Using the Federal Funds Futures Market to Predict Monetary Policy Actions

Raymond E. Owens and Roy H. Webb

C hanges in interest rates directly affect anyone who borrows or lends. A benchmark interest rate is the federal funds rate, the monetary policy instrument of the Federal Reserve System ("The Fed"). The federal funds rate serves as an anchor for the financial system, and other interest rates key off its current level and expected changes in it. Accurate predictions of changes in the federal funds rate are, therefore, of great value to persons engaged in a wide variety of business activities.

Forecasting interest rates during the last few decades has been especially difficult. Over that period, the economy has been rocked by a number of macroeconomic shocks that have had substantial impacts on interest rates. Equally difficult for analysts has been the challenge of accurately anticipating monetary policy actions in a setting in which the monetary policy process has been opaque. In recent decades, monetary policy goals have been numerous and on occasion contradictory, and policy has generally followed discretion rather than a set of clear, consistent rules. Clarity has also been limited by institutional practices that have provided incomplete information on monetary policy decisions to the public. Prior to 1994, for example, the Federal Open Market Committee (FOMC) used an operating procedure that targeted borrowed reserves and yielded a federal funds rate objective that was difficult to elucidate even well after the fact (Cook, 1989). In addition, during that period the FOMC chose not to immediately reveal its policy decision or its inclination regarding near-term future policy actions at the conclusion of its meetings, leaving financial market participants to guess the action taken.

Beyond these factors, at least until October 1988, the specific sources of changes in short-term interest rate forecasts also were often difficult to identify because financial market forecasters often relied on the yields on short-term Treasury securities as their benchmark for short-term interest rates. Although changes in these rates were often affected by anticipated Fed policy actions, interest rate movements were also affected by changes in expected inflation, Treasury refunding plans, and other variables. These factors could lead to a highly variable spread between rates on short Treasuries and those on federal funds. As a result, a change in interest rates could arise from sources other than monetary policy actions, and no independent means was usually available to decompose the change into the impacts from the individual factors. This situation changed to some extent in 1988 when the Chicago Board of Trade (CBOT) began trading 30-day Federal Funds Futures, a contract based on the average monthly federal funds interest rate, the Fed's monetary policy instrument. This contract has been widely interpreted as an unbiased forecast of the expected interest rate on federal funds and has been considered a useful tool in identifying the impact of anticipated changes in monetary policy on interest rates. Of course, this estimate does not necessarily move in lockstep with expected movements in interest rates on other short-term securities, because of the other factors often embedded in those rates.

In this article, we review the development and basic mechanics of the Federal Funds Futures market. Following this description, we show that efforts to assess the usefulness of this market as a predictor of subsequent Fed monetary policy actions have generally supported the value of this tool. Our new look at the market emphasizes that the Federal Funds Futures market provides a valuable forecasting tool to the public at a nearly zero cost—namely an unbiased, reasonably accurate forecast of the future federal funds rate changes by the FOMC.

1. THE FEDERAL FUNDS FUTURES MARKET

Federal Funds Futures contracts began trading on the floor of the Chicago Board of Trade in October 1988. This event signaled the beginning of essentially public, market-based forecasts of future interest rates on federal funds. The traditional price-discovery mechanism of futures markets thus began to provide outside observers with the basic knowledge needed to construct informed forecasts of FOMC target changes. There are several steps involved in processing the market quotes, however, and at this point it will be helpful to review the specifics of the contract.

The contract traded is, of course, a well-defined instrument, and identifying changes in the federal funds rate embedded in the contract prices requires some simple arithmetic. First, though, are the basics of the contract. Federal Funds Futures contracts are traded for the current month and for future

months—effectively about six or seven months out. The contracts are for the interest paid on a principal amount of $5 million of overnight federal funds held for thirty days and are priced on the basis of 100 minus the overnight federal funds rate for the delivery month. A 7.25 yield, for example, equals a price of 100 minus 7.25, or 92.75. For settlement purposes, the contract is to be compared to the average daily federal funds effective rate as reported by the Federal Reserve Bank of New York.

An additional feature of the contracts is that their pricing information is widely available in a timely fashion. The closing prices from the previous day's trading are quoted in the financial pages of most major newspapers. Moreover, nearly real time quotes are available on the Internet, with the CBOT's website being a reliable source.[1]

In the four months of each year in which there is no meeting of the FOMC—and assuming inter-meeting changes in the funds rate are not anticipated—the contracts' prices represent the expected federal funds target rate previously announced by the FOMC, after accounting for small deviations such as "misses" by the Fed's trading desk or special liquidity premiums that may exist in the market. In these months, the estimate of the federal funds rate should differ from the actual rate only by the misses. In contrast, for each of the eight months in which the FOMC meets, calculating the expected federal funds rate is slightly more complicated. In these months, the expected average for the period represents a weighted average of the federal funds rate before the FOMC meeting and the rate expected after the meeting. When rates are expressed in percentages, this is equivalent to:

$$i_{t,h}^{f} = \frac{ki_{t+h}^{e} + (m - k)i_{t+h}^{\hat{e}}}{m} \tag{1}$$

where $i_{t,h}^{f}$ is the Federal Funds Futures contract rate at time t for h periods ahead, i_{t+h}^{e} is the expected federal funds rate leading up to the FOMC meeting k days into the month, $i_{t+h}^{\hat{e}}$ is the estimate of the funds rate after the meeting, and there are m days in the month of the FOMC meeting.

The expected federal funds rate after the FOMC meeting can be derived as:

$$i_{t+h}^{\hat{e}} = \frac{mi_{t,h}^{f} - ki_{t+h}^{e}}{m - k} \tag{2}$$

This expected federal funds rate can be interpreted as a forecast of the of the FOMC's target rate subsequent to the meeting. It is often useful to convert this forecast to an anticipated probability that the FOMC changes its target rate. We can derive that anticipated probability by adding assumptions that

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[1] The CBOT's quotes (with a ten minute delay) may be found at www.cbot.com/cbot/quotes/fin_futures/0,1860,FF,00.html.

we believe are generally realistic. First, assume that the FOMC changes rates only at scheduled meetings. That has been a good assumption since 1994—the FOMC has changed its target between meetings on only four occasions (April 18, 1994, October 15, 1998, January 3, 2001, and April 19, 2001). Second, assume that the FOMC chooses between no change in its target and a change of amount delta. Then by definition (and suppressing the subscripts for clarity):

$$i^{\hat{e}} = p(i^e + \Delta i^T) + (1 - p)i^e \qquad (3)$$

where Δi^T is the expected change in the target rate and p is the anticipated probability that the FOMC changes its target. This can be solved for p, yielding

$$P = \frac{100(i^{\hat{e}} - i^e)}{\Delta i^T} \qquad (4)$$

where, again, the subscripts are suppressed for clarity. This calculation thus extracts the probability of a target change that is implied by the futures quote.

2. MONETARY POLICY TRANSPARENCY

The previous section showed that forecasters can mechanically derive the expected funds rate and the probability of a change in the federal funds rate from information in the Federal Funds Futures contract prices. But a significant issue regarding forecasts of federal funds rate changes that has so far been ignored is the degree of transparency in the monetary policy process. Because the Fed uses the federal funds rate as its primary monetary policy instrument, forecasting the federal funds rate is nearly equivalent to forecasting the decisions of the FOMC. The clearer the rules that govern monetary policy, the easier it is to forecast the federal funds rate.

The conduct of monetary policy by the Fed is not fully transparent. Part of the lack of transparency rests on the basic approach of relying on discretion rather than on a set of fixed rules. Other sources of opaqueness arise when information about monetary policy decisions is not promptly made available to the public. From an efficiency standpoint, this policy approach has been the focus of much debate among monetary economists (see, for example, Goodfriend, 1996). From a forecasting standpoint, however, the lack of transparency poses a challenge. Forecasters must accept some degree of opaqueness as a given; but, in recent years, the process has become somewhat more transparent.

A quantum increase in transparency occurred in February 1994, when the FOMC began publicly announcing its decision regarding the federal funds rate target immediately following the conclusion of their meeting. This information reduced the uncertainty surrounding the federal funds rate in the period following meetings, and greatly assisted forecasters.

While this change in procedure improved forecasters' accuracy, it marked a point of departure in efforts to assess the reliability of the Federal Funds Futures contract prices as predictors of the federal funds rate. It is widely understood that substantial changes in the economic environment or in the policy regime can markedly reduce the value of pre-change data in gauging subsequent activity. In this case, the 1994 change meant that the track record of forecasts using data from before 1994 could not be used to ascertain forecast reliability going forward. As a result, we focus only on information in the post-1994 period. In the next section, the role and reliability of this information will be assessed.

3.   EMPIRICAL RESULTS

This section examines how well futures prices predict policy actions by the FOMC. We choose to limit our focus to policy actions made at the second FOMC meeting in 1994 and later. At its first meeting in 1994 the FOMC shattered its precedent in two ways. First, the committee explicitly announced that it had a target for the Federal funds rate; previously, obscure language such as "degrees of reserve pressure" had amounted to a code for funds rate changes in the FOMC's records of policy actions and other publications. Second, the FOMC announced its funds rate target on the afternoon of February 4, only a few hours after the decision was made. Previously no information was announced until several weeks after an FOMC meeting.

This move toward greater transparency by the FOMC would be expected to improve the precision of forecasts of future policy moves, and thus increase the efficiency of the Federal Funds Futures market. Söderström (1999) has documented substantial differences in the performance of the market before 1994 and after. While the earlier period is of undoubted historical interest, the later period is more relevant for practitioners who would like to extract information from futures market prices.

An important question to ask of forecasts is whether they are unbiased predictors. Thus, we first examine whether the forecast extracted from futures prices accurately predicts the policy action taken by the FOMC thirty days later. Specifically, we estimate the following regression equation

$$\Delta i_t^T = \alpha + \beta (i_{t-30}^f - i_{t-30}^T) + \epsilon_t \tag{5}$$

where i_t^T is the FOMC's target for the federal funds rate at the end of date t, Δ is the difference operator, i_{t-30}^f is the value of the federal funds rate target at date t anticipated by market participants thirty days earlier, α and β are parameters to be estimated, and ϵ_t is an error term assumed to be white noise. Unlike other studies, we do *not* use monthly average data. The use of monthly averages introduces a variety of influences on the effective funds rate that obscures the

focus of our study, the predictability of FOMC target changes. For example, seasonal reserve demands can introduce large movements into the effective funds rate at the end of calendar quarters. In addition, the timing of an FOMC meeting in a given month will alter the effective forecast horizon between months. Furthermore, since 1994 the FOMC began to make most of its target rate changes at scheduled meetings, thereby removing much uncertainty of the timing of possible changes. To bypass these and other complicating factors, our dependent variable is recorded for each FOMC meeting, and we therefore have eight observations each year. If the forecasts are unbiased, then $\hat{\alpha} = 0$ and $\hat{\beta} = 1$.

The forecasts did not display significant bias at the conventional five percent level. Our sample period covers March 1994 to January 2001, a period in which there were fifty-six FOMC meetings. The OLS estimate of α is -4.29, with an estimated standard error of 2.75, and the estimate of β is 0.89, with an estimated standard error of 0.12. The F value for testing the joint restrictions $\hat{\alpha} = 0$ and $\hat{\beta} = 1$ is 2.58, and thus the unbiasedness hypothesis is not rejected at the five percent level; however, the hypothesis would be rejected at the ten percent level. No serial correlation of the residuals was apparent. The market prediction picked up a large portion of the changes in the actual funds rate, which is indicated by an R^2 statistic of .49. However, the average market prediction was larger than the average actual change, as indicated by the rejection of unbiasedness at the ten percent level.

In seventeen of the eighteen times the FOMC changed its target, the predicted change had the same sign as the actual change; on the other occasion the predicted change was zero. Thus, in this relatively small sample the market accurately predicted the direction of change.

Looking at the tendency toward overpredicting target changes, it could be useful to know whether there was a tendency toward overpredicting the frequency of changes. A quick look is suggestive. We first calculated the implicit probability of a target change from the market prices as follows. First, if the predicted change was at least twenty-five basis points, the implicit probability of a target change was set to unity. Otherwise, the absolute value of the predicted change was divided by twenty-five (basis points) to calculate the implicit probability of a target change. Over the sample period the FOMC changed its target at about one third of the meetings considered. Yet our estimate of the implicit probability of a move averaged 0.52, well above the observed frequency of .32.

More formal analysis confirms this finding. We used probit analysis to estimate

$$\mathrm{I}\Delta i_{\mathrm{t}}^{T} = \alpha + \beta \Pr \Delta i_{\mathrm{t}-30}^{T} + e_t \tag{6}$$

where $I\Delta i_t^T$ is an indicator variable that takes the value of one if the FOMC moves at its meeting at date t, and zero if it chooses not to move. On three occasions in the sample period, the FOMC changed its target between meetings; on those occasions, we set the value to one at the next meeting. $\Pr \Delta i_{t-30}^T$ is the implicit probability that the FOMC will change its funds rate target in the next thirty days. Once again, if the implicit probability is an unbiased estimate of the observed frequency of target changes, then $\hat{\alpha} = 0$ and $\hat{\beta} = 1$.

The probit estimate of α was -1.37, with an estimated standard error of 0.36, and the estimate of β was 1.67, with an estimated standard error of 0.56. The chi-squared statistic for testing the joint hypothesis that $\hat{\alpha} = 0$ and $\hat{\beta} = 1$ was 30, and thus the hypothesis is rejected at conventional significance levels.

Thus, the implicit probability of a target change significantly overpredicts the frequency of changes thirty days ahead. However, the R^2 statistic for equation (4) was reasonably large at .49, which compares favorably with other variables that have been used to estimate interest rate changes. Also, the market accurately predicts the direction of target changes. Remembering that we have only fifty-six observations, the marginal rejection of unbiasedness may be a small sample phenomenon that would not be expected to persist (see Webb, 1987).

4.   COMPARISON WITH OTHER RESULTS

There has not been a consensus in the literature on whether federal funds rate futures prices are biased predictors of FOMC target changes. Robertson and Thornton (1997), for example, studied monthly averaged data from 1988 to 1997 and found a significant bias in one-month-ahead predictions. Our method of analysis differs from theirs in several important respects. First, they used pre-1994 data. In addition, their counterpart to equation (4) does not contain a slope coefficient. Also, Robertson and Thornton use monthly average data for the effective funds rate in their empirical work, whereas we use the FOMC's target on a particular day. The use of monthly averages introduces seasonal effects, most importantly end-of-quarter spikes in the funds rate due to balance sheet window dressing by financial institutions. Also, during the post-1994 period the FOMC mostly changed its target at scheduled meetings, which varied considerably in their timing within a month. Thus, when examining a one-month-ahead forecast, the effective horizon of the forecast would vary considerably. For example, in 1995 the Fed met on February 1, but in March they met on the 28th. Based on the market price on the last day of the previous month, the forecast horizon would be one day and twenty-eight days, respectively. And in four months each year there is no scheduled FOMC meeting. These factors create predictable errors in the regression analysis.

Söderström (1999), however, reached a different conclusion. Also using monthly averaged data, his analysis documented the major difference between

pre-1994 data and more recent data. He also recognized the importance of seasonal effects on monthly-averaged data and used dummy variables to attempt to adjust for their average effects. He found that, including the dummy variables, the market's prediction of the effective federal funds rate was unbiased when made immediately before an FOMC meeting. A potential shortcoming of his approach, in contrast to the one presented in this paper, remains the limitation of monthly averaged data for forecasting FOMC meeting outcomes.

As an example of the power of the market forecast, consider November 17, 2000. The FOMC had issued a press release following its meeting on November 15 in which it stated its belief that the balance of risks was tilted toward conditions generating inflationary pressures. Many analysts interpret such a statement to imply that the FOMC believes the next change in its funds rate target is more likely to be an increase than a decrease. However, the market quote for November 17 was 93.53, which implies that the contract's funds rate for December was 6.47 percent. Using equations (2) and (4) above, market participants placed a twenty-seven percent implicit probability on a twenty-five basis point decrease in the federal funds rate at the next FOMC meeting on December 17. While the FOMC did not change the funds rate at the December meeting, they lowered the funds rate fifty basis points early in January 2001, and another fifty basis points later that month at the scheduled FOMC meeting. Thus the market recognized the direction of the next move mid-November, and conveyed that information to market observers.

5.   CONCLUSION

The federal funds rate plays a key role in the financial and economic environment facing individuals and businesses. Accurately forecasting the rate can be valuable but has often been very difficult. This paper describes two important innovations in forecasting the funds rate—the development of the Federal Funds Futures market in 1988 and a substantial improvement in the transparency of monetary policy in 1994. The paper then assesses the impact of these innovations on forecasters' ability of anticipate changes in the funds rate from 1994 to 2000.

We use the information from the Federal Funds Futures market 30 days in advance of FOMC meetings to gauge market participants' views of the likelihood and magnitude of FOMC target rate changes. We found that futures market prices were unbiased predictors of target rate changes when evaluated at the usual five percent level. At the ten percent level, though, the hypothesis of no bias was rejected. Despite that marginal bias, market forecasts are valuable. They accurately predict the direction of target changes and are a means to enhance the prospective accuracy of market forecasts. We believe that these developments give readers the ability to forecast the federal funds rate at least as well as highly paid Fed watchers did in the not-too-distant past.

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