the Federal Reserve forecast reflects the arrival not just of new public information, but also of new information observed only by the Federal Reserve. On the one hand, this means that the change in the Federal Reserve forecast is a noisy measure of new public information. To the extent that the Federal Reserve acts on the basis of the new public information, the fact that we are controlling for this information imperfectly means that the coefficient on the Federal Reserve's action is biased up. On the other hand, to the extent that the Federal Reserve acts on the basis of its new private information and commercial forecasters respond to those actions, by controlling for the change in the Federal Reserve forecast we tend to understate the importance of its actions to commercial forecast revisions. One can show that in the natural baseline case where the Federal Reserve puts the same weight on new public and private information in choosing its action, the two sources of bias just balance.

[23] Similarly, the h subscripts need to be adjusted some of the time. In particular, to ensure that both the initial and subsequent commercial forecasts concern inflation in the same quarter, the dependent variable in (5) is the commercial forecast in month $t + 1$ of inflation h quarters after month t. Thus when month t is the last month of a quarter, the dependent variable is in fact $\hat{\pi}^C_{h-1,t+1}$. Likewise, the Federal Reserve forecasts for both t and $t + 1$ are forecasts of inflation h quarters after month t.

reflect all of the events of and information released during month $t + 1$. As a result, one wants to see if the DRI forecasts in month $t + 1$ respond to monetary actions in month $t + 1$, not month t. Because the Federal Reserve forecasts are more often done early in the month, one needs to control for the change in the Federal Reserve forecast from $t + 1$ to $t + 2$ to capture the new information that DRI may receive between the end of month t when it makes the initial forecast and the end of month $t + 1$ when it makes its subsequent forecast.

The Survey of Professional Forecasters presents even more complicated timing issues. The SPF is only done at the end of the middle month of each quarter. Thus, the next forecast after month t is in month $t + 3$. For the same reasons mentioned for DRI, the appropriate control variable is therefore the change in the Federal Reserve forecast from month $t + 1$ to month $t + 4$. In addition, to minimize the possibility that the Federal Reserve actions are responses to information that becomes available between the two forecast dates rather than to its forecast as of the initial forecast date, we consider the relationship between the SPF forecast in $t + 3$ and monetary-policy actions only in month $t + 1$.[24]

Results.—Table 8 presents the results. Since the data are the same as those used in the information-revelation regressions, the sample periods are the same as in those regressions.[25] Panel A shows the results for the dummy variable for Federal Reserve actions, and Panel B shows the results for the change in the funds-rate target. The estimates of ρ, the coefficient on the change in the Federal Reserve forecast, are positive in the vast majority of cases, but are usually not significant. Not surprisingly, the estimates of κ, the coefficient on the initial commercial forecast, are close to one and overwhelmingly significant.[26]

Our main interest, however, is in λ, the coefficient on the measure of policy actions. The estimates of λ support the hypothesis that contractionary monetary actions cause commercial forecasters to raise their inflation forecasts. A very large majority of the estimates are positive, and a substantial number of them are significant at conventional levels. None of the estimates are significantly less than zero. There is certainly variation in the strength of the finding, however. For the Blue Chip and SPF forecasts, the estimated coefficients are positive in every case, and for Blue Chip, they are often significant. For the DRI forecasts, in contrast, about a third of the estimates are negative, and only a few are significantly larger than zero. Table 8 also shows the results using revisions of average forecasts up through four quarters ahead rather than revisions of forecasts for individual quar-

[24] We have also investigated an alternative way of addressing the problem that both the Federal Reserve's actions and commercial inflation forecasts could be responding to information released between the times of the initial forecasts and the Federal Reserve's actions. The alternative is to control for the main pieces of information released early in the interval between the two commercial forecasts. Relative to our main approach of controlling for the change in the Federal Reserve forecast, this approach has an advantage and a disadvantage. The advantage is that, because it does not require data on Federal Reserve forecasts, it permits a larger sample. The disadvantage is that, because one cannot control for all publicly available information, it can only partially address the problem.

The specific variables we control for are the percentage changes in payroll employment, average hourly earnings of production workers, and average weekly hours of production workers. Although this change in specification noticeably alters the results of many of the individual regressions, it has virtually no impact on the fraction of the estimates that are positive or their average size. Because of the larger sample sizes, however, the standard errors are generally smaller; as a result, more of the estimates are significantly larger than zero.

[25] Because the Federal Reserve rarely makes long-term forecasts in two consecutive months, the sample sizes for the six-quarter horizon using Blue Chip and the seven-quarter horizon using DRI are less than fifteen. We therefore do not consider these horizons. Also, because the SPF forecasts are made only once a quarter, it is not possible to consider the next forecast after month t of inflation for horizon $h = 0$ (the contemporaneous quarter): by the time of the next forecast ($t + 3$), inflation for the initial quarter has been realized and thus is no longer being forecast. We therefore consider the responses of contemporaneous forecasts to monetary actions only for Blue Chip and DRI. Finally, because theory predicts that a forecast should not be predictable given the previous forecast, and because the estimated residuals do not show any consistent pattern of serial correlation, the standard errors in Table 8 are corrected for heteroskedasticity but not for serial correlation.

[26] Because the other variables in the regression are not known when the initial forecast is made, the hypothesis that the forecast is rational does not imply that κ should equal one. We therefore do not impose this restriction. However, imposing it has little effect on the estimates or significance of the other coefficients.

TABLE 8—ESTIMATES OF RESPONSE OF INFLATION FORECASTS TO MONETARY-POLICY ACTIONS
$$\hat{\pi}^C_{h,t+1} = \eta + \lambda M_t + \kappa \hat{\pi}^C_{ht} + \rho(\hat{\pi}^F_{h,t+1} - \hat{\pi}^F_{ht}) + \upsilon_{h,t+1}$$

Forecast horizon (Quarters)	η	λ	κ	ρ	R^2	N
			A. Dummy Variable			
Blue Chip						
0	−0.12 (0.16)	0.14 (0.06)	1.01 (0.05)	0.11 (0.07)	0.87	31
1	0.15 (0.35)	0.05 (0.03)	0.95 (0.09)	0.17 (0.09)	0.87	31
2	0.11 (0.20)	0.03 (0.03)	0.96 (0.05)	0.10 (0.10)	0.93	31
3	0.14 (0.19)	0.05 (0.02)	0.96 (0.04)	0.17 (0.07)	0.95	31
4	0.19 (0.13)	0.07 (0.02)	0.95 (0.03)	0.07 (0.06)	0.97	31
5	0.11 (0.12)	0.04 (0.03)	0.96 (0.03)	0.10 (0.06)	0.97	27
μ (0–4)	0.09 (0.18)	0.05 (0.03)	0.97 (0.04)	0.39 (0.12)	0.94	31
DRI						
0	1.24 (0.23)	0.31 (0.12)	0.65 (0.07)	0.14 (0.15)	0.68	27
1	0.19 (0.16)	0.12 (0.07)	0.95 (0.04)	−0.14 (0.13)	0.94	50
2	−0.05 (0.32)	−0.01 (0.12)	1.01 (0.08)	−0.03 (0.28)	0.86	50
3	0.33 (0.24)	0.02 (0.11)	0.92 (0.06)	0.07 (0.14)	0.88	50
4	0.57 (0.24)	0.15 (0.14)	0.85 (0.06)	−0.31 (0.37)	0.82	50
5	0.55 (0.17)	0.22 (0.07)	0.89 (0.03)	0.14 (0.18)	0.94	48
6	0.56 (0.35)	0.17 (0.14)	0.88 (0.09)	0.96 (0.52)	0.88	28
μ (0–4)	0.41 (0.16)	0.03 (0.04)	0.87 (0.05)	0.33 (0.21)	0.92	27
SPF						
1	−0.01 (0.46)	0.28 (0.19)	1.00 (0.10)	0.35 (0.14)	0.87	40
2	−0.58 (0.44)	0.08 (0.19)	1.11 (0.09)	−0.10 (0.11)	0.85	40
3	−0.22 (0.27)	0.16 (0.11)	1.04 (0.05)	0.02 (0.12)	0.90	40
4	1.13 (0.27)	0.33 (0.13)	0.80 (0.05)	0.23 (0.19)	0.83	39
μ (1–4)	0.08 (0.28)	0.30 (0.13)	0.99 (0.06)	0.03 (0.17)	0.92	39
			B. Change in Funds-Rate Target			
Blue Chip						
0	−0.06 (0.18)	0.30 (0.15)	0.99 (0.05)	0.10 (0.07)	0.86	31
1	0.19 (0.35)	0.15 (0.09)	0.94 (0.09)	0.16 (0.10)	0.87	31
2	0.16 (0.22)	0.09 (0.08)	0.95 (0.05)	0.10 (0.10)	0.93	31
3	0.22 (0.17)	0.16 (0.05)	0.94 (0.04)	0.16 (0.07)	0.95	31
4	0.27 (0.13)	0.19 (0.05)	0.93 (0.03)	0.05 (0.06)	0.97	31
5	0.14 (0.11)	0.13 (0.06)	0.96 (0.02)	0.10 (0.06)	0.97	27
μ (0–4)	0.14 (0.20)	0.13 (0.09)	0.95 (0.05)	0.37 (0.13)	0.94	31
DRI						
0	1.27 (0.24)	0.80 (0.26)	0.63 (0.06)	0.11 (0.14)	0.69	27
1	0.14 (0.17)	0.17 (0.17)	0.96 (0.04)	−0.13 (0.14)	0.94	50
2	0.01 (0.25)	−0.27 (0.43)	0.99 (0.06)	0.05 (0.21)	0.87	50
3	0.32 (0.24)	−0.20 (0.31)	0.92 (0.06)	0.09 (0.14)	0.88	50
4	0.47 (0.23)	−0.16 (0.30)	0.87 (0.06)	−0.26 (0.36)	0.81	50
5	0.43 (0.16)	0.40 (0.09)	0.92 (0.03)	0.18 (0.19)	0.94	48
6	0.40 (0.27)	0.20 (0.26)	0.91 (0.07)	1.04 (0.55)	0.88	28
μ (0–4)	0.37 (0.16)	0.01 (0.09)	0.88 (0.05)	0.36 (0.22)	0.92	27
SPF						
1	−0.03 (0.45)	0.11 (0.34)	1.00 (0.10)	0.38 (0.13)	0.86	40
2	−0.62 (0.36)	0.09 (0.45)	1.12 (0.07)	−0.09 (0.13)	0.85	40
3	−0.29 (0.24)	0.19 (0.28)	1.05 (0.05)	0.02 (0.15)	0.90	40
4	1.05 (0.31)	0.23 (0.36)	0.81 (0.06)	0.31 (0.18)	0.80	39
μ (1–4)	−0.06 (0.27)	0.40 (0.33)	1.01 (0.06)	0.04 (0.22)	0.91	39

Notes: $\hat{\pi}^C$ and $\hat{\pi}^F$ denote commercial and Federal Reserve inflation forecasts; h and t index the horizon and date of the forecasts. M is the indicator of monetary-policy actions. Because the time within the month that the forecasts are made varies across forecasters, the actual time and horizon subscripts for the inflation forecasts and the monetary-policy variable also vary across forecasters; see text for details. The sample periods are 1984:2–1991:11 for Blue Chip; and 1974:8–1979:8 and 1984:2–1991:11 for DRI and SPF. Numbers in parentheses are robust standard errors. The forecast horizons μ (0–4) and μ (1–4) refer to the averages of 0 to 4 quarters ahead and 1 to 4 quarters ahead, respectively.

ters.[27] All of the point estimates of λ are positive, but only for one is the t-statistic over two.

The magnitudes of the estimated effects are close to what one would expect given our previous findings about the information content of policy actions. For the dummy variable, the average point estimate for the average forecast revision over the next four quarters is 0.13. This implies that a report in the *Wall Street Journal* of a rise in the federal funds rate raises commercial forecasts of inflation over the next year by between one- and two-tenths of a percentage point. For comparison, the corresponding figure from the information-revelation regressions in Table 7 is 0.16. This figure implies that a contractionary monetary action signals that the Federal Reserve forecast is also between one- and two-tenths of a percentage point above what one would expect given the commercial forecast.

For the funds-rate target, the average point estimate for the impact of a policy action on commercial inflation forecasts up to four quarters ahead is 0.18. In the previous section, we found that a rise of 100 basis points in the funds-rate target signals a Federal Reserve forecast roughly 27 basis points above what one would expect given the commercial forecast. Our results here therefore indicate that commercial forecasters change their forecasts by about two-thirds of this amount.

D. *Implications for the Impact of Federal Reserve Actions on the Term Structure*

The asymmetric-information hypothesis suggests that interest rates at all horizons rise in response to monetary contractions because market participants raise their expectations of inflation. In this section, we compare the predicted changes in interest rates due to the changes in expected inflation associated with monetary actions with the observed changes in interest rates at various horizons following monetary actions. This comparison provides a way of gauging whether the asymmetric-information effects identified in earlier sections can explain a substantial amount of the mysterious behavior of the term structure following monetary actions. We begin with the relatively straightforward case of short-term rates, and then turn to the more difficult case of long-term rates.

Of course, asymmetric information concerning inflation is not the only possible explanation of policy's impact throughout the term structure. For example, if inflation is very sluggish, a contractionary action stemming from a change in the Federal Reserve's inflation goals could imply long-lasting increases in real rates and only very gradual decreases in inflation, and thus increases in long-term nominal rates. Similarly, there could be asymmetric information not about inflation, but about the equilibrium real rate. That is, a contractionary action could signal that the Federal Reserve has information that the current and future real interest rates consistent with normal output are higher than previously believed, and thus cause nominal rates to rise. Finally, long-term nominal rates might overreact to changes in short-term rates. That is, the rational expectations theory of the term structure might fail.

Our goal is not to provide a complete analysis of how much these or other possible mechanisms contribute to the response of interest rates to policy actions. Rather, we ask the narrower question of how much of the response is consistent with the hypothesis that actions reveal Federal Reserve information about inflation. Note, however, that the hypothesis based on sluggish inflation predicts that Federal Reserve actions should signal that its inflation forecasts are below those of commercial forecasters and that commercial forecasters should revise their expectations of inflation down in response to contractionary policy actions. Both predictions are contradicted by our findings in subsections B and C of this section. And given the strong evidence in Section II of the existence of asymmetric information about inflation, the hypothesis that this asymmetry is central to the impact of policy actions on the term structure seems at least as plausible as the alternatives based on asymmetric information about equilibrium real rates or on overreaction. Thus our hypothesis deserves serious consideration as a candidate explanation of the response of interest rates throughout the term structure to policy actions.

[27] That is, we estimate regressions of the form: $\hat{\bar{\pi}}^C_{h,t+1} = \eta + \lambda M_t + \kappa\hat{\bar{\pi}}^C_{ht} + \rho(\hat{\bar{\pi}}^F_{h,t+1} - \hat{\bar{\pi}}^F_{ht}) + \bar{v}_{h,t+1}$, where bars over the variables indicate averages up to horizon h. The results reported are for $h = 4$, but again they are similar for other horizons.

TABLE 9—ESTIMATED IMPACT OF MONETARY-POLICY ACTIONS ON EXPECTED INFLATION AT SHORT HORIZONS

Forecast horizon (Months)	Dummy variable			100-basis-point change in funds-rate target			Change in Treasury bill rate[a]
	Blue Chip	DRI	SPF	Blue Chip	DRI	SPF	
	(Percentage points)						
3	0.09	0.21	0.28	0.22	0.49	0.11	0.55
6	0.07	0.13	0.23	0.17	0.22	0.10	0.54
12	0.06	0.09	0.21	0.16	0.00	0.14	0.50

[a] From Cook and Hahn (1989a, Table 3). These estimates show the effect of a 100-basis-point change in the funds-rate target on the relevant Treasury bill rate on the day of the change.

Short-Term Interest Rates.—Table 8, discussed above, gives estimates of the impact of policy actions on expected inflation as measured by commercial forecasts in the current quarter and each of the next four quarters. Finding the actions' impact on expected inflation at horizons up to a year is thus just a matter of calculating the appropriate averages from these estimates.

For simplicity, we assume that policy actions occur in the middle of a quarter. To compute the impact of an action on expected inflation over the life of a 3-month Treasury bill, we therefore average the estimated impacts on expected inflation in the current quarter and in the next quarter. That is, we calculate $\Delta\pi_3^e = (\hat{\lambda}_0 + \hat{\lambda}_1)/2$, where π_3^e is expected inflation over a 3-month horizon and $\hat{\lambda}_0$ and $\hat{\lambda}_1$ are estimates of λ for $h = 0$ and $h = 1$ in equation (5) reported in Table 8. Similarly, we calculate an action's impact on expected inflation over the lives of 6-month and 12-month Treasury bills as $\Delta\pi_6^e = (\hat{\lambda}_0 + 2\hat{\lambda}_1 + \hat{\lambda}_2)/4$ and $\Delta\pi_{12}^e = (\hat{\lambda}_0 + 2\hat{\lambda}_1 + 2\hat{\lambda}_2 + 2\hat{\lambda}_3 + \hat{\lambda}_4)/8$.[28]

Table 9 reports the results. As before, we measure actions by both the dummy variable and the change in the funds-rate target. For comparison, the final column shows Cook and Hahn's estimates of the impact of a 100-basis-point change in the funds-rate target on the Treasury bill rate at that horizon.

The results suggest that policy actions have a noticeable impact on expected inflation at short horizons. The results using the change in the funds-rate target suggest that a 100-basis-point increase in the target raises expected inflation over the coming 3 months by about 20 basis points, and over the coming 6 and 12 months by about 10 basis points. The overall rise in Treasury bill rates for all three horizons is about 50 basis points. Thus, between a fifth and almost half of the response of short-term rates to policy actions appears to reflect changes in expected inflation. Not surprisingly, however, most of the response reflects changes in real rates.

The results using the dummy variable are similar. An increase in the funds-rate target raises expected inflation over the coming 3 months by about 15 basis points, and over the coming 6 and 12 months by about 10 basis points.[29]

Policy Actions and Expected Inflation at Longer Horizons.—Discerning the impact of policy actions on expected inflation at horizons

[28] We have no estimate of actions' impact on the Survey of Professional Forecasters' expectation of inflation in the current quarter. For both Blue Chip and DRI, the impact on expected inflation in the current quarter is much larger than the impact in later quarters. For SPF, we therefore conservatively assume that the effect for the current quarter is the same as the effect for the next quarter.

[29] If a policy action becomes expected between the time of the initial commercial forecast and the action itself, the revisions in expected inflation (and the consequent changes in interest rates) occur at the time the action becomes anticipated, not when it actually occurs. Cook and Hahn, however, consider changes in interest rates just on the days of policy actions. Thus, the results here and in Table 11 may overstate how much of the changes in interest rates in response to policy actions stem from the revelation of Federal Reserve information. During Cook and Hahn's sample period, however, policy actions were frequent and did not take place at regular intervals, and often occurred at times other than those of regular FOMC meetings. More generally, policy actions were not subject to anything approaching the degree of speculation that they are today. As a result, the assumption that actions did not become expected between the time of the previous commercial forecast and when they actually occurred appears to be a reasonable first approximation.

beyond a year is both more important and more difficult. It is more important because the actions' impact on long-term rates is puzzling. It is more difficult because we have little direct evidence about the actions' effect on expected inflation beyond a year, and no direct evidence at all about their effect beyond seven quarters. Thus, any estimates of their effect on expected inflation at long horizons must be indirect.

One piece of indirect evidence comes from the behavior of inflation. If the Federal Reserve has a narrow target rate for inflation and brings inflation back to that range rapidly after a departure, long-term expected inflation must be close to the Federal Reserve's target regardless of what is happening in the near term. But if the Federal Reserve brings inflation back to its normal level only slowly, market participants are likely to revise their expectations of long-term inflation in response to news about short-term inflation.

The actual behavior of inflation is consistent with the view that the Federal Reserve brings inflation back to normal only slowly after a shock. Standard Box-Jenkins analysis suggests that inflation for our full sample period (1968 IV–1991 IV) is well described as an IMA(1, 1) process. For example, both the Akaike and Schwarz criteria point to this specification. The MA coefficient is -0.42 (with a standard error of 0.10). Thus, in response to a generic 1-percentage-point innovation in inflation, expectations of inflation in all subsequent quarters should rise by 0.58 percentage points. Estimating other low-order ARMA processes for the change in inflation yields similar results. Further, as a check for the possibility of slow mean reversion, we also estimate AR-8 and AR-12 processes for the change in inflation. We find that these, too, suggest that inflation is very persistent.[30] And as we show below, it is the medium-term rather than the long-term behavior of inflation that is crucial for the impact of policy actions on interest rates.

A second piece of indirect evidence comes from examining whether the Federal Reserve's medium-term forecasts contain useful information about inflation at longer horizons. We ask whether a market participant using a medium-term commercial inflation forecast in predicting inflation at longer horizons could improve on that forecast if he or she had access to the Federal Reserve's medium-term forecast.

Specifically, we consider an individual in month t trying to forecast inflation from 4 quarters after month t to 8 quarters after, from 8 to 12 quarters after, and from 12 to 16 quarters after. We regress actual inflation over these periods on a constant, a commercial medium-term inflation forecast, and the comparable Federal Reserve forecast. Our interest is in whether the coefficient on the Federal Reserve forecast is positive; that is, we want to know whether the Federal Reserve's medium-term inflation forecast helps predict inflation two, three, and four years in the future.

We use the forecast in month t of inflation four quarters after month t as our medium-term inflation forecast. This forecast is available for a large number of observations for all of our forecasters. As before, we correct the standard errors for heteroskedasticity and for serial correlation over $h + 1$ quarters. Thus, for example, when we consider inflation from between 8 and 12 quarters ahead, we correct for heteroskedasticity over 13 quarters. One implication is that the standard errors should be interpreted with extreme caution: the justification for the standard errors is asymptotic, and the forecast horizons are substantial compared with our sample periods. This is especially true for the Blue Chip forecasts, where we have only 11 years of data.

Table 10 reports the results. For the short Blue Chip sample, the results show little value in the Federal Reserve forecasts for predicting inflation two to four years ahead. But for DRI and SPF, the estimates suggest that the Federal Reserve forecasts contain considerable information. All of the point estimates are above one-half, and most are close to one. Moreover, the t-statistics (which, as indicated above, should be viewed as highly approximate) suggest that many of the estimates are statistically significant. Thus, the bulk of the evidence suggests that the Federal Reserve's medium-term forecasts contain useful information about longer-term inflation.

Long-Term Interest Rates.—The indirect evidence supports the view that monetary actions

[30] Other authors also find that inflation is highly persistent. See, for example, Robert B. Barsky (1987).

TABLE 10—TESTS OF FEDERAL RESERVE ADDITIONAL INFORMATION FOR INFLATION AT LONG HORIZONS

$$\pi_{ht} = \delta + \gamma_C \hat{\pi}^C_{4t} + \gamma_F \hat{\pi}^F_{4t} + \nu_{ht}$$

Forecast horizon (Quarters)	δ	γ_C	γ_F	R^2	N
Blue Chip					
5–8	2.17 (0.72)	0.18 (0.14)	0.10 (0.07)	0.26	93
9–12	2.64 (1.06)	0.17 (0.31)	−0.04 (0.20)	0.07	92
13–16	2.93 (0.97)	0.14 (0.34)	−0.10 (0.34)	0.02	84
DRI					
5–8	0.80 (1.22)	−0.82 (0.49)	1.67 (0.57)	0.37	146
9–12	1.84 (1.47)	−0.59 (0.43)	1.19 (0.48)	0.18	145
13–16	2.98 (1.58)	−0.51 (0.29)	0.86 (0.36[a])	0.08	137
SPF					
5–8	2.09 (1.36)	−0.64 (0.29)	1.32 (0.27)	0.31	64
9–12	3.07 (1.69)	−0.41 (0.43)	0.85 (0.52)	0.12	64
13–16	4.26 (1.95)	−0.41 (0.52)	0.60 (0.55)	0.04	61

Notes: π denotes inflation, and $\hat{\pi}^C$ and $\hat{\pi}^F$ denote commercial and Federal Reserve inflation forecasts; h and t index the horizon and date of the forecasts. The sample periods are 1980:1–1991:11 for Blue Chip; 1970:7–1991:11 for DRI; and 1968:11–1991:11 for SPF. Numbers in parentheses are robust standard errors.

[a] Standard error calculated using Newey-West procedure because the Hansen-Hodrick standard error cannot be computed.

affect inflationary expectations at fairly distant horizons. We therefore want to go a step farther and ask whether the magnitudes involved are large enough to account for much of the impact of monetary actions on long-term interest rates. Specifically, we want to extrapolate our findings in Table 8 to longer horizons, and then estimate by how much actions' effects on the path of expected inflation affect various long-term rates.

This exercise is clearly just a back-of-the-envelope calculation. We have no conclusive evidence that policy actions affect expected inflation at long horizons, and there are many possible ways of extrapolating our findings for short horizons to obtain quantitative estimates of the effect at long horizons. Nonetheless, we think it is useful to derive at least rough estimates of the likely effect of monetary actions on expected inflation at long horizons and, thus, of the behavior of long-term interest rates associated with the revelation of Federal Reserve information.

We proceed as follows. For each commercial forecaster, we pool the different forecast horizons and reestimate the regressions underlying Table 8 by nonlinear least squares, constraining the λ's to follow an AR-1 process. That is, loosely speaking, we fit an AR-1 process to the estimated λ's in Table 8. Our estimates of the λ's at horizons beyond those for which we have direct evidence are just the λ's implied by the estimated process.

We then use these λ's to find the impact of policy actions on the interest rates on Treasury bonds of different maturities through their impact on the path of expected inflation. We account for the fact that Treasury bonds are not pure discount bonds, so that changes in expected inflation at short horizons have larger effects than changes at long horizons.[31]

The nonlinear least squares estimates imply that the effect of policy actions on expected inflation are quite persistent. For Blue Chip, the immediate effect of a 100-basis-point rise in the target is a rise in expected inflation of 30 basis points, and the long-run effect is a rise of 14 basis points. When the dummy variable is used instead of the change in the target, the immediate effect of a tightening is a rise of 14 basis points, and the long-run effect is a rise of 5 basis points. For SPF, the

[31] Specifically, we consider a bond with an interest rate equal to the average for Cook and Hahn's sample period (1974–1979) for that maturity. We assume that the term structure is initially flat at that rate, and that it changes by the change in the path of expected inflation. We then find how this change affects the price of the bond and, thus, its implied yield.

TABLE 11—ESTIMATED IMPACT OF MONETARY-POLICY ACTIONS ON EXPECTED INFLATION AT LONG HORIZONS

Forecast horizon (Years)	Dummy variable			100-basis-point change in funds-rate target			Change in Treasury bond rate[a]
	Blue Chip	DRI	SPF	Blue Chip	DRI	SPF	
			(Percentage points)				
3	0.05	0.11	0.21	0.15	0.04	0.15	0.29
5	0.05	0.11	0.21	0.15	0.02	0.15	0.21
7	0.05	0.11	0.21	0.14	0.01	0.15	0.19
10	0.05	0.11	0.21	0.14	0.01	0.15	0.13
20	0.05	0.10	0.21	0.14	−0.00	0.15	0.10

[a] From Cook and Hahn (1989a, Table 3). These estimates show the effect of a 100-basis-point change in the funds-rate target on the relevant Treasury bond rate on the day of the change.

estimates suggest virtually no time variation in the effect on expected inflation. Expected inflation rises essentially permanently by 15 basis points using the change in the target and by 21 basis points using the dummy variable. For DRI, the results vary depending on the indicator of monetary policy actions used. When policy actions are measured using the change in the funds rate target, the estimates imply that the impact of a 100-basis-point rise in the target on expected inflation falls rapidly from an increase of 82 basis points in the current quarter, to essentially no effect two quarters ahead, to a long-run decrease of 2 basis points. However, when we use the dummy variable in place of the change in the target, the results for DRI are similar to those for the other two forecasters. The estimates imply that the immediate effect of a policy tightening is a rise of 31 basis points and that the long-run effect is a rise of 10 basis points.

Table 11 reports the effects on interest rates on bonds of different maturities through this channel. As in Table 9, the final column gives Cook and Hahn's estimates of the effect of a 100-basis-point change in the target on the yield of a Treasury bond of the corresponding maturity. For the two cases where the estimated impact on expected inflation is essentially constant over time, interest rates at all horizons rise by the amount of the rise in expected inflation. For the other four cases, the estimated impact is a more complicated function of the estimated effect on the path of expected inflation.

The results indicate that the impact of policy actions on expected inflation through the revelation of Federal Reserve information may account for much of the effect of policy actions on long-term rates. In particular, using either Blue Chip or SPF, this channel accounts for a rise of over 10 basis points in long-term interest rates in response to a 100-basis-point rise in the funds-rate target. This represents over half of the overall response of 5-year and 7-year bond rates found by Cook and Hahn, and essentially all of the response of 10-year and 20-year rates. Because the effects of a 100-basis-point rise in the funds-rate target are much less persistent for DRI, the results using the DRI forecasts suggest essentially no impact through this channel. However, when we use the dummy variable to measure policy actions, the results for all three forecasters suggest that the actions have substantial effects on long-term rates.

These results do not depend on the actions' impact on expected inflation at very long horizons. Because Treasury bonds are not pure discount bonds, short-term and medium-term expected inflation are more important to their value than long-term expected inflation. For example, about half of policy actions' estimated impacts on the 20-year bond rate shown in Table 11 stem from their effect on expected inflation over the first six years, and an additional quarter of the impacts comes from their effect on expected inflation over the following five years. The relative unimportance of very long-term expectations increases the plausibility of our back-of-the-envelope calculation, since our estimates of the impact of information revelation on expected inflation are surely less speculative for the short and medium run than for the very long run.

IV. Conclusion

The most important finding of this paper is that the Federal Reserve appears to possess information about the future state of the economy that is not known to market participants. Our estimates suggest that if they had access to the Federal Reserve's forecasts of inflation, commercial forecasters would find it nearly optimal to discard their forecasts and adopt the Federal Reserve's. This information advantage appears to exist for real output as well as for inflation.

The existence of this information asymmetry has important implications for the behavior of interest rates. The tests discussed above suggest that Federal Reserve actions reveal some of its additional information and forecasters respond by changing their expectations of inflation. As a result, the information revelation associated with monetary actions can explain why interest rates at even long horizons rise when the Federal Reserve tightens policy.

Our finding of substantial asymmetric information between the Federal Reserve and the public may also have implications for a variety of other studies in monetary economics. First, as mentioned in the introduction, many models of central-bank behavior emphasize the potential importance of an information advantage for the monetary authority. For example, in models with rational expectations and flexible prices, activist monetary policy can stabilize real output only if the monetary authority has additional information about the state of the economy (Sargent and Wallace, 1975; Barro, 1976). To give another example, Barro and Gordon (1983), Canzoneri (1985), and Cukierman and Meltzer (1986) argue that in settings where optimal monetary policy is not dynamically consistent, asymmetric information between the monetary authority and the public about the benefits of expansionary policy has important implications for the conduct of policy, the monetary authority's desire for secrecy, and the relation between economic conditions and policy actions. Our results bear on the importance of all of these models of asymmetric information.

Second, an even broader literature is concerned with the possibility of asymmetric information in financial markets, and of actions providing signals of that information. In the case of inflation and interest rates, it is easy to identify a participant that may have additional information (the Federal Reserve) and one important set of its actions (changes in its funds-rate target). Even more important, the Federal Reserve and commercial inflation forecasts provide a potential record of the informed party's additional information. As a result, this setting may be particularly fruitful for investigating this general class of models. As we have described, in this case there is overwhelming evidence of the existence of asymmetric information and considerable evidence that actions provide signals of that information and that those signals are important to the actions' effects. This suggests that asymmetric information and signaling deserve serious consideration in the analysis of financial markets more generally.

Finally, a large literature dating back to at least Christopher A. Sims (1980) and Ben S. Bernanke and Alan S. Blinder (1992) attempts to identify the effects of monetary policy by examining the response of the economy to the component of a policy instrument, such as the federal funds rate, that is orthogonal to some set of publicly available information. Our results suggests that there is a fundamental problem with this approach. The component of monetary policy orthogonal to publicly available information reflects not just random variations in policy, but also the Federal Reserve's responses to information that it has but the public does not. As a result, the estimates of policy's effects from this approach are contaminated with the effects of the shocks that are causing the changes in policy. Thus, the existence of a significant information advantage for the Federal Reserve may have important implications not just for the behavior of interest rates and theoretical analyses of central-bank behavior, but for a wide range of empirical investigations of monetary policy.

Our finding of substantial asymmetric information between the Federal Reserve and the public may also have implications for the debate over Federal Reserve reporting practices. The Federal Reserve could eliminate its information advantage by releasing the Green Book forecasts as soon as they are made. Provided that the information content of the Green Book forecasts remained the same, immediate release would benefit all those who use forecasts. Immediate release would presumably also increase the transparency of monetary policy-making by showing more of the motivation behind FOMC decisions. It could thus have the benefit of reducing the financial-market volatility associated with speculation about Federal Reserve actions and motives.

The obvious complication is that immediate release could change the information content of the Green Book forecasts. Given the prestige of the Federal Reserve and the forecasts' importance to monetary policy, the forecasts would surely attract a great deal of attention if they were released without delay. This could lead the Federal Reserve staff to change how it made the forecasts. For example, it could cause the staff to be less willing to depart from the consensus of private forecasts, to put more weight on easily documented model simulations and less on its judgments, or to report more optimistic forecasts.

Even if early release did not change how the staff made the forecasts, it would take years, and perhaps decades, for the statistical record to be long enough for this to be clear. Thus, regardless of whether early release changed the information content of the forecasts, the knowledge that the forecasts were being released could cause users of the forecasts to have less confidence in them. In the case of monetary policy, if the FOMC became less sure of the forecasts' value, it might place more weight on other, potentially less reliable, sources of information in policy-making. Thus, the finding that the Federal Reserve forecasts contain valuable information about future economic developments is not enough to settle the question of whether it would be desirable for the Federal Reserve to release those forecasts.

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