Commentary

Mark W. Watson

This paper addresses three questions related to market anticipations of monetary policy actions. First, how can "anticipations" and "surprises" be measured? Second, has there been a change in the market's ability to anticipate monetary policy? Third, how far in advance does the market anticipate changes in the Federal Reserve's policy instrument?

These are important questions, and this paper makes four distinct contributions as it attempts to provide answers. Following earlier work by Poole and Rasche (2000) and Kuttner (2001), the paper uses the federal funds futures market to construct measures of anticipated and surprise movements in the target federal funds rate. The first contribution of the paper is a comparison of two versions of these measures. In February 1994, the Federal Open Market Committee (FOMC) began the practice of issuing a press release after each meeting that summarized their deliberations. The second contribution of this paper is an analysis of how this change in FOMC procedure affected the ability of the market to anticipate future changes in the federal funds rate. Regressions involving variables that measure "expectations" are prone to econometric problems that are technically similar to the classical problem of "errors-in-variables." The third contribution of this paper is an adjustment for this problem. Much of the paper's analysis is made possible by a new dataset that provides a qualitative summary of the market's expectations about changes in the target federal funds rate. The fourth contribution of the paper is the development of this dataset that was constructed by a careful analysis of reports that appeared in the *Wall Street Journal*.

I will begin this discussion by stepping outside the authors' analysis to address the general problem of measuring the forecastability of a time series and ask how futures prices might help with this task. I will then provide a brief and selective summary of the paper's main results. One of the important results in the paper is that the February 1994 change in FOMC procedure presaged an increase in the market's ability to anticipate changes in the target federal funds rate.

HOW FORECASTABLE IS THE FEDERAL FUNDS RATE?

To begin, consider the decomposition of the change in the federal funds rate, ff,

$$(0.1)\qquad \begin{aligned} ff_t &= (ff_t - ff_{t/t-1}) + (ff_{t/t-1} - ff_{t/t-2}) + \cdots \\ &\quad + (ff_{t/t-h+1} - ff_{t/t-h}) + ff_{t/t-h} \end{aligned}$$

where $ff_{t/t-k} = E(fft \mid \text{information available at } t-k)$. The first term on the right-hand side of (0.1) represents the information about ff_t that is unknown at time $t-1$ and revealed at time t; the second term represents the information revealed at time $t-1$, etc. All of the terms on the right-hand side of this equation are mutually uncorrelated, and this implies that the variance of ff_t can be decomposed as

(0.2)

$$\operatorname{var}(ff_t) = \sum_{k=0}^{h-1} \operatorname{var}(ff_{t/t-k} - ff_{t/t-k-1}) + \operatorname{var}(ff_{t/t-h}).$$

This decomposition of variance means that the fraction of the variability in ff_t associated with information revealed at time $t-k$ is

$$R_k^2 = \frac{\operatorname{var}(ff_{t/t-k} - ff_{t/t-k-1})}{\operatorname{var}(ff_t)}.$$

In many ways, values of R_k^2 provide an ideal summary of the ability of the market to anticipate changes in the federal funds rate. For example, $\sum_{k=i}^{\infty} R_k^2$ shows the fraction of the variability of ff_t associated with information revealed at $t-i$ or earlier.

Can R_k^2 be estimated using data from the futures market? In principle, yes. In practice, no. To see this, consider a futures contract with a payoff that is tied to the value of ff_t. Then, abstracting from changes in risk and discounting, changes in the price of the contract between periods $t-k-1$ and $t-k$ can be used to construct $f_{t/t-k} - ff_{t/t-k-1}$. The variance of these changes is the numerator of R_k^2, and the denominator is the variance of ff. Thus, these futures prices make it possible to estimate R_k^2.

In practice, federal funds rate futures contracts have payoffs that depend on the average value of the federal funds rate over a month, rather than the value on a particular day. This means that changes in futures prices can be used to compute averages of expected changes in the federal funds rates, such

Mark W. Watson is a professor of economics and public affairs at the Department of Economics and Woodrow Wilson School, Princeton University, and a research associate at the National Bureau of Economic Research.

as $m^{-1}\sum_{i=0}^{m-1}(ff_{t+i|t-k}-ff_{t+i|t-k-1})$. So, in general, the variance of changes in the federal funds rate futures price will depend on the variance of $ff_{t+i|t}-ff_{t+i|t-1}$ for all days in the month as well as the covariance between each of these terms. This makes it impossible to estimate R_k^2 from the futures data.

THE APPROACH USED BY POOLE, RASCHE, AND THORNTON

Complications like this mean that additional assumptions must be made if the federal funds futures market is to be used to summarize market anticipations. This paper uses assumptions made in earlier papers by Poole and Rasche (2000) and Kuttner (2001). The assumptions are similar, and here I will review Kuttner's version. The federal funds futures contract for the current month has a payoff that depends on the average federal funds rate in the current month. Thus, if there are 30 days in the month, the current date is denoted by t, and the month ends at date $t+k$, then

$$FFF_t - FFF_{t-1} \approx \frac{1}{30}\sum_{i=0}^{k}(ff_{t+i/t} - ff_{t+i/t-1}) \tag{0.3}$$

where FFF_t denotes the price of the futures contract and $\approx$ reflects the fact that changes in risk and discounting have been ignored. Now, consider a date when the federal funds rate changes unexpectedly (so that $ff_t-ff_{t|t-1}\neq 0$), and no other changes are expected during the month (so that $ff_{t+i|t}-ff_{t+i|t-1} = ff_t-ff_{t|t-1}$, for $i=1,\ldots,k$). For this date,

$$ff_t - ff_{t/t-1} \approx \frac{30}{k+1}(FFF_t - FFF_{t-1}). \tag{0.4}$$

Thus, date t surprises in the federal funds rate can be measured by scaling up changes in the price of the federal funds futures.

Earlier researchers (Poole and Rasche, 2000, and Kuttner, 2001) used these estimates of surprise movements in the federal funds rate in regressions of the form

$$i_t = \alpha + \beta(ff_t - ff_{t/t-1}) + \varepsilon_t \tag{0.5}$$

where i_t is a longer-term interest rate and $ff_t-ff_{t|t-1}$ is estimated by (0.4). These papers estimated (0.5) for dates when the approximations in (0.3) and (0.4) seemed reasonable a priori: that is, those dates when the target federal funds rate changed. This paper refines this earlier analysis by explicitly incorporating measurement error in (0.4). The authors estimate the magnitude of this measurement error using a variety of methods, all focusing on days when the target component of $ff_t-ff_{t|t-1}$ was zero, as determined from their reading of the business press. Reassuringly, they find that these measurement error corrections have little effect on the estimates of β in (0.5).

In addition, this paper compares estimates of (0.5) using the Poole and Rasche estimates of $ff_t-ff_{t|t-1}$ and the Kuttner estimates. They find little difference between the estimates, suggesting comparability of the Kuttner and Poole/Rasche measures.

DID FORECASTABILITY CHANGE IN 1984?

An important empirical conclusion in this paper is that the market was better able to anticipate changes in the target federal funds rates after February 1994. I offer two pieces of confirmatory empirical evidence.

First, consider the decomposition of the changes in the federal funds rate target, ff_t^*:

$$\Delta ff_t^* = a_t + u_t\,,$$

where a_t denotes the anticipated component and u_t is the unanticipated component. The fraction of the variability of the changes in ff_t^* that are unanticipated is $E(u_t^2)/E[(\Delta ff_t^*)^2]$, and the fraction anticipated is 1 minus this value. Using the Poole/Rasche (2000) measures of u_t, this fraction can be estimated from the data reported in the paper. For dates before February 1994, 80 percent of the variance of Δff_t^* was anticipated. For dates after February 1994, this fraction increases to 91 percent. Thus, in both periods, the market correctly anticipated the bulk of changes in the target rate, but there does appear to be a marked improvement in market expectations in the post-February 1994 sample period.

The second piece of empirical evidence is an estimate of how well long-term interest rates forecast the federal funds rate. Let

$$W_{t+90} = \frac{1}{90}\sum_{i=0}^{89} ff_{t+i}$$

denote the average value of the federal funds rate over the next 90 days, and let R_t^{90} denote the 90-day interest rate. From the expectations theory of the term structure, $R_t^{90}\approx W_{t+90|t}$. Consider the regression:

$$W_{t+90} - ff_t = \alpha + \beta(R_t^{90} - ff_t) + \varepsilon_t \tag{0.6}$$

If changes in ff_t are not predictable, $\beta = 0$ in (0.6) and the regression R^2 is also zero. If changes in ff_t are predictable, then $\beta = 1$ and the regression R^2 is nonzero. More generally, the R^2 from (0.6), or its generalization containing other variables as well as the term spread, measures the predictability of change in the federal funds rate.

Table 1 shows the results from estimating (0.6) using monthly averages of federal funds rates and monthly 3-month Treasury bill rates over the two sample periods considered in this paper. The results are quite striking. Evidently, there is a marked increase in the predictability of federal funds rate changes, post 1994, at least at the 3-month forecast horizon.

FINAL COMMENTS

In this paper, Poole, Rasche, and Thornton have further refined the use of federal funds futures prices for decomposing changes in the federal funds rate into anticipated and unanticipated components. They develop a new qualitative dataset that compliments the quantitative data in the futures prices. Their results suggest that changes in FOMC procedures adopted in February 1994 have improved the market's ability to anticipate changes in the target federal funds rate. My crude calculations, summarized above, are consistent with these conclusions. These results focus on very short-run forecasts (3 months in my analysis above).

A more important question involves the market's ability to forecast over longer horizons, particularly to form conditional forecasts: "If the path of inflation is ___ and the path of GDP growth is ___, then the path of the federal funds rate will be ___." Accurate long-run conditional forecasts follow from consistency of long-run Federal Reserve policy. Evaluating long-run conditional forecasts poses interesting and important questions, and I look forward to seeing extensions of this paper in that direction.

Table 1

Predicting Changes in the Federal Funds Rate Using 3-Month Treasury Bills

Sample period	$\hat{\beta}$ (SE)	R^2
1987:01–1994:01	–0.02 (0.14)	0.00
1994:02–2001:06	0.97 (0.14)	0.61

NOTE: Estimates of (0.6) over the sample period are shown in the first column. Data are monthly. SE denotes the estimated heteroskedastic autocorrelation–robust standard error.