

INTEREST RATE PRODUCTS



Protecting Funding  
Margins with Binary  
Options on the Target  
Federal Funds Rate



# INTRODUCTION

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Most sources of long-dated Treasury funding – term fed funds, term repo and term Eurodollar placements, for example – tend to track the overnight fed funds rate closely. If the overnight fed funds rate is low and if the next policy move by the Federal Open Market Committee (FOMC) looks like a push toward higher rates, then a treasurer might be wise to extend funding from very short dates (e.g., overnight to a week) out to longer terms (e.g., as much as three months or more). Conversely, if the FOMC's target for the overnight fed funds rate seems poised to move lower, then the treasurer may favor shorter-dated funding vehicles.

In periods of unsettled monetary policy, however, it may be impossible for the funding desk manager even to make a reasonable guess. Few would disagree that the interval since autumn 2007 has been one of those times. Uncertainty concerning what the FOMC might, or might not, do in the future makes it hard to decide what near-term funding arrangements are best.

A good way for funding desk managers to cope with such uncertainty is to hedge funding risk with Binary Options on the Target Federal Funds Rate (more simply, Fed Binaries).

# A REVIEW OF FED BINARY OPTIONS

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Binary options are tied to events and take their name from the fact they offer only two outcomes. An event happens, or it doesn't – no in-between. If the event happens, then a binary option pays its buyer a contract-specified amount and requires its seller to pay that amount. If the event doesn't happen, then a binary option makes no payment.

With Fed Binaries, the events in question are FOMC monetary policy decisions. When the FOMC raises or lowers its target level for the overnight fed funds rate, the relevant Fed Binary call or put will pay the option buyer \$1,000 and will require the option seller to pay

\$1,000. When the expected move does not occur, the Fed Binary option buyer receives nothing; likewise, the Fed Binary option seller pays nothing. This is in sharp contrast to the continuum of outcomes and payouts offered by conventional interest rate options.

Fed Binaries differ from conventional interest rate options in ways other than the form of their payouts. For example, most other exchange-traded options are American-style, allowing the buyer to exercise at any time, either prior to or at expiry. Fed Binaries are European-style options, for which exercise may occur only at expiry.

## ADAPTING TO 100 MINUS RATE TERMS

The underlying reference for Fed Binaries is the target fed funds rate, expressed in terms of the familiar IMM Index, i.e., as 100 minus rate. If the target fed funds rate is 4.50 percent, then the corresponding IMM Index value is 95.50 (equal to 100 minus 4.50). A downward shift in the target rate to 4.00 percent becomes 96.00. A hike in the target rate to 4.75 percent becomes 95.25.

Fed Binaries are listed at 12.5 basis point (bp) strike price intervals. Exhibit 1 displays a range of target fed funds rate, in conventional percentage form, with the corresponding call and put strike prices in 100 minus rate terms. For sake of illustration, we assume options with a strike price of 95.50 are at-the-money (implying a target fed funds rate of 4.50).

As Exhibit 1 suggests, if you anticipate a drop in the target fed funds rate and you want to be an option purchaser, then you would think in terms of buying a call. That's because a decline in the target rate from 4.50 to 4.25 percent amounts to an increase from 95.50 to 95.75 in IMM Index terms. Conversely, if you anticipate a target rate hike and if as before you want to be an option purchaser, then you would think in terms of buying a put, because a shift from 4.50 to 4.75 in rate terms translates to a decrease from 95.50 to 95.25 in IMM Index terms.

### EXHIBIT 1: POSSIBLE FED BINARY OPTION STRIKE PRICES

Target Rate (%)	Call Strike Prices (100 – rate)	Put Strike Prices (100 – rate)
4.000	96.000	
4.125	95.875	
4.250	95.750	
4.375	94.625	
4.500	94.500	94.500
4.625		94.375
4.750		94.250
4.875		94.125
5.000		95.000

# PROBABILITY-BASED PRICING

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Each Fed Binary option prices in terms of the probability that the option, with its specified strike price, will expire in-the-money. This depends in turn on the probability that the FOMC will shift its target rate up or down and by the appropriate amount. This contrasts strongly with the pricing of conventional interest rate options, where both option strike prices and option payoffs are typically gauged in terms of either interest rate basis points or bond or note price points.

With a Fed Binary call, the owner receives payment only if the target rate immediately following the corresponding FOMC meeting – expressed in IMM Index terms – is higher than the call's strike price. Similarly, with a Fed Binary put, the holder receives payment only if the post-FOMC meeting target rate (again, rendered in IMM Index terms) is lower than the put's strike price. In either case, the outcome depends on the probability that the FOMC will shift its target rate in the anticipated direction and in the anticipated magnitude.

Given the structure of these contracts, such conventional option pricing factors as time to expiration, interest rates and implied volatility come into play in uncanny ways – or not at all.

*Time to expiry* and the level of *interest rates* enter jointly into the pricing of Fed Binaries via the discounting to present of expected option outcomes. The discounting process typically will exert less influence on the valuation of a Fed Binary option with nearby expiry than on the valuation of a Fed Binary that expires in the distant future. To see this, suppose that money market interest rates are very high, say, 10.5 percent per annum from overnight out to 6 months. A deep-in-the-money Fed Binary option that expires just after the FOMC meeting a week from today and that looks all but certain to pay its owner \$1,000 at expiry, is apt to be fairly valued close to its maximum price of 100 points. Another

deep-in-the-money Fed Binary option that likewise appears all but certain to pay its holder \$1,000 at expiry, but which expires just after the FOMC meeting six months from today, might be fairly valued around 95 price points, rather than 100. The discount that applies to the longer-dated option reflects the half-year interval that market participants must wait for the option's outcome to materialize.

By contrast, *implied volatility* is unlikely to play any recognizable role in the pricing or position management of Fed Binaries. Implied volatility, as option market practitioners know it and use it, derives its interpretation from the family of stochastic differential equations that serve as the foundation for conventional Black-Sholes or Black option pricing. Long ago, this framework proved its suitability for modeling the dynamics of market interest rates and asset prices. It is neither tractable nor even appropriate, however, for modeling the dynamics of an administered policy rate such as the FOMC target for the overnight fed funds rate.

In a less formal sense, of course, Fed Binary options do reflect market participants' assessment of volatility. One can use Fed Binary prices to infer the menu of policy alternatives that market participants perceive the FOMC to be contemplating, as well as the market-wide estimate of the probability distribution governing which menu item, or items, the FOMC might ultimately select. In situations where market participants have no clue as to what future actions the FOMC will take – the interval since mid-2007 probably qualifies as a good example – the perceived menu of policy alternatives will be correspondingly broad. In times when there is widespread consensus as to the FOMC's intentions and likely future actions, the perceived menu of policy alternatives will be correspondingly short (e.g., no change in target, versus a 25 bps reduction in target).

## EXAMPLE 1: PROBABILITY PRICING OF A FED BINARY OPTION

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Suppose the market assigns 30 percent probability to a hike in the target rate of 25 bps or more at the next FOMC meeting. For sake of illustration, let's assume that, in terms of the target level, this signifies an increase from 4.50 percent at present to a new level of 4.75 percent or higher. In IMM Index terms, this would be a shift from 95.50 to 95.25.

Accordingly, the 95.375 Fed Binary put that expires immediately after the next FOMC meeting will have 30 percent probability of expiring in the money and will cost \$300 (30 probability points at \$10 per point)<sup>1</sup>. The call buyer pays this and the call seller collects it.

Now assume the FOMC subsequently moves its target rate from 4.50 to 4.75 percent. This outcome causes the 95.375 put to expire in-the-money. The buyer of the put collects \$1,000; when this is netted against the \$300 premium she paid when she purchased the option, her net gain is \$700. The seller of the put must pay \$1,000; when balanced against the \$300 premium that he collected when he sold the option, his net loss is \$700.

Conversely, suppose the FOMC holds its target rate at 4.50 percent. The buyer of the 95.375 put, having purchased the option for \$300, will receive nothing. The seller of the put, who earned \$300 of premium at the sale of the option, is obliged to pay nothing at expiry.

<sup>1</sup> As explained earlier, the Fed Binary option price is technically the expected value of the payoff at option expiry, discounted to present. If money market interest rates are reasonably low and if the option expiry date is reasonably near, then the extent of discounting will be small enough that one can ignore it, as we do in these examples.

## EXAMPLE 2: BANK FUNDING AND FOMC EVENT RISK

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### The Core Strategy

Imagine that it is the beginning of November 2007. Having seen the FOMC slash the fed funds target rate from 5.25 percent to 4.75 percent on September 18 and then cut it again to 4.50 percent on October 31, your thinking might run along these lines:

The clear signal from the October meeting was that, with the latest two target rate reductions, the FOMC might well be done easing credit market conditions for the foreseeable future (“...the Committee judges that, after this action, the upside risks to inflation roughly balance the downside risks to growth”). Indeed, the FOMC admits it remains concerned about inflation (“...the recent increases in energy and commodity prices, among other things, may put renewed upward pressure on inflation”). This appears to suggest that the target rate is apt to remain at 4.50 percent for some time, but that the most likely move, if there is one, will be towards higher rates.<sup>2</sup>

Reasonably, you conclude that now is a good time to switch from weekly funding to, say, 90-day funding.

Market conditions on November 1, 2007, are as follows:

With the target fed funds rate newly established at 4.50 percent, the overnight fed funds rate itself is at 4.59 and 90-day term fed funds trade at 4.70 percent. At a fixed rate of 4.70 percent, funding \$500 million for 90 days would cost \$5.875 million.

Having borrowed at this rate, you have the comfort of knowing that a rate hike at the next FOMC meeting on December 11 will not affect your cost of funds.

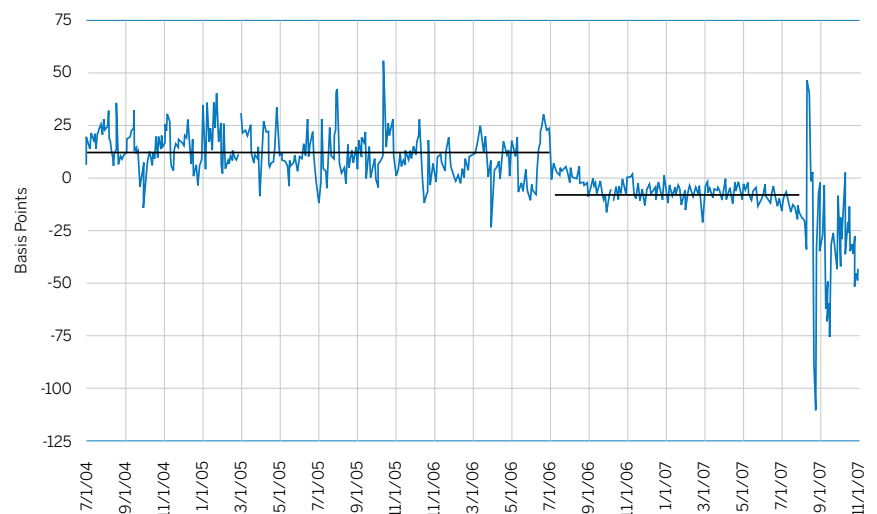
<sup>2</sup>From October 31, 2007 FOMC Monetary Policy Release.

## A Nagging Doubt

With a jittery stock market, and nothing but bad news emanating from the housing and securitized loan markets, you are concerned that events might compel the FOMC to loosen credit market conditions a bit more – or perhaps a lot more were a real emergency to arise.

With this in mind, you review some money market history. Exhibit 2 displays the spread between the 90-day term and overnight fed funds rates from July 1, 2004, through November 1, 2007. Between July 1, 2004 and June 30, 2006, when the Fed was tightening credit market conditions, 90-day term fed funds traded at a premium to overnight fed funds: The spread between them averaged roughly 18.75 bps and ranged between 0 and 40 bps. Between July 3, 2006 and July 31, 2007, during which time the FOMC held the target fed funds rate steady at 5.25 percent, the spread between overnight and 90-day term fed funds narrowed significantly, averaging just over 6.25 bps.

**EXHIBIT 2: THE SPREAD BETWEEN THE 90-DAY TERM REPO AND OVERNIGHT FED FUNDS RATES**



Next, you consider various ways in which your core term-funding strategy might go wrong. Suppose, contrary to your earlier surmise, that the FOMC were to lower the target to 4.25 percent on December 11 and that the 60-day term fed funds rate were to drop to around 4.45 percent in response (as your review of recent history suggests might occur). For the 55 days of your funding program that then remain, the cost of funding \$500 million at new and lower market rate levels would be slightly less than \$3.4 million. But if you have already locked in a fixed term funding rate of 4.70 percent, then the cost for the remaining 55 days is around \$3.59 million. Thus, in this scenario, committing to 90-day term financing would entail an opportunity cost of roughly a \$199,000.

Now suppose that the economic news right before the December FOMC meeting is sufficiently dire to motivate a 50 bp ease. Under this scenario, the market-funding rate for the remaining 55 days to would drop to 4.20 percent, making a cost of \$3.208 million to fund \$500 million. Compared to the cost structure you would lock in with today's 90-day term funding rate, the difference would amount to an opportunity cost of \$382,000.

## Twinking the Core Strategy for Event Risk

At some point, the potential opportunity cost arising from FOMC event risk is simply too great for you to absorb. Thus, you decide that it might be worthwhile to consider protecting your basic term funding strategy against a surprise easing move of 50 bps or more at the December 11 FOMC meeting.

You can accomplish this by buying Fed Binary calls. In setting up this event-risk hedge, the practical questions you must answer are: 1) which strike price to buy; 2) what the cost will be; and 3) how many Fed Binary calls you need to buy. For this purpose, Exhibit 3 displays a range of possible Fed Binary call strike prices and a hypothetical probability distribution.

Suppose that, for the moment at least, market participants attach negligible probability to a 50 bp ease. Thus, the December 95.875 call is priced at five probability points. At \$10 per probability point, the option will cost \$50. If the FOMC were indeed to drop its target rate to 4.00 percent or lower on December 11, then this call would expire in-the-money, paying you \$1,000.

Exactly what protection would the December 95.875 call provide for you? With the FOMC target currently at 4.50 percent, the IMM Index is 95.50. If there is no change in the target rate, then the December 95.875 Fed Binary call will expire out-of-the-money. A 50 bp lowering of the target rate on December 11 would push the IMM Index to 96.00, at which level the call would expire in-the-money.

### EXHIBIT 3: A POSSIBLE PROBABILITY DISTRIBUTION – FED BINARY CALL OPTIONS

Target Fed Funds Rate	Rate Fed Binary Call Strike Price (100-rate)	Probability of ITM Expiration
4.50	95.500	
	95.625	46%
4.25	95.750	
	95.875	5%
4.00	96.000	0%

To determine how many December 95.875 Fed Binary calls to buy, start with the amount you want to protect – in this case, the \$382,000 opportunity loss that you would sustain in the event of a surprise 50 bps reduction in the FOMC target rate. Divide this by the anticipated net gain from one binary call. Given the assumptions above this is \$950 (equal to \$1000 payoff less the \$50 premium that you must pay to purchase the option). This calculation indicates that an appropriate hedge position would be 402 December 95.875 binary calls.

At \$50 per call, this hedge position will cost \$20,100. If events compel the FOMC to lower its target rate 50 bps or more, then each call will pay you \$1,000, for a total \$402,000. This outcome comprises a net gain of \$381,900, plus \$20,100 with which to recoup the cost of purchasing the options.

If instead the FOMC either raises its target, or does nothing, or lowers the target by some amount less than 50 bps, then the hedge position will pay you nothing. Although you will have foregone \$20,100 of option premium, this might still seem a reasonable price for insurance against event risk.

Re-expressed in terms of its impact upon your effective term funding rate, the cost of this insurance outlay raises it from 4.70 percent to around 4.716 percent. That is, it costs an extra 1.6 basis points per annum to insulate yourself from the event risk described above.

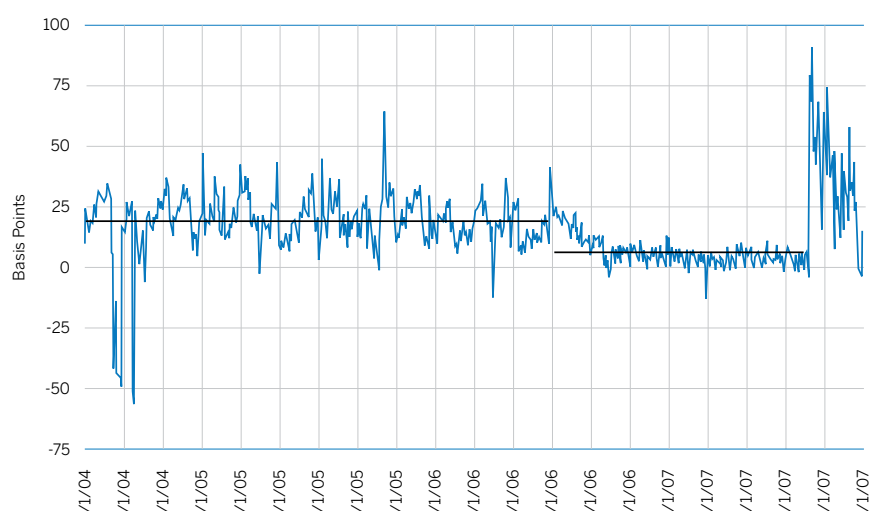
## EXAMPLE 3: A FORWARD-STARTING HEDGE AGAINST A HIGHER TARGET RATE

Suppose you fund a \$700 million fixed-income portfolio in the term repo market and assume once again that it is early November 2007. Given the outcome of the October 31, 2007 FOMC meeting, after which it seems 4.50 percent may be as low as the target fed funds rate will go for some months, you decide to lock in your funding cost for the next three months at the 90-day term repo rate of 4.30 percent prevailing on November 1. The implied dollar cost of funding your position is \$7.525 million.

Hardly a week passes, though, before it begins to look as though the next FOMC action might be to raise the target rate. Certainly this appears to be the thrust of the news from the energy and commodity markets that the FOMC had mentioned in its October 31 statement. Suppose the FOMC were forced to change course and to nudge the target rate up by 25 bps at each of its next two meetings on December 11, 2007 and January 30, 2008. Given that your cost of funding would be fixed at 4.30 percent between now and early February, these policy actions would have no immediate impact upon you. But they will matter a great deal to you when your term funding program runs off in early February 2008.

Exhibit 4 displays the spread between the 90-day term repo rate and overnight fed funds from July 1, 2004 through November 1, 2007. When the Fed was tightening credit market conditions between July 2004 to June 2006, 90-day repo rates tended to trade at a premium to fed funds: The spread ranged largely between 40 and -10 bps around an average level just over 12 bps.

**EXHIBIT 4: THE SPREAD BETWEEN THE 90-DAY TERM AND OVERNIGHT FED FUNDS RATES**



During the subsequent episode, when the FOMC held the target rate at 5.25 percent, 90-day repo traded at a slight discount to fed funds. The spread (term repo minus overnight fed funds) became less variable than before and the average retreated to -5.5 bps.

Consider what might happen if by early February 2008 the target rate has risen to 5.00 percent. The historical relationships summarized above suggest that the 90-day term repo rate should trade in the realm of 5.12 percent. At this rate the cost of funding a \$700 million portfolio for a 90-day term would rise to \$8.98 million for the next three months – a \$1.435 million increase over your cost of term funds for the preceding three months.

One way to protect your term funding plan against this contingency is to construct a forward hedge using Fed Binary puts. As the fed funds target rate rises, puts with successively lower strike prices will come into-the-money. Exhibit 5 illustrates which strike price will expire in-the-money (ITM) or out-of-the-money (OTM) given three possible policy outcomes.

If you anticipate a 50 bp increase in the target rate, from 4.50 to 5.00 percent, between “now” and the end of your current funding arrangement, then the January 95.125 Fed Binary put might be a good choice for this kind of forward-starting hedge. If the target rate does go to 5.00 percent, then this option will expire in-the-money, paying buyers \$1,000. By contrast, the January 95.00 Fed Binary put would expire precisely at-the-money, paying its buyers nothing.

The market may assign only slight probability to this turn of events. Thus, assume the January 95.125 put to be trading at 3 percent probability in mid-November. At \$10 per probability point, this translates into a \$30 price for this Fed Binary put.

#### EXHIBIT 5: SHIFTS IN FED BINARY OPTION MONEYNESSESS DURING A FED TIGHTENING PROGRAM

Target Fed Funds Rate	Fed Binary Put Strike Prices	Moneyness	Target Rate	Fed Binary Put Strike Prices	Moneyness	Target Rate	Fed Binary Put Strike Prices	Moneyness
4.50	95.500	ATM		95.500	ITM		95.500	ITM
	95.625	OTM		95.375	ITM		95.375	ITM
4.25	95.750	OTM	4.75	95.250	ATM		95.250	ITM
	95.875	OTM		95.125	OTM		95.125	ITM
4.00	96.000	OTM		95.000	OTM	5.00	95.000	ATM

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If the option expires in-the-money, then its net proceeds will amount to \$970 (\$1,000 payout at expiry minus \$30 option premium at purchase). Accordingly, to protect against the possibility of a \$1.435 million increase in the cost of funding your \$700 million portfolio, you would purchase 1,480 January 95.125 binary puts. That is, you would divide the amount against which you want to protect – here, a potential \$1,435,000 increase in your funding cost – by the \$970 net gain for one put. Given these assumptions, this funding “insurance” position will cost \$44,400 (1,480 puts times the \$30 cost of one put).

In terms of its impact upon your effective term funding rate, this insurance outlay will raise it from 4.30 percent to around 4.326 percent. That is, it will cost you roughly an extra 2.6 basis points per annum.

If the turn of events that concerns you fails to materialize – that is, if the FOMC cuts its target, or does nothing, or raises the target rate by less than 50 bps – then the January 95.125 puts will pay nothing. However, were a 50 bp target rate hike to occur, this option position will generate a \$1,435,600 net payout (\$1,480,000 in proceeds at expiry minus the \$44,400 initial cost). This payout will effectively hold your funding cost at the earlier 4.30 percent cost of funds. Such an outcome would put your funding desk in an advantageous position relative to competitors who haven’t availed themselves of this kind of low-cost protection.

# CONCLUSION

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Fed Binary options are designed to help market users take positions on or protect against the event risk associated with shifts in the fed funds target rate – whether these shifts are expected or not. Because of the unique pricing properties of Fed Binaries, they can prove both efficient and cost-effective risk management tools, as these examples demonstrate.

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To learn more about Binary Options on the Target Federal Funds Rate, visit [www.cmegroup.com/interestrates](http://www.cmegroup.com/interestrates).

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