THE FED FUNDS FUTURES RATE AS A PREDICTOR OF FEDERAL RESERVE POLICY

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INTRODUCTION

Monetary policy's effects on the economy are pervasive, and the Federal funds rate plays a central role in the Federal Reserve's implementation of its policy. Changes in the Federal funds rate rapidly affect other money market interest rates, and changing expectations of future policy can significantly influence stock and bond prices. As demonstrated by Bernanke and Blinder (1992), changes in the Federal funds rate also have significant effects on real economic activity.[1] It is not surprising, therefore, that the Fed funds futures market has received increasing attention as a gauge of expected Federal Reserve policy actions.[2]

How well does the Fed funds futures market anticipate changes in the Federal funds rate? This article addresses that question by evaluating the futures market's one- and two-month-ahead forecasts of the funds rate. Specifically, it assesses the efficiency of the Fed funds futures market by testing the market's forecasts for the properties implied by rational

[1]The Federal funds rate is also an ingredient in more sophisticated measures of monetary policy as described in Bernanke and Mihov (1995) and Strongin (1995). Those measures also incorporate the volume of nonborrowed and total reserves.

[2]See, for example, McGee (1995).

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expectations. Over the 1989–1994 period, the futures-based forecasts generally satisfy this criterion: incorporating additional data available to investors when the contracts are priced yields only marginal improvements over the futures-only forecasts. Of the indicators considered, only the change in the inflation rate and the spread between three-month commercial paper and the Fed funds rates are statistically significant in within-sample tests of rationality at the 0.05 level. These indicators do not tangibly improve out-of-sample forecasts, however.

THE FED FUNDS FUTURES MARKET

Fed funds futures contracts are designed to hedge against (or speculate on) changes in the overnight effective Fed funds rate, which is the interest rate prevailing in the interbank market for overnight reserves. The Chicago Board of Trade (CBT) offers contracts on the Fed funds rate at a variety of maturities.[3] The most popular of these are the one- and two-month contracts, and the "spot month" contract based on the remainder of the current month's rate.[4] They are marked to market on each trading day, and final cash settlement occurs on the first business day following the last day of the contract month.[5]

The settlement price for the contract is based on the relevant month's average effective overnight Fed funds rate as reported by the Federal Reserve Bank of New York. The average includes weekends and holidays, whose rates are carried over from the rate prevailing on the most recent business day.[6] The pre-tax profits for an investor long in Fed funds contracts purchased on date t for delivery in month s, π_t^s, is proportional to the difference between the futures rate, f_t^s, and the average of the month's Fed funds rate, r_t,

$$\pi_t^s = f_t^s - \frac{1}{M}\sum_{i \in s} r_i$$

[3]The CBT now refers to Fed funds futures as Thirty-Day Interest Rate futures.

[4]The price of the spot month contract is a weighted average of the previous overnight Fed funds rates for the month and the term rate for the remainder of the month. For example, the January settlement price applied to a futures contract purchased on January 11 would be 10/31 × the average overnight Fed funds rate for previous 10 days + 21/31 × the term Fed funds rate for the 21 days remaining in the contract month.

[5]For all but the spot month contract, the CBT limits price fluctuations to 150 basis points daily. The limit is expanded to 225 basis points when the limit is reached on three consecutive trading days. Further details on the market's operation can be found in "Thirty-Day Interest Rate Futures for Short-Term Interest Rate Management," Kuprianov (1993), and Carlson, McIntire, and Thomson (1995).

[6]A uniform 30-day month is used in calculating the tick size.

where M is the number of calendar days in the month. Arbitrage by risk-neutral investors implies no predictable profit opportunities, or $E_t(\pi_t^s) = 0$, which in turn implies that the futures rate is equal to the average of expected future realized rates on Fed funds,

$$f_t^s - E_t\left(\frac{1}{M}\sum_{i\in s} r_i\right) = 0 \tag{1}$$

where E_t represents the mathematical expectation conditional on information available to investors at time t.[7]

A number of previous studies have analyzed the T-bill futures market, including: Rendleman (1979); Hedge and McDonald (1986); Patel and Zeckhauser (1990); Cole, Impson, and Reichenstein (1991); and Hafer, Hein, and MacDonald (1992). These studies found that futures rates generally yield accurate predictions of future spot T-bill rates at most horizons, and rarely fail to satisfy properties of rational forecasts. The only prominent exception to this pattern is Howard (1982), who found that simple time-series models dominate futures-based forecasts at short horizons.

Two features distinguishing the Fed funds futures market from the LIBOR, T-bill, and Eurodollar markets are its short history, and its relatively small size. T-bill futures have been traded since 1976, while the Fed funds futures market has existed only since October, 1988. The volume of Fed funds contracts traded in 1992 was only one-fourth that of T-bill futures, and one-third that of LIBOR contracts.[8] In light of the market's relatively short track record, the efficiency of the Fed funds market is an open question.

ARE FED FUNDS FUTURES FORECASTS RATIONAL?

This section examines forecasts of the Fed funds rate based on the one- and two-month-ahead Fed funds futures contracts. Specifically, it reports tests of the unbiasedness and rationality properties implied by eq. (1). The forecasts are unbiased if the futures rate is, on average, equal to the

[7]Because the futures price anticipates the realized Fed funds rate instead of the Fed's target rate, technical factors affecting the Open Market Desk's ability to hit the target rate may, in principle, affect the futures rate. In practice, the discrepancy between the target and the realized rates largely disappears in monthly averages, however. Carlson, McIntire, and Thomson (1995) found that the mean absolute deviation between the effective and target rates is no more than six basis points.

[8]The Fed funds futures market has grown rapidly since 1994. By the third quarter of 1995, the volume of contracts traded and open interest have both reached levels comparable to those of the T-bill futures market.

realized spot rate. The rationality property says that the Fed funds futures rate should incorporate all available information useful for predicting the funds rate. This implies that no variable available in month t should be able to predict the futures market's *error* in forecasting the month $t + 1$ funds rate. The out-of-sample forecasting performance of the futures-based forecasts is also examined, and compared to the performance of alternative forecasts.

Figure 1 plots the data used in the analysis: the monthly average of the effective overnight Fed funds rate and the corresponding Fed funds futures rate for the period from May 17, 1989, through December 7, 1994. In general, the implied funds rate is very close to the spot rate, especially close to the settlement date. The one-month-ahead contract, as expected, seems to track the actual rate very closely, while the forecast error associated with the two-month-ahead contract appears somewhat larger. Overall, little bias is apparent in either of the two futures rates. Only from 1990 to mid-1992, when Federal Reserve policy led to a sharp decline in the Fed funds rate, is there a persistent discrepancy. During this period, the futures rate consistently overforecast the spot rate, suggesting that the decline in the funds rate was to some extent unanticipated by market participants.

Evidence from Monthly Data

Using data at a monthly frequency, the unbiasedness and rationality properties are easily tested by regressing the spread between the futures rate and the realized spot rate on a constant and a variety of economic indicators investors might plausibly have used to predict the Fed funds rate. For the k-month-ahead futures rate, the regressions are of the form:

$$\bar{f}_t^{t+k} - \bar{r}_{t+k} = a + \theta(L)x_{t-l} + u_{t+k} \qquad (2)$$

where $\bar{r}_{t+k}$ is the average funds rate prevailing in month $t + k$, and $\bar{f}_t^{t+k}$ is the average futures rate for the month $t + k$ contract, priced in month t.[9] The forecast error is u_{t+k}. Candidate indicators, x_t, are included in the regression by way of the lag polynomial, $\theta(L)$. In cases where the t-dated indicator is not known at time t, l is set to one to introduce an additional lag; in other cases, l is zero.[10] Unbiasedness implies $a = 0$, and rationality that $\theta(L) = 0$.

[9]Regressions of this form impose a unit coefficient on $\bar{f}_t^{t+k}$. Tests not reported in the article confirm that the restriction is easily satisfied, paralleling Patel and Zeckhauser's (1990) findings for T-bill futures rates.

[10]Most economic data, such as inflation and employment, are reported with a one-month lag, so a fair test of rationality would use lagged values of those variables.

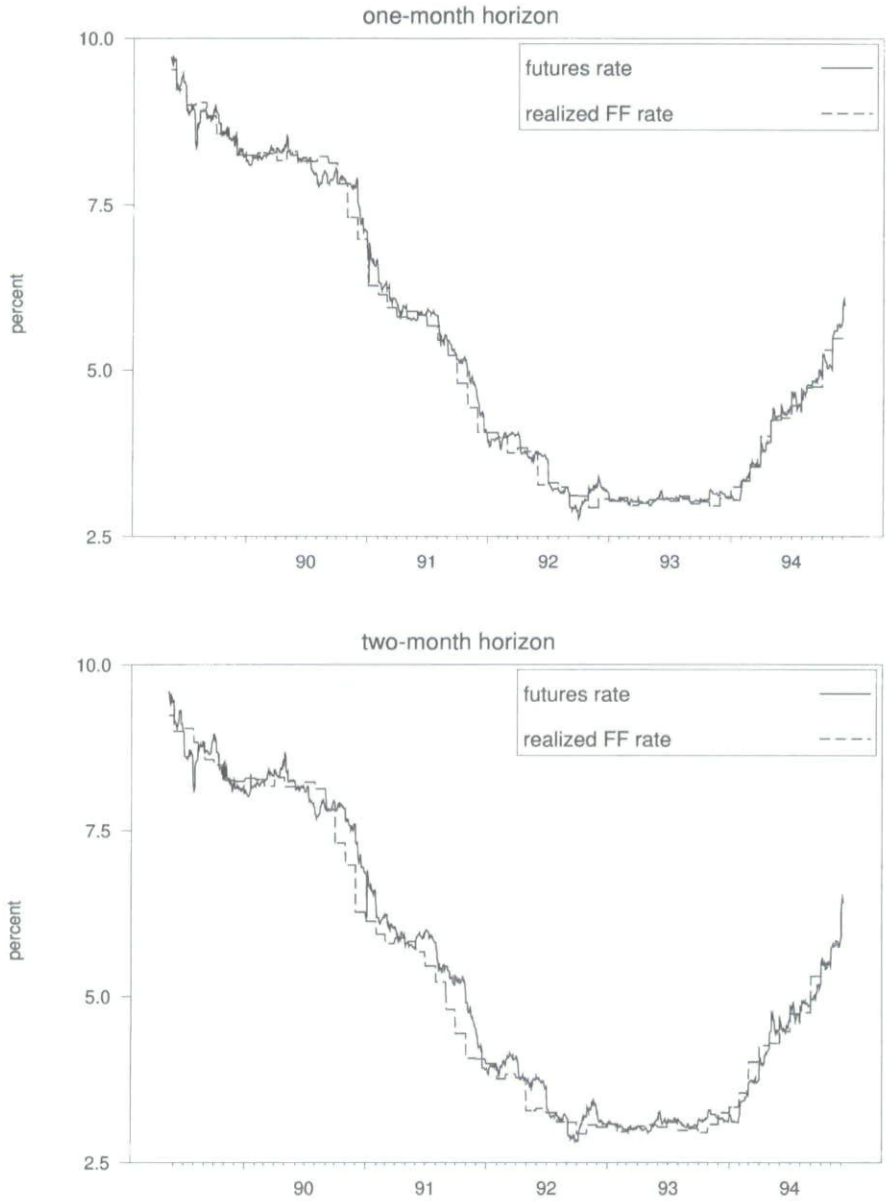

FIGURE 1
Futures market and realized Fed funds rates.

Within-Sample Tests

The first line of Table I tests for bias in the one-month futures rate by simply regressing the forecast error on a constant term. The statistically

TABLE I

Monthly Tests of Unbiasedness and Rationality: One-Month Horizon

Indicator	*Estimated Constant*	*Significance Level*		$\bar{R}^2$
		Constant	*Indicator(s)*	
None	6.1	0.00	—	—
Inflation change (1–2)	5.9	0.00	0.05	0.061
Nonborrowed reserves growth (1–2)	4.7	0.07	0.59	−0.015
Total reserves growth (1–2)	3.8	0.14	0.31	0.001
Base growth (1–2)	2.5	0.68	0.80	−0.024
M1 growth (1–2)	4.5	0.17	0.84	−0.026
M2 growth (1–2)	9.4	0.00	0.25	0.013
3-month paper—FF spread	4.3	0.04	0.02	0.066
1-year note—FF spread	5.9	0.01	0.78	−0.014
30-year—FF spread	4.4	0.20	0.54	−0.009
Funds rate change	5.0	0.02	0.09	0.029
Unemployment rate change (1–2)	−15.7	0.35	0.17	0.024
Payroll employment growth (1–2)	8.4	0.00	0.25	0.012
UI claims change (1–2)	5.5	0.01	0.58	−0.014
Industrial production growth (1–2)	6.4	0.01	0.87	−0.027
IP growth (1–2) & inflation change (1–2)	5.8	0.01	0.20	0.031
Empl. growth (1) & inflation change (1–2)	7.6	0.00	0.05	0.073

Notes: The table reports the results from estimating eq. (2). The spread between the average one-month-ahead futures rate and the average Fed funds rate in that month is regressed on a constant and the indicator (or indicators) listed. Numbers in parentheses are the lags of the indicator included; where none is given, the current month's indicator is used. The results use the 66 monthly observations from June, 1989 through November, 1994. Interest rate data are in basis points.

significant estimated constant term shows that the one-month futures rate exhibits a premium of just over six basis points.

To test the rationality hypothesis, the futures-based forecast errors are regressed on a variety of economic indicators falling into four categories: inflation, employment and output, reserves and money, and interest rates and interest rate spreads. All of the variables except those based on interest rates are lagged one month to account for their delayed availability. The lag lengths selected are those yielding the best within-sample fit. The table reports the joint significance level of the indicators included in eq. (2).

At the one-month horizon, statistically significant $\theta(L)$ coefficients are scarce. The change in the CPI inflation rate, shown on the second line of the table, is one of the few indicators displaying a systematic relationship to the futures-based forecast error that is significant at the 0.05 level. The only other indicator with a significant within-sample relationship is the current month's spread between the interest rates on three-month commercial paper rate and overnight Fed funds. Because the expectations hypothesis of the term structure implies a relationship

TABLE II

Monthly Tests of Unbiasedness and Rationality: Two-Month Horizon

Indicator	*Estimated Constant*	*Significance Level*		$\bar{R}^2$
		Constant	*Indicator(s)*	
None	12.1	0.00	—	—
Inflation change (1–2)	12.0	0.00	0.18	0.022
Nonborrowed reserves growth (1–2)	10.7	0.01	0.56	−0.013
Total reserves growth (1–2)	8.7	0.03	0.33	0.004
Base growth (1–2)	9.6	0.31	0.94	−0.030
M1 growth (1–2)	9.0	0.09	0.74	−0.022
M2 growth (1–2)	17.8	0.00	0.21	0.018
3-month paper—FF spread	10.3	0.00	0.12	0.023
1-year note—FF spread	12.4	0.00	0.72	−0.014
30-year—FF spread	10.1	0.06	0.63	−0.012
Funds rate change	9.2	0.01	0.01	0.075
Unemployment rate change (1–2)	−27.3	0.29	0.10	0.040
Payroll employment growth (1–2)	18.9	0.00	0.01	0.126
UI claims change (1–2)	13.0	0.00	0.42	−0.004
Industrial production growth (1–2)	13.5	0.00	0.56	−0.013
IP growth (1–2) & inflation change (1–2)	12.8	0.00	0.41	0.001
Empl. growth (1) & inflation change (1–2)	17.0	0.00	0.02	0.109

Notes: The table reports the results from estimating eq. (2). The spread between the average two-month-ahead futures rate and the average Fed funds rate in that month is regressed on a constant and the indicator (or indicators) listed. The results use the 65 monthly observations from June, 1989 through November, 1994. See also notes to Table I.

between the slope of the term structure and future changes in interest rates, it is plausible that such a short-term interest rate spread might be informative about future changes in the funds rate. Both of these indicators explain roughly 6% of the forecast error variance, suggesting that there is some information in the inflation and term structure data that is not being fully exploited by investors.

Employment growth and the change in the inflation rate, shown on the last line of the table, are also jointly significant at the 0.05 level. However, the $\bar{R}^2$ is only marginally higher than it is in the inflation-only regression. The remaining indicators' lack of statistical significance and low $\bar{R}^2$ show that none contains any information on future Fed funds rate that is not already contained in the futures rate.

An analogous set of results for the two-month-ahead contracts is reported in Table II. The estimated constant in the table's first line implies a premium of just over 12 basis points, roughly twice that of the one-month contracts. Again, the scarcity of significant estimates of the $\theta(L)$ coefficients suggests little deviation from rationality. Only the differenced funds rate and payroll employment growth are significant at the 0.05

TABLE III

Monthly Out-of-Sample Forecast Errors

	One-Month-Ahead		*Two-Month-Ahead*	
Indicator	*RMSE*	*Signif. Level*	*RMSE*	*Signif. Level*
Futures rate only	17.7	—	30.5	—
Futures rate + constant	16.1	0.38	27.7	0.42
No change	25.4	0.03	42.2	0.00
Differentiated inflation	15.4	0.26	27.5	0.40
3-month paper—FF spread	17.7	0.99	27.0	0.34
Employment growth	16.1	0.36	26.4	0.21
Empl. growth & infl. change	15.5	0.27	26.5	0.24
Christiano–Eichenbaum–Evans	20.9	0.39	30.2	0.91

Notes: The models are initialized on the period from June, 1989, through December, 1990, and estimated recursively and evaluated from January, 1991 onward. The lags of the indicators are the same as those used in Tables I and II. The Christiano–Eichenbaum–Evans specification is defined in the text. The significance levels reported are for the test that the model's RMSE is equal to that of the futures-only forecast. See also notes to Table I.

level, and these indicators account for less than 8 and 13%, respectively, of the within-sample forecast error variance.

Out-of-Sample Forecasts

The scattered deviations from rationality reported in Tables I and II may be merely the result of spurious within-sample fitting. (After all, even under the null hypothesis that all of the $\theta(L)$ coefficients equal zero, a test at the 0.05 level would reject the null hypothesis one out of twenty times.) This section presents results based on out-of-sample forecasts of the Fed funds rate. Not only does this represent a much more stringent test for deviations from rationality, but it also yields a measure of the quantitative significance of those deviations.[11]

The results of the out-of-sample forecasting exercises for the one- and two-month horizons appear in Table III. The table reports the Root Mean Squared Error (RMSE), and statistical significance of the difference between that model's RMSE and that of the "futures rate only" forecast. To ensure that no out-of-sample information is incorporated into the forecast, the parameters of the augmented model [i.e., α and $\theta(L)$] are estimated recursively using the Kalman filter.[12] The models are esti-

[11]Carlson, McIntire, and Thomson (1995) also examined forecasting performance, but their analysis was limited to the naive "no change" forecast and a simple autoregressive model.

[12]The test statistic is based on the difference between the squared forecast error from the augmented model, $\hat{u}_{t+1}$, and the "futures rate only" forecast error, $(t-1)^{-1}\Sigma_{t-1}^{T-1}[(\bar{r}_{t+1} - \bar{f}_t^{t+1})^2 - \hat{u}_{t+1}^2]$, which is asymptotically normally distributed.

mated on the June, 1989 through December, 1990 subsample, and evaluated over the January, 1991 through November, 1994 period.

Comparing the first and second lines shows that subtracting a (recursively estimated) constant from the futures rate improves forecasting performance slightly, reducing the RMSE by 1.6 and 2.8 basis points at the one- and two-month horizons. The futures-rate-based forecasts are significantly more accurate than the "no change" forecast, with a difference of over 9 and 14 basis points at the one- and two-month horizons.

The out-of-sample results corroborate the within-sample rationality tests, and show that the quantitative significance of the deviations reported earlier is quite small. The fourth line of the table shows that augmenting the model with the change in the inflation rate reduces the RMSE by only 0.7 and 0.2 basis points (relative to the "futures + constant" forecast) at the one- and two-month horizons. Neither differs significantly from the "futures only" RMSE. Employment growth helps to reduce the RMSE marginally at both horizons, but slightly more at two months. The three-month paper to Fed funds spread, which is statistically significant in sample at the one-month horizon, fails to improve the out-of-sample RMSE at that horizon; it does marginally improve the two-month-ahead forecasts, however.

As a final comparison, the table reports the RMSEs from forecasts based on a Vector Autoregression (VAR) similar to the one developed by Christiano, Eichenbaum, and Evans (CEE) (1994). Their specification, which was designed to assess the economy's response to unforecastable changes in the Fed funds rate, models monetary policy as a function of lagged employment, inflation, nonborrowed reserves, and total reserves, as well as lagged values of the funds rate itself. Over this relatively short sample, very short lag lengths gave the best out-of-sample performance; the specification used here includes four lags of the funds rate, three lags of the change in inflation, and only one lag each on employment growth, nonborrowed reserves growth, and total reserves growth.[13] Unlike the other forecasts evaluated in Table III, the CEE model does not incorporate futures rate data.

Although it does noticeably better than the "no change" forecast, the CEE model's RMSE statistics are four to five basis points higher than the futures-only forecast's. The CEE model's relative performance improves somewhat at the longer two-month horizons, however. At two months, its

[13]Including the change in sensitive materials prices, as suggested by Christiano et al., actually increases the model's out-of-sample forecast RMSE. Consequently, it is excluded from these regressions.

RMSE is only 2.5 basis points larger than that from the constant-adjusted futures-based forecast.

The CEE model's relative improvement at the two-month horizon suggests that the macroeconomic fundamentals on which it is based are very informative for gauging the longer-term direction of the funds rate. Presumably, this reflects the Federal Reserve's systematic response to the kinds of variables included in the CEE specification. The futures rates' better performance at the shorter one-month horizon can be explained by the market's incorporation of information on the likely timing of funds rate changes, such as the dates of the Federal Open Market Committee (FOMC) meetings.

Overall, the results demonstrate that month-to-month changes in the Federal funds rate over the 1989–1994 period contain a significant predictable element, which is reflected in the Fed funds futures rate. The futures rate significantly outperforms the "no change" forecast, although the relatively modest improvement in RMSE suggests that many of the Fed's actions surprised the financial markets. The predictable changes in the funds rate are, however, rationally forecast by the futures market, and the inclusion of other sources of information yields only trivial improvements over the futures-based forecast.

Evidence from Daily Data

The results presented above all utilize monthly average data, ignoring any information contained in daily Fed funds futures rates. In principle, it is possible to construct more powerful tests of the rationality hypothesis by exploiting the availability of daily data. The tests use a daily version of eq. (2),

$$f_t^s - \bar{r}_s = a + \theta(L)x_{t-1} + u_t^s \tag{3}$$

where s indexes the month, and t, the day. For k-month-ahead contracts, $t \in s - k$. As in the monthly regressions, the x are lagged l additional days to account for the timing of the data releases.

Using daily data introduces two complications. One is that the variable being forecast is an average of daily rates. This overlap in the forecast periods introduces moving-average serial correlation in the forecast errors, which distorts the estimated standard errors if left uncorrected. Following Hansen and Hodrick (1980), the results use an estimate of the

TABLE IV

Daily Tests of Unbiasedness and Rationality: One-Month Horizon

Indicator	*Estimated Constant*	*Significance Level*		$\bar{R}^2$
		Constant	*Indicator(s)*	
None	5.9	0.00	—	—
Nonborrowed reserves growth (5)	4.9	0.04	0.30	0.105
Total reserves growth (5)	4.8	0.06	0.32	0.012
Base growth (5)	4.4	0.40	0.76	0.000
M1 growth (5)	4.5	0.22	0.62	0.003
M2 growth (5,10,15,20)	8.6	0.00	0.27	0.031
3-month paper—FF spread	4.9	0.04	0.04	0.045
1-year note—FF spread	5.6	0.04	0.58	0.004
30-year—FF spread	3.9	0.37	0.50	0.007
Differenced funds rate	5.8	0.01	0.23	0.000
UI Claims, weekly (10,15,20,25)	5.8	0.01	0.39	0.002
UI Claims, 4-week average (10)	5.9	0.01	0.20	0.025

Notes: The table reports the results from estimating eq. (3). The spread between the one-month-ahead futures rate and the average Fed funds rate in that month is regressed on a constant and the indicator listed. Numbers in parentheses are the lags (in days) of the indicator included. Where none is given, the current day's indicator is used. The results use the 1381 daily observations from May 17, 1989, through October 31, 1994. Standard errors are corrected for heteroskedasticity and MA(22) serial correlation as described in the text. Interest rate data are in basis points.

covariance matrix corrected for heteroskedasticity and moving-average serial correlation.[14]

A second issue is the limited availability of high-frequency data for use in forecasting the Fed funds rate. Only financial market data, such as interest rates and spreads, are available at a daily frequency. No economic data are released daily, but weekly data on reserves, the money supply, and unemployment insurance claims can be used in the analysis.

Within-Sample Tests

Tables IV and V summarize tests for unbiasedness and rationality based on eq. (3). As in the monthly results, the one- and two-month contracts exhibit premia of approximately 6 and 12 basis points, respectively. And, as before, very few of the indicators are helpful in explaining the futures-

[14]The pattern of serial correlation introduced by the structure of the Fed funds futures contracts differs slightly from that encountered in the study of forward rates. Because the contract is based on a calendar-month average, the daily forecast errors will be correlated with other days' errors if they fall within the same month; adjacent forecast errors will be uncorrelated, however, if they fall in different months. Because months contain at most 23 business days, an MA(22) correction is appropriate. The robust standard error procedure also corrects for the way in which the forecast error variance falls with the approach of the delivery month.

TABLE V

Daily Tests of Unbiasedness and Rationality: Two-Month Horizon

Indicator	*Estimated Constant*	*Significance Level*		$\bar{R}^2$
		Constant	*Indicator(s)*	
None	11.9	0.00	—	—
Nonborrowed reserves growth (5)	10.1	0.01	0.21	0.014
Total reserves growth (5)	9.7	0.04	0.13	0.018
Base growth (5)	14.8	0.14	0.72	0.001
M1 growth (5)	10.2	0.12	0.63	0.002
M2 growth (5,10,15,20)	17.3	0.00	0.04	0.053
3-month paper—FF spread	10.8	0.01	0.13	0.025
1-year note—FF spread	11.9	0.01	0.98	−0.001
30-year—FF spread	9.4	0.21	0.61	0.004
Differenced funds rate	11.6	0.00	0.04	0.001
UI Claims, weekly (10,15,20,25)	11.8	0.00	0.96	−0.001
UI Claims, 4-week average (10)	11.9	0.00	0.44	0.011

Notes: The table reports the results from estimating eq. (3). The spread between the two-month-ahead futures rate and the average Fed funds rate in that month is regressed on a constant and the indicator listed. The results use the 1361 daily observations from May 17, 1989 through September 30, 1994. See also notes to Table IV.

based forecast errors, supporting the rationality hypothesis. In the case of the one-month-ahead forecasts, only the three-month paper to Fed funds interest rate spread is significant at the 0.05 level; for the two-month-ahead forecasts, M2 and the differenced funds rate are significant.

Out-of-Sample Forecasts

As shown in Table VI, additional information yields very little—if any—improvement in out-of-sample forecasts of the Funds rate. At the one-month horizon, including the three-month to Fed funds spread reduces the RMSE by a mere 0.2 basis points; the other indicators make the forecasts worse. For two-month contracts, M2 and the differenced Fed funds rate also yield slight improvements.

Explaining the Bias in the Fed Funds Futures Rate

Although the Fed funds futures rate passes the rationality tests, it fails the tests of unbiasedness; in the 1989 to 1994 sample, the one-month futures rate exceeds the spot rate by six basis points, and the two-month rate by 12. What might explain this bias?

TABLE VI

Daily Out-of-Sample Forecast Errors

	One-month-ahead		*Two-Month-Ahead*	
Indicator	*RMSE*	*Signif. Level*	*RMSE*	*Signif. Level*
Futures rate only	17.2	—	26.7	—
Futures rate + constant	15.6	0.53	23.7	0.54
No change	24.9	0.03	38.8	0.00
M1 growth	15.7	0.47	23.9	0.50
M2 growth	15.9	0.49	23.6	0.45
3-month paper–FF spread	15.4	0.33	23.4	0.39
Differenced funds rate	15.7	0.45	23.5	0.43

Notes: The models are initialized on the period from May 17, 1989, through December 28, 1990, and estimated recursively and evaluated on the January 2, 1991, through December 7, 1994 period. The lags of the indicators are the same as those used in Tables IV and V. See also notes to Table IV.

One possibility is that the bias is merely an artifact of the sample under consideration. As shown in Figure 1, the only persistent discrepancy between the futures and spot rates occurs during a period in which the Fed, perhaps responding to unexpected weakness in the economy, pursued a policy that led to a sequence of sharp reductions in the Fed funds rate—some greater than 50 basis points in size. By contrast, the increase in the Fed funds rate that began in 1994 was more gradual. Hence, the bias may simply reflect the predominance of negative (i.e., expansionary) monetary policy surprises in the sample.

A second hypothesis is that the observed bias reflects the expected co-movement between Fed funds futures and the market return. Long investors in Fed funds futures profit when the realized funds rate is lower than the futures rate. If unexpected reductions in the Fed funds rate are also associated with positive returns on stocks, Fed funds futures will exhibit a positive beta, and will therefore earn a positive expected excess return.

Although a systematic investigation of this hypothesis is beyond the scope of this article, it is broadly consistent with the data. The return on Fed funds futures is, in fact, positively correlated with stock returns. Using the S&P 500 stock index to compute the market return, the contracts' betas, estimated from monthly data from June, 1989 through November, 1994, are positive and statistically significant at the 0.01 level. The relative sizes of the one- and two-month contracts' betas, 0.0024 and 0.0038, are comparable to the two contracts' relative biases. The CAPM may, therefore, be able to explain the small premium on Fed funds fu-

tures. In addition, the positive correlation between unanticipated reductions in the Fed funds rate and stock market returns suggests an interesting avenue for future research.

CONCLUSIONS

This article analyzes the Fed funds futures rates' ability to forecast the funds rate, and by extension, short-run movements in monetary policy. Three aspects of their performance are examined: first, whether the futures rate is an unbiased predictor of the Fed funds rate; second, whether the forecast errors satisfy the rationality property implied by the efficient markets hypothesis; and third, the extent to which incorporating information other than the futures rate improves out-of-sample forecasting performance.

The study's main conclusion is that although Fed funds futures rate exhibits a small premium, the market efficiently incorporates virtually all publicly available quantitative information that can help forecast changes in the Funds rate. Although a few of the indicators examined are statistically significant in within-sample rationality tests, these indicators yield only marginal improvements in the accuracy of out-of-sample forecasts.

One important implication is that, to a large extent, month-to-month changes in the Federal funds rate are predictable, and the Fed funds futures market is very good at anticipating these changes. Traders, investors, or economists interested in predicting near-term Fed actions would be hard pressed to improve on the Fed funds futures rate. The futures rate could also be used by members of the FOMC to gauge the financial market's expectations of its actions. (How the FOMC should use this information is another question altogether.) A second implication is that changes in the Fed funds rate are often unanticipated, even by the futures market. Economists interested in the response of financial markets and the economy to monetary policy "shocks" should find the Fed funds futures rate a simple but effective way to identify those surprises.

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