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The Fed Funds Futures Rate as a Predictor of Federal Reserve Policy

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Abstract

This paper examines the relationship between the one- and two-month Fed funds futures rates and the observed Fed funds rate. The paper's main finding is that Fed funds futures rates embody rational forecasts of the spot rate, in the sense that the prediction errors are not forecastable on the basis of readily available information. The results show that short-term changes in Federal Reserve policy contain a significant systematic component, which is accurately anticipated by the financial markets.

1 Introduction

Since their introduction in October of 1988, Fed funds futures (also known as Thirty-Day Interest Rate futures) have been widely cited in the financial press as a predictor of Federal Reserve policy.[1] This paper econometrically evaluates the futures market's forecasts of the funds rate in an effort to ascertain whether those forecasts satisfy properties of rational expections.

The results show that over the 1989–94 period, futures rates generated very accurate forecasts of the Fed funds rate at one- and two-month horizons. In formal tests of the rationality hypothesis, data available to investors when the contracts were priced are only weakly correlated with the errors from forecasts based on the futures rate. For the one-month-ahead contract, only the (differenced) inflation rate and the spread between three-month commercial paper and the Fed funds rate are statistically significant at the 0.05 level. Quantitatively, the size of this deviation is small, in the sense that incorporating

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[1] See, for example, "Futures Market Has Factored In Interest-Rate Increase."

information from other readily-available indicators reduces the out-of-sample forecast error only marginally. The results show that short-term changes in Federal Reserve policy contain a significant systematic component, which is accurately anticipated by the financial markets.

2 A brief description of the Fed funds futures market

As the name implies, Fed funds futures contracts are designed to hedge against (or speculate on) changes the overnight Fed funds rate, i.e., the overnight interest rate in the inter-bank reserves market. In light of the funds rate's central role in the Federal Reserve's short-run operating procedure, the Fed funds futures rate is a potentially informative gauge of expected near-term monetary policy actions.[2] Like the one-month LIBOR contract, the settlement price for the Fed funds futures contract is based on an average of daily rates over the contract month.[3]

The Chicago Board of Trade (CBOT) offers a number of different contracts on the Fed funds rate; the most popular are the one-, two- and five-month varieties, and the contract based on the remainder of the current month's funds 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 pre-tax profits accruing to the purchase at date t of Fed funds futures contract for month s, π_t^s, can be expressed in terms of the difference between the relevant average of the Fed funds rate, r_t, and the futures rate, f_t^s:

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

[2]Bernanke and Blinder (1992) argue that the funds rate is the most informative gauge of the macroeconomic impact of monetary policy. Strongin (1992) discusses the behavior of the funds rate under the Federal Reserve's current procedure of targeting borrowed reserves.

[3]Specifically, the settlement price is based on the 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.

[4]The price of the current month's 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 federal funds rate for previous 10 days + 21/31 × the term Federal funds for the 21 days remaining in the contract month.

[5]For all but the current-month contract, the CBOT limits price fluctuations to 150 basis points daily. The limit is expanded to 225 basis points if 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," and Kuprianov (1993).

where $t \in s-k$ for the k-month ahead contract, and M is the number of days in the month. The arbitrage condition for risk-neutral investors, $E_t(\pi_t^s) = 0$, implies the futures rate is equal to the expected future average funds rate,

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

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

Well-functioning futures markets have usually been found to generate rational forecasts of future spot rates. A number of previous studies have found that rates from T-bill futures markets rationally anticipated spot rates at most horizons.[6] The very small volume of trades in Fed funds futures raises some doubts about the market's efficiency in anticipating future Funds rate movements, however. Relative to other short-term interest rate derivative instruments, the market for Fed Funds futures has remained small, with total annual trading volume in 1992 only one-third that of one-month LIBOR futures, and about one-fourth that of T-bill futures.[7]

3 Are Fed funds futures forecasts rational?

This section examines the rationality of futures-based funds rate forecasts using spot and futures data from May 17, 1989 through December 7, 1994 for the one- and two-month ahead contracts.[8] Figure 1 plots the monthly average of the effective overnight Fed funds rate and the corresponding Fed funds rate implied by the futures price, lagged appropriately to match the spot rates.

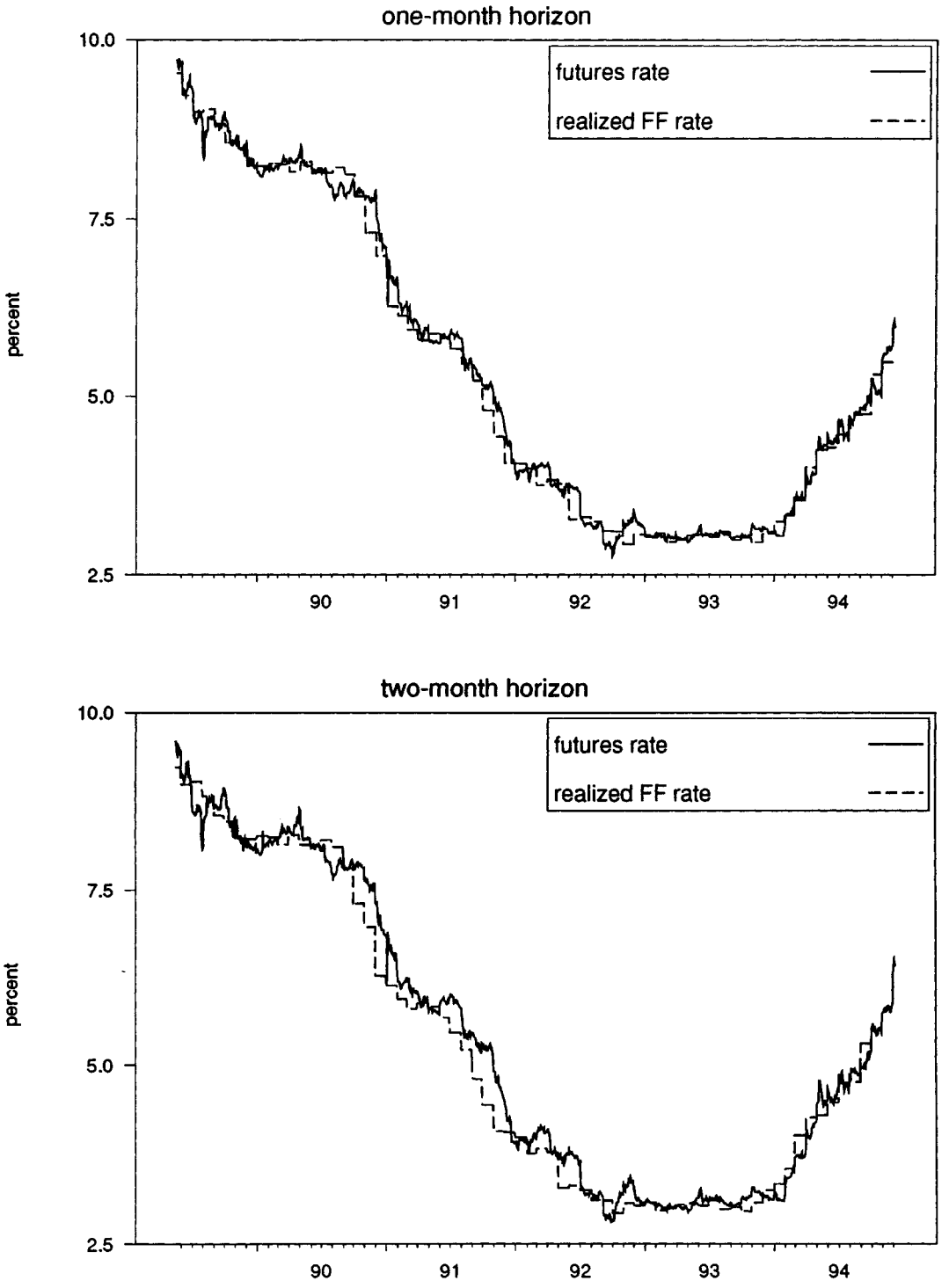
In general, the implied funds is very close to the spot rate — especially as the settlement date approaches. The one-month-ahead contract, as expected, seems to track the actual rate very closely, while the forecast error associated with the two-month-ahead contract appears somewhat larger. Overall, no bias is visible in either of the two futures rates. Only during 1990 and 1991, when Federal Reserve policy led to a sharp decline in the Fed funds

[6] See, for example, Rendleman (1979), Patel and Zeckhauser (1990), and Cole, Impson and Reichenstein (1991).

[7] The Fed funds futures market's similarity to the LIBOR and Eurodollar futures markets raises some doubts about the Fed funds futures market's long-run viability.

[8] Because the market for five-month-ahead futures has only been active since 1993, the sample is too small to evaluate the performance of this market.

Figure 1: **Futures market and realized Fed funds rates**



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.

3.1 Evidence from monthly data

This section presents tests for unbiasedness and rationality of futures-based funds rate forecasts based on the arbitrage condition, equation 1. According to this condition, the Fed funds futures rate should incorporate all information available to investors when the contract is priced. Hence, the error from the futures-based forecast should be orthogonal to variables in investors' information set. A linear version of this proposition can be tested by regressing the errors from futures-based forecasts on a variety of economic indicators contained in the time-t information set that might plausibly provide information on future changes in the Fed funds rate.

For the k-month-ahead futures rates, the regressions are of the form:

$$\bar{r}_{t+k} - \bar{f}_t^{t+k} = \alpha + \beta(L)x_{t-l} + u_{t+k} \ , \tag{2}$$

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. Lags on the indicator x_t may be included by way of the lag polynomial $\beta(L)$. In cases where the t-dated indicator is not actually known at time t, l is set to one to introduce an additional lag; in other cases, l is zero. The forecast error is denoted u_{t+k}.[9]

3.1.1 In-sample tests

The first line of table 1 provides a test of the unbiasedness hypothesis for the one-month futures rate by simply regressing the forecast error on a constant term. The statistically significant estimate of α in the third column shows that the futures rate exhibits a small forward premium of nearly five 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

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

Table 1: Monthly Tests of Unbiasedness and Rationality: One-Month Horizon

Indicator	Lags	Constant estimate	Constant p-value	Indicator p-value	$\bar{R}^2$
None (constant only)		−4.8	0.02	...	...
Differenced inflation	1–2	−4.7	0.02	0.04	0.064
Nonborrowed reserves growth	1–2	−3.8	0.13	0.74	−0.022
Total reserves growth	1–2	−2.8	0.26	0.41	−0.003
Base growth	1–2	−2.1	0.73	0.83	−0.025
M1 growth	1–2	−3.7	0.26	0.90	−0.028
M2 growth	1–2	−7.9	0.01	0.25	0.013
3-month paper – FF spread	0	−3.2	0.13	0.03	0.055
1-year note – FF spread	0	−4.7	0.03	0.81	−0.015
30-year – FF spread	0	−3.6	0.29	0.65	−0.012
Differenced funds rate	0	−3.8	0.07	0.11	0.024
Unemployment rate	1–2	13.4	0.42	0.24	0.014
Payroll employment growth	1–2	−7.0	0.01	0.30	0.006
UI claims	1–2	−4.4	0.04	0.70	−0.020
Industrial production growth	1–2	−5.1	0.02	0.89	−0.027
IP growth & infl. change	1–2,1–2	−4.4	0.04	0.18	0.036
Empl. growth & infl. change	1,1–2	−6.2	0.01	0.05	0.072

Notes: The regressions use the 66 monthly observations from 1989:6 through 1994:11. Data are in basis points. The numbers in the "Lags" column indicate the number and dating of the indicators included in the regression.

those based on interest rates are lagged an extra month to account for the lags in their availability. The lag lengths selected are those yielding the best in-sample fit. The column labeled "Indicator" reports the p-value from the F test joint exclusion of the indicator terms in equation 2.

At the one-month horizon, statistically jointly significant $\beta(L)$ coefficients are relatively 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 relation to the futures-based forecast error that is significant at the 0.05 level. The only other indicator with a significant in-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 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 six percent 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. For the remaining indicators, the low p-values and $\bar{R}^2$s show that none of them 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 2. These contracts also appear to exhibit a small forward premium, on the order of 11 basis points. As in the one-month-ahead contracts, the scarcity of significant estimates of the $\beta(L)$ coefficients suggest scant deviation from rationality. Only the differenced funds rate and payroll employment growth are significant at the 0.05 level, and these indicators account for seven and 12 percent, respectively, of the in-sample variance of the forecast error variance.

3.1.2 Out-of-sample forecasts

The scattered deviations from rationality reported in tables 1 and 2 may be merely the result of spurious in-sample fitting. (After all, even under the null hypothesis that all of the $\beta(L)$ coefficients equal zero, a test at the 0.05 level would reject the null hypothesis one

Table 2: Monthly Tests of Unbiasedness and Rationality: Two-Month Horizon

Indicator	Lags	Constant estimate	Constant p-value	Indicator p-value	$\bar{R}^2$
None (constant only)		−10.9	0.00	...	...
Differenced inflation	1–2	−10.7	0.00	0.17	0.024
Nonborrowed reserves growth	1–2	−9.7	0.02	0.56	−0.013
Total reserves growth	1–2	−7.7	0.05	0.36	0.001
Base growth	1–2	−9.0	0.34	0.96	−0.031
M1 growth	1–2	−8.1	0.13	0.75	−0.022
M2 growth	1–2	−16.3	0.00	0.24	0.014
3-month paper − FF spread	0	−9.2	0.01	0.13	0.020
1-year note − FF spread	0	−11.2	0.00	0.71	−0.013
30-year − FF spread	0	−9.2	0.08	0.69	−0.013
Differenced funds rate	0	−8.1	0.01	0.02	0.071
Unemployment rate	1–2	25.7	0.32	0.11	0.039
Payroll employment growth	1–2	−17.5	0.00	0.01	0.125
UI claims	1–2	−11.7	0.00	0.44	−0.005
Industrial production growth	1–2	−12.3	0.00	0.56	−0.013
IP growth & infl. change	1–2,1–2	−11.5	0.00	0.40	0.002
Empl. growth & infl. change	1,1–2	−15.6	0.00	0.02	0.109

Notes: The regressions use the 65 monthly observations from 1989:6 through 1994:10. See also notes to table 1.

Table 3: Monthly Out-of-Sample Forecast Errors

Indicator	One-month-ahead		Two-month-ahead	
	RMSE	p-value	RMSE	p-value
Futures rate only	16.7	...	29.3	...
Futures rate + constant	16.1	0.72	27.7	0.63
No change	24.6	0.03	41.3	0.00
Differenced inflation	15.4	0.48	27.5	0.60
3-month paper – FF spread	17.7	0.67	27.0	0.51
Employment growth	16.1	0.70	26.4	0.35
Empl. growth & infl. change	15.5	0.50	26.5	0.39
Christiano-Eichenbaum-Evans	20.9	0.26	30.2	0.76

Notes: The models are initialized on the 1989:6 through 1990:12 subsample, and estimated recursively and evaluated from 1991:1 onward. The lags of the indicators are the same as those used in tables 1 and 2. Details on the Christiano-Eichenbaum-Evans specification appear in the text. See also notes to table 1.

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, it also yields a measure of the quantitative significance of those deviations.

The results of the out-of-sample forecasting exercises for the one- and two-month horizons appear in table 3. The table reports the Root Mean Squared Error (RMSE), and the p-value for a test that the RMSE of a model that uses the futures rate in conjunction with one of the indicators differs significantly from 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 $\beta(L)$) are estimated recursively using the Kalman filter.[10] The models are estimated on the June 1989 through December 1990 subsamples, 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

[10]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, $(t-1)^{-1}\sum_{t=1}^{T-1}[(\bar{r}_{t+1} - \tilde{f}_t^{t+1})^2 - \hat{u}_{t+1}^2]$, which is asymptotically normally distributed.

RMSE by 0.6 and 1.6 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 8 and 12 basis points at the one- and two-month horizons.

The out-of-sample results generally confirm the rationality tests in the preceding section, but 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 was 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 innovations in the Fed funds rate, models monetary policy as a function of lagged employment, inflation, non-borrowed 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.[11] Unlike the other forecasts evaluated in table 3, the CEE model does not incorporate futures rate data.

The RMSE statistics reported on the last line of table 3 show that over the 1991–94 period, the CEE model generated somewhat less accurate funds rate forecasts than the futures rates, although it does much better than the "no change" forecast. At the one-month horizon, the difference in RMSEs is four to five basis points. The CEE model's relative performance improves at longer horizons, however. At two months, the RMSE from the CEE model is only 2.5 basis points greater than that from the constant-adjusted

[11] 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 was excluded from these regressions.

futures-based forecast.

The CEE model's relative accuracy 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 FOMC meetings.

Overall, the results show that month-to-month changes in the Federal funds rate over the 1989–94 period contained a significant predictable component. Fed funds futures rates appear to provide rational forecasts of these changes; the inclusion of other sources of information fail to improve the futures-based forecasts significantly.

3.2 Evidence from daily data

The results presented above all utilized monthly average data, ignoring any information that may be contained in daily rates on Fed funds futures. In principle, it is possible to construct more powerful tests of the rationality hypothesis by exploiting the availability of daily data.

3.2.1 In-sample tests

The use of 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. We follow Hansen and Hodrick (1980) in using an estimate of the covariance matrix corrected for heteroskedasticity and moving-average serial correlation.[12]

A second issue is the limited availability of high-frequency data for use in forecasting the Fed funds rate. Obviously, financial market data, such as interest rates and spreads,

[12]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 4: Daily Tests of Unbiasedness and Rationality: One-Month Horizon

Indicator	Lags	Constant estimate	Constant p-value	Indicator p-value	$\bar{R}^2$
None (constant only)		−4.7	0.00	...	...
Nonborrowed reserves growth	5	−3.8	0.10	0.38	0.007
Total reserves growth	5	−3.8	0.14	0.41	0.008
Base growth	5	−3.9	0.45	0.89	−0.001
M1 growth	5	−3.8	0.30	0.77	0.000
M2 growth	5–20	−7.3	0.01	0.29	0.030
3-month paper − FF spread	0	−3.7	0.13	0.05	0.040
1-year note − FF spread	0	−4.4	0.10	0.59	0.003
30-year − FF spread	0	−3.1	0.47	0.59	0.004
Differenced funds rate	0	−4.6	0.05	0.29	0.000
UI Claims, weekly	10–25	−4.6	0.04	0.49	0.002
UI Claims, 4-week average	10	−4.7	0.04	0.23	0.021

Notes: The regressions use the 1381 daily observations from May 17 1989 through October 31 1994. Where a range of lags is specified, they are at five-day intervals (e.g., 5–20 ⇒ lags at 5, 10, 15, and 20 days). Standard errors are corrected for heteroskedasticity and MA(22) serial correlation as described in the text. See also notes to table 1.

are available at a daily frequency. Weekly series such as reserves, the money supply, and unemployment insurance claims, may also be incorporated in a daily analysis.

Tables 4 and 5 summarize tests for unbiasedness and rationality similar to those presented in tables 1 and 2, based on a daily version of equation 2,

$$\bar{r}_s - f_t^s = \alpha + \beta(L)x_{t-l} + u_t^s \quad , \tag{3}$$

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

As in the monthly results, the one- and two-month contracts exhibit forward premia of approximately 5 and 10 basis points, respectively. And as before, very few of the indicators are helpful in explaining the futures-based forecast errors, confirming the rationality hypothesis. In the case of the one-month-ahead forecasts, only the three-month paper Funds

Table 5: Daily Tests of Unbiasedness and Rationality: Two-Month Horizon

Indicator	Lags	Constant estimate	Constant p-value	Indicator p-value	$\bar{R}^2$
None (constant only)		−10.6	0.00	...	...
Nonborrowed reserves growth	5	−9.0	0.03	0.23	0.012
Total reserves growth	5	−8.6	0.06	0.13	0.017
Base growth	5	−13.9	0.15	0.68	0.002
M1 growth	5	−9.2	0.15	0.68	0.001
M2 growth	5–20	−16.0	0.00	0.03	0.053
3-month paper − FF spread	0	−9.6	0.02	0.15	0.023
1-year note − FF spread	0	−10.7	0.02	0.98	−0.001
30-year − FF spread	0	−8.5	0.24	0.66	0.003
Differenced funds rate	0	−10.4	0.01	0.05	0.001
UI Claims, weekly	10–25	−10.6	0.01	0.96	−0.002
UI Claims, 4-week average	10	−10.6	0.01	0.44	0.011

Notes: The regressions use the 1361 daily observations from May 17 1989 through September 30 1994. See also notes to table 4.

rate spread is significant at the 0.05 level; for the two-month-ahead forecasts, M2 and the differenced Funds rate are also significant.

3.2.2 Out-of-sample forecasts

In the daily data, additional information seems to improve the funds-rate forecasts even less than it did with the monthly data. As shown in table 6, the differenced Fed funds rate yields a marginal improvement, reducing the RMSE by 0.2 to 0.3 basis points relative to the "futures + constant" forecast , depending on the horizon. For the one-month futures contracts, incorporating additional explanatory variables makes the forecasts worse. In the case of the two-month contracts, both M2 and the three-month paper Fed funds spread yield only slight — and statistically insignificant — improvement.

4 Conclusions

This paper analyzed Fed funds futures rates' ability to forecast the funds rate. Three aspects of their performance were scrutinized: first, whether futures rates were unbiased predictors;

Table 6: Daily Out-of-Sample Forecast Errors

Indicator	One-month-ahead		Two-month-ahead	
	RMSE	p-value	RMSE	p-value
Futures rate only	16.4	...	25.8	...
No change	24.3	0.03	38.3	0.00
Futures rate + constant	15.3	0.53	23.3	0.54
M1 growth	15.4	0.60	23.5	0.57
M2 growth	15.6	0.65	23.2	0.51
3-month paper – FF spread	15.4	0.57	23.1	0.50
Differenced funds rate	15.1	0.44	23.0	0.46

Notes: The models are initialized on the May 17 1989 through December 28 1990 subsample, 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 4 and 5. See also notes to table 4.

second, whether the forecast errors satisfied the orthogonality property implied by rational expectations; and third, the extent to which incorporating information beyond the futures rate improved out-of-sample forecasting performance.

The conclusion is that although Fed funds futures rates appear to exhibit a small forward premium, the market does efficiently incorporate virtually all publicly available information on the likely direction of future Funds rate movements. Although some indicators displayed enough of a correlation to the futures-based forecast errors to generate violations of the orthogonality tests, including these indicators yielded only marginal improvements in the accuracy of out-of-sample forecasts.

Taken together with the observation that the forecasts from Fed funds futures rates did much better than the "no change" forecast, these results suggest that over the sample examined, systematic changes in the Fed funds rate were accurately forecast by financial market participants.

References

Bernanke, Ben S. and Alan S. Blinder (1992), "The Federal Funds Rate and the Channels of Monetary Transmission," *American Economic Review* **82**, 901-921.

Christiano, Lawrence J., Martin Eichenbaum, and Charles L. Evans (1994), "Identification and the Effects of Monetary Policy Shocks," Working Paper #94-2, Federal Reserve Bank of Chicago.

Cole, C. Steven, Michael Impson and William Reichenstein (1991), "Do Treasury Bill Futures Rates Satisfy Rational Expectation Properties?" *Journal of Futures Markets* **11**, 591–602.

"Futures Market Has Factored In Interest-Rate Increase," *Wall Street Journal*, January 30, 1995, p. C1.

Hansen, Lars Peter and Robert J. Hodrick (1980), "Forward Exchange Rates as Optimal Predictors of Future Spot Rates: An Econometric Analysis," *Journal of Political Economy* **88**, 829–853.

Kuprianov, Anatoli (1993), "Money Market Futures," in Cook and LaRoche, (ed.), *Instruments of the Money Market.* Richmond: Federal Reserve Bank of Richmond, 188–217.

Patel, Jayendu, and Richard Zeckhauser (1990), "Treasury Bill Futures as Unbiased Predictors: New Evidence and Relation to Expected Inflation," *Review of Futures Markets* **8**, 352–369.

Rendleman, Richard J., Jr. and Christopher E. Carabini (1979), "The Efficiency Of The Treasury Bill Futures Market," *Journal of Finance* **34**, 895-914.

Strongin, Steven H. (1992), "The Identification of Monetary Policy Disturbances: Explaining the Liquidity Puzzle," Working Paper #92-27, Federal Reserve Bank of Chicago.

"Thirty-Day Interest Rate Futures for Short-Term Interest Rate Management," Chicago Board of Trade, 1992.

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