

FED FUNDS

Reference Guide: CBOT® Fed Funds Futures

	FFM3	FFN3	FFO3
D	990150	991000	991250
H	990200	991050	991350
L	990100	990900	991150
2	990150	991050	991300
1	990100	991000	991250
N	990150	991050	991300
P	990150	990750	991100
	FFU3	FFV3	FFX3
D	991600	991550	991700
H	991600	991750	991750
L	991350	991500	991500

Table of Contents

- Introduction 3
- Key Benefits 3
- CBOT Fed Funds Futures Contract Salient Features 4
- Fed Funds and the Short-Term Money Markets 4
- Fed Funds as a Key Benchmark 5
- Fed Funds Futures Current Month Contract Pricing 6
- Pricing the Current Month Contract 6
- Final Settlement 8
- Fed Funds Futures Deferred Month Contract Pricing 8
- Strip Rates 10
- Fed Funds Futures and the Probability of a Fed Policy Shift 11
- A Probability Refresher 12
- A Limitation and a Final Word 12
- Appendix: 30-Day Fed Funds Futures Salient Features 14

Reference Guide: CBOT Fed Funds Futures

Introduction

Chicago Board of Trade (CBOT®) Fed Funds futures (in the CBOT Rules and Regulations, 30-Day Fed Funds futures, but here, simply fed funds) provide trading opportunities and resources for the management of risk exposures associated with a variety of money market interest rates.

These contracts serve a range of end users for a variety of purposes. Among the more prominent:

- *Proprietary traders and hedge fund managers* can use CBOT fed funds futures to express opinions about shifts in U.S. Federal Reserve monetary policy. Traders can also use these futures to make a variety of relative value trades. For example, by combining fed funds futures with CBOT interest rate swap futures, they can trade the bank credit yield curve.
- *Fixed-income portfolio managers* can use CBOT fed funds futures to hedge stub risk (the risk that arises because of a date mismatch between the underlying and the hedge instrument) or to protect against adverse shift in overnight funding rates.
- *Bank treasury officers* can use CBOT fed funds futures to stabilize the cost of overnight transactions in the cash fed funds market and to protect against shifts in other short-term interest rate markets to which they have exposure.

Key Benefits

The end users who participate in the CBOT fed funds futures market do so for economic reasons. Among the most important, CBOT fed funds futures are cost-effective, liquid, transparent, and flexible. Not to be overlooked in an era haunted by the specter of record-setting corporate credit defaults is the fact that every CBOT futures trade is virtually without credit risk

- *Liquidity*: The liquidity that comes from the transaction volume and stable open interest of the CBOT fed funds market gives you market breadth, depth, and immediacy.
- *Transparency*: The CBOT open auction and screen-based trading platforms make the market-clearing price of the moment publicly available to all market users regardless of their information or outlook.



- *Cost-effectiveness*: Because of the liquidity and transparency of the CBOT fed funds market, futures users encounter significantly lower transaction costs than do users of over-the-counter risk management alternatives.
- *Flexibility*: CBOT fed funds futures also allow you to operate more nimbly than you can in most other markets. As underlying markets develop or your risk management needs change, you can adjust your positions or even change strategic direction completely in minutes, as opposed to hours or even days.
- *Credit guarantee*: Users of CBOT fed funds futures benefit from the futures margining system which makes all futures trades virtually free of credit risk. This makes the CBOT contracts comparable to the strongest credits and greatly preferable to exposures to lower-quality credits. In fact, no CBOT market user has ever suffered loss due to counterparty default.

CBOT Fed Funds Futures Contract Salient Features

The key features of the CBOT fed funds futures contracts are summarized in the appendix of this reference guide. For more detailed contract specifications, you should consult the *Rules and Regulations of the Chicago Board of Trade*.

Fed Funds and the Short-Term Money Markets

Money markets serve to channel funds between borrowers and lenders, matching those who need cash with those who have cash to invest. The amount being borrowed, the length of the loan, and the interest costs for the use of the cash are specified when the transaction is initiated. The interest rates associated with the buying and selling of cash are the costs, or price, of money in different credit markets.

A variety of borrowers and lenders participate in the money markets, trading many different debt instruments in separate cash market segments. One such segment is the fed funds market. By law, U.S. banks must hold reserves with the banks that make up the Federal Reserve Bank system, the central bank of the United States. Since these reserves do not earn interest, banks have an incentive to lend any excess funds to other banks in need of reserves. These interbank transactions are collectively known as the *fed funds market*.

Each business day, U.S. banks trade dollar deposits among themselves with a one-day term to maturity (overnight fed funds). The rate charged among banks on any given day for these overnight loans is such a significant indicator of the cost of credit that it is reported the next day by the Federal Reserve Bank of New York, which computes the weighted average rate at which these interbank transactions are carried out. This average rate is known as the *fed effective rate*.

The Federal Open Market Committee (FOMC), which is responsible for implementing national monetary policy, uses the fed effective rate to measure the extent to which it has achieved the policy objectives set by the governors of the Federal Reserve Bank. Prior to 1994, the fed effective rate targeted by the FOMC was always a closely guarded secret. Beginning in 1994, the FOMC began announcing changes in its policy stance. Then in 1995, it began to explicitly state its target level for the fed funds rate. These statements were only intended, however, to announce a policy action or a major shift in the Committee's view about prospective developments.

Then in 2000, a new policy went into effect that provides even greater insights into the Committee's policies and opinions. Now the FOMC issues, shortly after each of its meetings, a statement that includes its assessment of the potential risks to attaining its longer-term goals of price stability and sustainable economic growth. These announcements clearly state the FOMC's view on issues such as the risk of heightened inflation pressures or future economic weakness. The time frame covered by their announcements intentionally extends beyond the next Committee meeting.

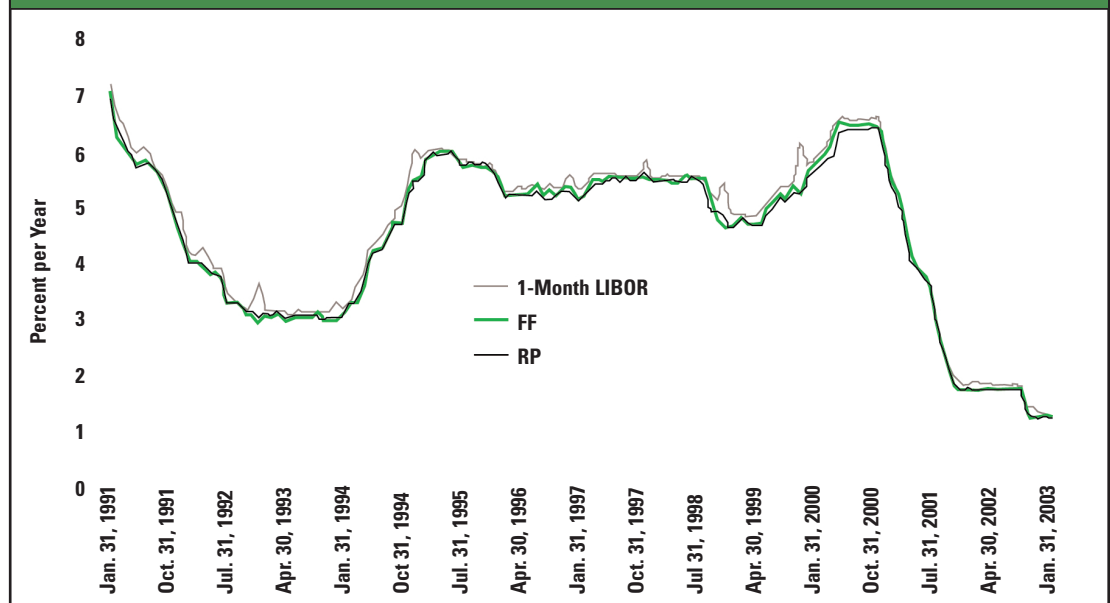
Fed Funds as a Key Benchmark

Since the fundamental and technical factors that influence one short-term cash instrument will generally affect other short-term cash instruments in a similar manner, the fed effective rate serves as a key benchmark against which other short-term cash instruments are priced. The interrelationship among short-term instruments in different credit markets is demonstrated by the close correlation of movements in one-month term rates for fed funds (interbank loans), repurchase agreements (repos), certificates of deposit (CDs), commercial paper (CP), and Eurodollars (interbank loans denominated in U.S. dollars by non-domestic entities). Exhibit 1 illustrates key relationships.

Because the CBOT fed funds futures contract is based on overnight fed effective and one-month term fed funds rates, it is useful for managing the risk associated with changing credit costs for virtually any short-term cash instrument. Money managers, institutional investors, traders, and foreign and



Exhibit 1: Short-Term Interest Rates



This chart illustrates the close relationship between repo rates, 1-month LIBOR, and the fed funds benchmark. Notice, especially, that during most of this period, the fed funds line covers the repo line. The repo line separates in only a few places—e.g., during the first three-quarters of 2000. Otherwise, the correlation is so close that the repo line does not show.

domestic banks will find that the fed funds futures contract offers useful alternatives and flexible applications for managing risk in short-term maturity horizons.

Fed Funds Futures Current Month Contract Pricing

The price design of the CBOT Fed Funds futures contract makes it an unusually flexible instrument for managing short-term interest rate exposures. However, because the rate-averaging feature in the current month differs from the pricing convention for deferred contract months, it is important to understand these concepts thoroughly in order to take full advantage of the many opportunities available with fed funds futures.

Pricing the Current Month Contract

Futures contracts are primarily designed to reflect future price (or interest rate) expectations. While this is also true for fed funds futures, the contract is intentionally designed to behave quite differently during the settlement period. During an expiration month, the price for the current contract reflects the weighted average of not one, but two key components:

1. The realized overnight fed effective rates experienced to date
2. The expected fed effective rate to the end of the month

At the beginning of the settlement month, the contract's price is still based primarily upon future expectations about the fed effective rate. With each passing day, however, the other component—the actual fed effective rates experienced for that month—is also factored into the equation and becomes a more dominant factor in determining that month's final settlement price.

This price feature was designed to offer an effective means of managing exposure to changes in interest rates for whatever period remains to month-end, frequently called a stub exposure. It also has the effect of reducing price volatility in the expiring contract month. Because the final settlement price is an average of the daily fed funds effective rate, the farther into the month you go, the less effect one day's rate change can have, hence the reduction in price volatility.

The futures price during the current month can be expressed using this equation:

$$\text{Current Month Futures Price} = 100 - \left[\frac{\sum_{i=1}^j \text{realized (FER}_i\text{)}}{\text{Days}_n} + \frac{\sum_{l=j+1}^n \text{realized (FER}_l\text{)}}{\text{Days}_n} \right]$$

Here, j is the number of days passed to date and n is the actual number of days in the month. The following example helps to illustrate how the two major components affect the contract price—as well as how the contract price implies a term rate for the remaining days in the expiring month.

For example, on June 9, the June contract is priced at 98.515, indicating a rate of 1.485 ($100 - 98.515 = 1.485$). The overnight rate-to-date component of this price is an average of the daily fed effective rates for the first 9 days of June. If the average rate-to-date for these 9 days is 1.488 percent, then the June 9 price of 98.515 implies a term rate of 1.484 percent for the remaining 21 days in the month. This can be determined by using the same pricing formula above, but solving for the average expected fed effective rate (based on the current futures price) for the remaining 21-day period.

$$\text{Current Fed Funds Futures Rate} = 1.485 = (9/30) \times 1.488 + (21/30) \times 1.484$$



Final Settlement

By contract expiration, the settlement price is based exclusively upon the actual fed effective rates experienced each calendar day in the month. The final settlement price is derived from the simple average of the rates, calculated as follows:

$$\begin{array}{l} \text{Fed Funds} \\ \text{Futures} \\ \text{Settlement} \\ \text{Price} \end{array} = 100 - \frac{\sum_{i=1}^n \text{expected (FER}_i\text{)}}{\text{Days}_n}$$

To calculate the final settlement, add the daily fed effective rates and divide that figure by the number of calendar days in the month. The result is rounded up to the nearest one-tenth of one basis point.

It is important to remember that weekend and holiday rates assume the rate applied on the previous business day for which a rate was reported. In other words, Friday's rate is typically counted three times: as the overnight rate from Friday to Saturday, from Saturday to Sunday, and again from Sunday to Monday. In the example presented in Exhibit 2, which is for a September expiration, the Labor Day holiday falling on the fourth day of the month is also assigned the fed effective rate from the prior Friday.

Fed Funds Futures Deferred Month Contract Pricing

Typically, CBOT Fed Funds futures contracts trade 6 to 9 consecutive months out from the current date. However, deferred contracts can be listed for each of the 23 months that follow the current month. The price of each deferred contract tracks the one-month forward rate implied by an uncompounded average of the expected overnight fed funds rates, given the deferred month's specific position on the yield curve.

For this reason, the forward rates implied in fed funds futures prices tend to be lower than the comparable term rates, which are typically based on compounded averages. This does not mean that all deferred months will trade at the same price when rates are expected to remain stable. The farther out the deferred contract is, the greater the risk of an unforeseen change in interest rates.

Each 1 basis point change in yield (i.e., each 0.01 percent change) causes the price of a deferred contract month to move one tick in the opposite direction. For example, in November, the price of the December contract will be determined by the forward rate for the one-month period that

Exhibit 2: Final Futures Settlement Price, September Expiration			
Trading Day	Fed Effective Rate	Trading Day	Fed Effective Rate
9-01 Friday	1.26	9-16 Saturday	1.31
9-02 Saturday	1.26	9-17 Sunday	1.31
9-03 Sunday	1.26	9-18 Monday	1.35
9-04 Monday	1.26	9-19 Tuesday	1.34
9-05 Tuesday	1.29	9-20 Wednesday	1.29
9-06 Wednesday	1.32	9-21 Thursday	1.31
9-07 Thursday	1.30	9-22 Friday	1.28
9-08 Friday	1.28	9-23 Saturday	1.28
9-09 Saturday	1.28	9-24 Sunday	1.28
9-10 Sunday	1.28	9-25 Monday	1.31
9-11 Monday	1.27	9-26 Tuesday	1.34
9-12 Tuesday	1.29	9-27 Wednesday	1.35
9-13 Wednesday	1.31	9-28 Thursday	1.36
9-14 Thursday	1.32	9-29 Friday	1.34
9-15 Friday	1.31	9-30 Saturday	1.34
		Average Fed Effective Rate	1.30267
		Average Fed Effective Rate Rounded to Nearest 1/10 BP	1.3036
		Final Futures Settlement Price	98.697

begins on the first day of December. If the forward rate increased from 1.56 percent to 1.57 percent, the price of the December contract would be likely to decrease from 98.44 to 98.43. The following equation illustrates the deferred month pricing formula:

$$\text{Deferred Month Futures Price} = 100 - \frac{\sum_{i=1}^n \text{expected FER}_i}{\text{Days}_n}$$

Here, n is equal to the number of calendar days in the contract month and FER is equal to the fed effective rate. In the days immediately prior to expiration in the current month, arbitrage should force the price of the next month's contract to reflect a rate equal to the one-month term fed funds rate.



Strip Rates

Another way to assess the pricing of deferred futures contracts is to examine their implied strip rate. A strip is created by linking together a series of consecutive futures contracts. Market participants may use fed funds strips to manage risk exposures that extend beyond one month or to identify trading opportunities. The strip rate implied from current futures prices is also useful in that it reveals market expectations built into the short-term yield curve.

The value of the fed funds futures strip changes much like the value of a longer-term rate in response to a change in yields. The formula below is for an April-June strip that begins during the month of April:

$$\text{Strip Rate} = \left[\left(1 + R_{APR} * \frac{D}{360} \right) * \left(1 + \frac{R_{MAY}}{12} \right) * \left(1 + \frac{R_{JUNE}}{12} \right) - 1 \right] * \frac{360}{\text{Total Days}} * 100$$

Here, R is the rate implied by fed funds futures and D is the number of days remaining in the current month. The inputs required to determine the three-month strip rate from April to June, beginning on April 9, are displayed in Exhibit 3 below.

Exhibit 3: Data for Calculating a Strip Rate		
	Futures Price	Futures Rate
April contract	98.525	1.475*
May contract	98.55	1.45
June contract	98.58	1.42

* Eight days have already elapsed in April—the average fed effective rate is now 1.473% for the 22 remaining days of the contract month.

Substituting these values into the strip rate equation, we find that the strip rate is 1.4468%.

$$1.4468\% = \left[\left(1 + 0.01473 * \frac{22}{360} \right) * \left(1 + \frac{0.0145}{12} \right) * \left(1 + \frac{0.0142}{12} \right) - 1 \right] * \frac{360}{82} * 100$$

This rate can then be compared to actual term rates covering the same time period. Differences in the two rates may indicate opportunities for arbitrage trades between the cash and futures markets.

Once again, the analysis requires consideration of other subtle, but nevertheless important issues. In the example above, for instance, April is an expiring contract month whereas May and June are

deferred contracts. This means that the three futures contracts comprising the strip are responding to slightly different pricing factors. Prices for the April contract represent the realized and expected overnight fed effective rates in April, while May and June represent one-month rates beginning in May and June, respectively. In contrast, a strip created from three deferred contracts—each pricing future one-month rates—will provide a slightly different comparison of term vs. implied strip rates.

Fed Funds Futures and the Probability of a Fed Policy Shift

Perhaps no single interest rate is watched more intently than the fed funds target rate set by the Federal Open Market Committee (FOMC or, popularly, the Fed). Perhaps, too, no single financial policy decision carries more weight in all corners of the financial world than an FOMC decision concerning whether to raise, lower, or leave untouched the fed funds target.

In the weeks immediately prior to a Fed meeting, the financial media will carry comments to the effect that fed funds futures prices indicate, for example, a 43% probability for a 25 basis point (bp) decrease in the fed funds target rate.

These people are working from simple probability math, and you can do the same thing. Consider the market situation on March 27, 2003. The next FOMC meeting was scheduled for May 6. Also, for some weeks, at least some commentators had been saying the Fed would be likely to lower its already low target rate from 1.25% to 1.00%. Of course, the March 18 meeting had come and gone with no change in the target.

On March 27, the May fed funds futures contract was trading at a price of 98.86 which implied a fed funds rate of 1.14% ($100 - 98.86$). Using a standard probability equation, you could have used that implied rate to estimate the probability that the Fed would either lower the target to 1.00% on May 6 or leave it unchanged at 1.25%.

$$1.25\% * (6/31) + [1.00\%p + 1.25\%(1 - p)] * (25/31) = 1.14\%$$

Here p is the probability the Fed will lower its target rate 25 bps, $(1-p)$ is the probability the Fed will leave the target unchanged, $(6/31)$ is the fraction of the month during which the target is known to be 1.25%, and $(25/31)$ is the fraction of the month during which the target is unknown.

Solving for p , you will discover that in this case p equals 0.5456. That is, this exercise predicts a 55% probability that, given the market situation on March 27, 2003, the Fed would lower its target rate 25 basis points at its May 6 FOMC meeting and a 45% probability that it would leave the target unchanged.



A Probability Refresher

In case algebra was a long time ago, here is the step-by-step process for solving for p .

First, convert $6/31$ and $25/31$ into decimal fractions by dividing 6 by 31 and 25 by 31 to get 0.1935 and 0.8065. Next, rearrange the term $1.25(1-p)$ into $-1.25\%p + 1.25\%$. These two steps result in this array:

$$1.25\% * 0.1935 + [1.00\%p - 1.25\%p + 1.25\%] * 0.8065 = 1.14\%$$

Now multiply 1.25 by 0.1935 and the three terms inside the brackets by 0.8065 to produce this array:

$$0.2419 + 0.8065p - 1.0081p + 1.0081 = 1.14\%$$

Move 0.2419 and 1.0081 to the other side of the equal sign by changing their signs to produce this:

$$0.8065p - 1.0081p = 1.14 - 0.2419 - 1.0081$$

Do the subtraction to produce this:

$$-0.2016p = -0.1100$$

Shift the 0.2016 to the other side of the equal sign by dividing through to produce this:

$$p = -0.1100/-0.2016$$

Do the division, and you can see that p equals 0.5456, or a 55% probability.

A Limitation and a Final Word

These probability predictions should carry an important caveat that is too often observed in the breach. This equation assumes the Fed has a two-choice menu. It can either shift the target the amount in question or leave the target unchanged. The Fed obviously works from a far richer menu. Suppose the consensus is that the Fed will lower its target rate 25 bps. The Fed can do that, but it can also surprise the market with 50 bp move, an increase in the target, or no move at all. Adding even one more option to the menu requires a far more complicated calculation. However, as long as you recognize this limitation, this probability estimate can help you understand what the futures market has to tell you.

The choice of futures price months is important in making these calculations. When the FOMC meeting is close to the beginning of the month, as in this example where the May meeting is on May 6, you should use the futures contract for the meeting month. However, when the meeting falls any time after the middle of the month, it may be best to use the futures price for the next month. To see what the market has to say about the June 25, 2003 meeting, for example, you should look at the price of the July contract. Exhibit 4 shows that, for the eight regularly scheduled 2003 FOMC meetings, you would use the meeting month futures contract in three cases, the next month out in the other five cases.

Exhibit 4: Where to Focus Futures Predictions	
FOMC Meeting Date	Futures Contract for Prediction
January 29, 2003	February
March 18, 2003	April
May 6, 2003	May
June 25, 2003	July
August 12, 2003	August
September 16, 2003	October
October 28, 2003	November
December 9, 2003	December

An important benefit of using fed funds futures in this way is that the futures price is extremely sensitive to shifts in market sentiment. This 98.86 March 27 May futures price, after all, results from the interaction in the marketplace of a large group of people, each with a slightly different set of information and a slightly different economic outlook. As economic statistics emerge that make a Fed move seem more or less imperative, the futures price will reflect the new consensus, and the probability calculation allows you to put a number to it.



Appendix: 30-Day Fed Funds Futures Salient Features

Trading Unit	\$5 million
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Tick Size	\$20.835 per one-half of one basis point (1/2 of 1/100 of one percent of \$5 million on a 30-day basis rounded up to the nearest cent).
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Price Quote	100 minus the average daily effective fed funds rate for the delivery month (e.g., a 7.25 percent rate equals 92.75)
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Contract Months	First 24 consecutive calendar months.
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Last Trading Day	Last business day of the delivery month.
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Settlement	The contract is cash settled against the average daily effective fed funds rate, rounded to the nearest one-tenth of one basis point, for the delivery month. The daily effective fed funds rate is calculated and reported by the Federal Reserve Bank of New York.
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Trading Hours	Open Outcry: 7:20 a.m.—2:00 p.m. Chicago time, Mon-Fri. Electronic: 8:00 p.m.—4:00 p.m. Chicago time, Sun-Thu. Trading in expiring contracts closes at 2:00 p.m. Chicago time on the last trading day.
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Ticker Symbols	Open Outcry: FF Electronic: ZQ
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Daily Price Limit	None
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