Using Fed Funds Futures to Predict a Federal Reserve Rate Hike

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Abstract

This paper demonstrates formulas used by market participants to predict the probability of an increase in the Fed Funds rate and suggests how these formulas can be used in the classroom. Utilizing Fed funds futures contracts, instructors can demonstrate how the market anticipates actions by the Federal Open Market Committee and can give assignments to students to have them calculate the probability of a rate change. This activity can enhance students' understanding of financial markets, interest rates, and futures contracts and supply students with a useful tool to use in the business world.

Introduction

Fed funds futures contracts can be used to estimate the market's view of the probability of a rate change by the Federal Reserve. This information is frequently reported by the media and financial market participants often use this information as part of their decision making process. The purpose of this paper is to present and explain the formula frequently used by practitioners to predict the probability of a rate change by the Fed and to show how the formula can be utilized by students.

In addition to demonstrating to students how to determine the probability of an action by the Fed, the exercise described in this paper will help students better understand Fed funds futures, increase their awareness of the Federal Open Market Committee (FOMC) meeting schedule and improve their knowledge of the yield curve. In addition, this exercise provides an opportunity to demonstrate how markets set prices based on expectations of future events. The fed funds futures contracts offer finance and economics instructors the opportunity to illustrate market-based, short-term, interest rate forecasting and can provide a useful real business example for students.

This information is particularly relevant for a course on financial markets and intermediaries and for an economics course on money and banking. In addition, this information is useful in any course where interest rates, capital markets, and/or futures contracts are covered. Knowledge of this material (and other practical applications of financial theory) will be beneficial to students as they enter the workforce. Leading textbooks on financial markets and money and banking do not currently cover this subject; therefore, the material presented in this paper will assist instructors in incorporating a new topic into their classes.

Fed Funds Futures

Fed funds futures contracts are traded on the Chicago Board of Trade. The contracts are cash settled and do not have a daily price limit as do many other futures contracts. The contract size is five million dollars and the minimum movement is $20.835. Trading ceases in any contract month on the last day of the delivery month. Fed funds futures are used by banks and fixed-income portfolio managers to hedge against unexpected shifts in short-terms interest rates. In addition, traders can use the fed funds futures rate to take speculative positions relative to interest rate movements and Federal Reserve actions.[2]

A Fed funds futures quote is the discounted price from par. The fed funds rate implied by the futures contract is equal to 100 minus the contract price. Robertson and Thornton (1997) explain that the fed funds futures quote can be thought of as the average price for Fed funds in a particular contract month. The

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[2] See *"Reference Guide: CBOT Fed Funds Futures"* for additional information on fed funds futures contracts.

pricing differs depending on whether the contract expires in the current month or in future months. For the current month the contract price is equal to a weighted average of the actual fed effective rates realized to date and the expected fed effective rates for the remainder of the month. As the settlement date (last day of the month) approaches, the contract price is impacted less by expected rates and is determined primarily by the fed effective rates realized during the month.[3]

The pricing for contracts in deferred (future) months is based on the average expected fed effective rates for the contract month. Unlike the current month contract price, the contract pricing for future months is based only on expected rates.

When using fed funds futures contracts to predict the probability of Fed actions, it is important to keep in mind the difference in the pricing mechanisms for current versus deferred months. Since current month pricing will include realized fed effective rates, Fed actions that occur after the middle of the month will have little impact on the price of the futures contract. Therefore, if the FOMC meeting is after the middle of the month, the futures contract for the following month can be used because that contract will more fully express market expectations (this works well if the FOMC is not meeting in the following month).[4]

Examining Market Expectations

There are two approaches that can be utilized to have students determine likely rate changes by the Federal Reserve. The first approach, described in this section, involves using fed funds futures contract prices to examine the market's expectations relating to future interest rates without running the risk of getting bogged down in the determination of probabilities. This approach is relatively simple and intuitive and provides a good basis for understanding the calculation of the probabilities as described in the next section.

If market participants anticipate a rate change by the Fed, the market price of fed funds futures contracts will adjust to reflect the anticipated rate change. The fed funds rated implied by futures contracts will indicate the magnitude and direction of the anticipated change. For example, supposed that in September students were given the following information (or were told to look up the information):
- the current fed funds target rate = 4.75%,
- the next meeting of the Federal Open Market Committee is scheduled for October 25th,
and
- the current price for a November fed funds futures contract price is 95.025.

Based on this information the fed funds futures rate implied by the November futures contract is 4.975% (100 – 95.025). This rate indicates that market participants expect that the average fed funds rate for November will be 4.975% or almost 5%. From this example students can see that the market has priced in a very strong expectation that the Fed will increase the target fed funds rate by 25 basis points.

Alternatively, suppose the price for a November fed funds futures contract price is 95.195. This rate yields an implied fed funds rate of 4.805% (100 – 95.195). This implied rate is only 5.5 basis points above the current target rate indicating that, at the current point in time, market participants on average do not anticipate a rate increase by the Fed.

Students can easily examine Fed funds futures quotes at the Chicago Board of Trade (www.cbot.com) to discern the market's expectation for future interest rates. Examination of the full list of contracts offered at the Chicago Board of Trade gives the student insight into the market's expectation for a series of rate hikes. For example, if the Fed funds futures contract price remains constant for many distant months this implies market perception of a halt to Fed rate hikes.

Predicting the Probability of a Fed Action

The second way for students to use Fed funds futures to determine the market's expectations of future Fed funds rates is to determine the probability of a Fed rate change. In the first example from the previous section the fed funds futures implied rate of 4.975% is 22.5 basis points above the current fed funds rate = 4.75%. Therefore, the market has priced 90 percent of a 25 basis point increase in the fed funds rate into the futures contract (22.5/25 = .90 or 90%). This is interpreted to mean that the market has established a 90 percent probability of a 25 basis point increase in the fed funds rate.

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[3] For additional information on the pricing of fed funds futures, see *"Reference Guide: CBOT Fed Funds Futures."*
[4] For additional details see *"Reference Guide: CBOT Fed Funds Futures."*

The preceding calculation is based on a formula developed by Geraty (2000). Geraty's formula, presented here as Equation 1 gives the probability that the Fed will raise rates on the first day of the month.

$$\frac{\text{Fed funds rate implied by futures contract} - \text{The current fed funds rate}}{\text{Fed funds rate assuming a rate hike} - \text{The current fed funds rate}} \qquad (1)$$

Applying this formula to the previous example yields the following result:

$$\frac{4.975 - 4.75}{5.0 - 4.75} = .90$$

Note that Equation 1 can be expressed as follows:

$$\frac{\text{Implied fed funds rate - current target rate (in basis points)}}{\text{Expected magnitude of a rate change if there is a change (in basis points)}} \qquad (2)$$

If the FOMC is scheduled to meet after the middle of the month and there will not be a meeting in the following month, Equations 1 and 2 can be applied using the futures contract for the month following the meeting. In other circumstances, such as when the FOMC meeting is early in the month and/or there is also an FOMC meeting scheduled for the subsequent month, the formulas given above must be adjusted. The adjustment is necessary because the futures contract price during the contract expiration month is determined by an average of actual rates and expected rates.

An example will help explain the need for an adjustment to the formula. Assume that we are at the beginning of May and the current fed funds rate is 5.0%. The FOMC is scheduled to meet on May 10th and it is expected that, if the fed funds rate is changed, the target fed funds rate will be raised by 25 basis points to 5.25 percent. Also assume that the current price for a May fed funds futures contract is $94.845 giving an implied fed funds rate of 5.155% (100 – 94.845). Applying Equation 1 indicates a 62 percent probability of a rate increase.

$$\frac{5.155 - 5.0}{5.25 - 5.0} = .62$$

There is a problem in this calculation because the implied fed funds rate used in the numerator in Equation 1 accounts for the fact that the fed funds rate up to and including May 10 will be the current rate of 5% and that the rate for May 11 though 31 will reflect the market's expectation for a rate change (note that calendar days are used here and not business days). Therefore, using 5.25% the denominator of Equation 2 would be inappropriate because the fed funds rate will not be 5.25% for the entire month. Rather, a weighted average developed by Geraty (2000) should be used to reflect that for the first 10 days of the month the fed funds rate will be 5.0% and the last 21 days of the month the fed funds rate will be 5.25% (this assumes a 25 basis point rate increase if there is going to be a rate change). The weighted average rate is calculated as follows:

[(Current fed funds rate) *x* (Number of days up to and including the date of FOMC meeting)
plus
(Expected fed funds rate if changed) *x* (Number of days in month after the FOMC meeting)]
divided by
(Total number of days in the month)

Applying this formula to the example given above gives the following result:

$$\frac{(5.0 \times 10) + (5.25 \times 21)}{31} = 5.169$$

This weighted average should be should be substituted for the "Fed funds rate assuming a rate hike" in Equation 1. So for the previous example, the probability of a rate hike is determined as follows:

$$\frac{5.155 - 5.0}{5.169 - 5.0} = .9172$$

Therefore, after adjusting for the timing of the FOMC meeting in the formula, we can see that market indicates a 91.72 percent probability that there will be a 25 basis point increase in the fed funds rate when the FOMC meets on May 10.

When assigning an exercise the student's background and abilities must be considered. Demonstrating the full probability calculation using a weighted-average in the denominator is probably best reserved for students in more advanced classes. To avoid confusion in more basic-level courses, use contracts for months that do not have an FOMC meeting scheduled (e.g., use a November contract to examine the probability of a rate change at the October FOMC meeting).

Caveats

Although the fed funds futures contract prices are frequently used by market participants and the financial press to predict Federal Reserve action, the process is not an exact science and there are some caveats that must be considered. First, there is an assumption that the actual fed funds rate is equal to the target rates set by the FOMC. Robertson and Thornton (1997) indicate that, on average, the actual rate is close to the target rate.

A second consideration is that the process described above assumes that the FOMC will always change rates by 25 basis points. While 25 basis point changes are the norm, there have been some 50 basis point changes. If the rate implied by the fed funds futures contract price is more than 25 basis points above the current fed funds rate, then the possibility of a 50 basis point change should be considered. Geraty (2000) provides a formula to account for the possibility of a 50 basis point change.

It is also important to keep in mind that futures contract prices are not static. Therefore, the probability determined one day will be different from the probability on the next day. As described in the next section, this can be a positive aspect because students can see how information can change market expectations.

The final caveat is that the fed funds futures are not a perfect predictor of the fed funds target rate. Nosal (2001) examines the relationship between fed funds futures and the future federal funds rate. He finds that the Fed funds futures rate may overstate the Fed funds rate expected in the future in a rising rate environment and understate the Fed funds rate expected in the future in a falling rate environment. In addition, Robertson and Thornton (1997) document the bias and use a correction for the bias; however, they do not indicate how they develop the correction or the basis for the correction. This may be an interesting point of class discussion but would needlessly complicate the concept being taught.

Student Exercises

The fed funds futures can be used to enable students to examine market reactions to the arrival of new information and to examine certain economic events that are important to the market. For example, students can be required to calculate the probability of a rate change on a daily basis for a few days around to the release of economic news such as GDP reports or CPI releases. If unexpected information is received in the release of the economic news, students should be able to see the change in the market's view of likely action by the Fed. This exercise will be more applicable during a time when there is market speculation about Fed action.

Students can also be assigned historical time periods to calculate the probability of a Fed action and then their results can be compared with what actually happened. To help facilitate this exercise, information on the FOMC meeting schedule and other related information is included in Appendix 1. Both of these exercises can be used to stress to students that market prices are driven by expectations of what will happen in the future and can be shown show market expectations change over time.

Conclusion

Interest rate futures, particularly the Fed funds futures contracts, are not only useful tools for speculators and hedgers they offer practical information for financial market participants. With most business news media usually focused on Fed actions, and some news media giving the probability of a Fed rate change, market participants should know how the Fed funds futures market is used to forecast the likelihood of a rate change. This paper uses a formula developed at a futures trading company, and Fed funds futures quotes, to illustrate how students can use the Fed funds futures market to determine the market based likelihood of a Fed rate change.

References

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Appendix 1
Selected Fed Funds Information

Year	Month	Fed Funds Rate Beginning of Month	FOMC Meeting Dates	FOMC Action	Fed Funds Futures Contract Price*
2004	January	1.00%	27 & 28	No Change	99.998
	February	1.00%	No Meeting	n/a	99.000
	March	1.00%	16	No Change	98.995
	April	1.00%	No Meeting	n/a	99.000
	May	1.00%	4	No Change	98.980
	June	1.00%	29 & 30	25 bps increase	98.980
	July	1.25%	No Meeting	n/a	98.740
	August	1.25%	10	25 bps increase	98.575
	September	1.50%	21	25 bps increase	98.435
	October	1.75%	No Meeting	n/a	98.245
	November	1.75%	10	25 bps increase	98.090
	December	2.00%	14	25 bps increase	97.865
2005	January	2.25%	No Meeting	n/a	97.755
	February	2.25%	1 & 2	25 bps increase	97.500
	March	2.50%	22	25 bps increase	97.400
	April	2.75%	No Meeting	n/a	97.225
	May	2.75%	3	25 bps increase	97.000
	June	3.00%	29 & 30	25 bps increase	96.965
	July	3.25%	No Meeting	n/a	**
	August	3.25%	9	25 bps increase	**
	September	3.50%	20	25 bps increase	96.435
	October	3.75%	No Meeting	n/a	96.220
	November	3.75%	1	25 bps increase	95.995
	December	4.00%	13	25 bps increase	95.840
2006	January	4.25%	31	25 bps increase	95.735
	February	4.50%	No Meeting	n/a	95.500
	March	4.50%	27 & 28	25 bps increase	95.450
	April	4.75%	No Meeting	n/a	95.225
	May	4.75%	10	25 bps increase	95.040
	June	5.00%	28 & 29	25 bps increase	94.970
	July	5.25%	No Meeting	n/a	94.755

Notes: *Settlement price for the first trading day of the month. **Prices were not available in the *Wall Street Journal* for these dates.