THE CURVE ADVISOR

CURVATURE TRADING APPLICATIONS
Application #3: OPTIONS TRADING

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Curvature trading is one of the least-discussed tools in a trader's arsenal. It has valuable applications in: (1) directional trading, (2) range trading, (3) options trading, and (4) market-making. Over the four issues in this series, I will highlight how an understanding of curvature in Eurodollar futures can be used to improve returns in each of these areas.

There are two ways to look at value in options:

1) as a function of volatility, or
2) as a function of (terminal) probability.

Most books are written about the first. Very little is written about the second. I like to think about the first as a journey, and the second as the destination. They both describe the trip - in different but related ways. Any time you look at alternate views, you may develop a new approach to finding value.

DIFFERENT PERSPECTIVES

The standard way of looking at options value is to look at some function of volatility, Black Scholes vol or basis points per day. These are all reasonable ways of looking at how much an option should be worth. How much a contract will be priced to move in the future will typically have some component of how much it has moved in the past. You can use options to express a view on the volatility of a contract in a number of different ways, until its expiry.

Table 1:
EDM5 Call Prices

Strike	Settle
98.625	101.00
98.75	88.50
98.875	76.00
99.00	63.75
99.125	51.50
99.25	39.25
99.375	27.25
99.50	16.00
99.625	7.00
99.75	1.00
99.875	0.00
100.00	0.00

Options value can also be thought of as a function of probability at expiry. Table 1 shows the settlement prices (in basis points) on quarterly calls on EDM5 from January 27, 2015.[1] You can construct 12.5bp wide call butterflies around each of the strikes, as shown in Table 2. For example, the EDM5 99.625-99.75-99.875 call fly (highlighted in yellow) is constructed by buying one 99.625 call, selling two 99.75 calls and buying one 99.875 call. The result is a price of 5 basis points to purchase the call fly.[2] If you add up all the 12.5bp wide call flies for a particular contract (i.e. EDM5 98.625-**98.75**-98.875 call fly + 98.75-**98.875**-99.00 call fly + 98.875-**99.00**-99.125 call fly + … + 99.875-**100.00**-100.125 call fly), by *construction* the sum will be 12.5bps.[3]

Table 2:
EDM5 12.5bp Butterfly Prices

Butterfly Strikes	Price
98.625-**98.75**-98.875	0.00
98.75-**98.875**-99.00	0.25
98.875-**99.00**-99.125	0.00
99.00-**99.125**-99.25	0.00
99.125-**99.25**-99.375	0.25
99.25-**99.375**-99.50	0.75
99.375-**99.50**-99.625	2.25
99.50-**99.625**-99.75	3.00
99.625-**99.75**-99.875	5.00
99.75-**99.875**-100.00	1.00
99.875-**100.00**-100.125	0.00
Sum of Fly Prices:	**12.50**

[1] All data in the Tables and Charts herein are provided by the Chicago Mercantile Exchange.

[2] Options butterfly prices may be subject to some minor rounding and settlement distortions. For example, in practice it is nearly impossible to buy a fly for zero.

[3] When you add the sequence of flies, the back call spread of one fly gets cancelled out by the front call spread of the subsequent fly. In our particular example, all you are left with is long the 98.625-98.75 call spread vs short the 100.00-100.125 call spread, which ends up being: 12.5 - 0 = 12.5.

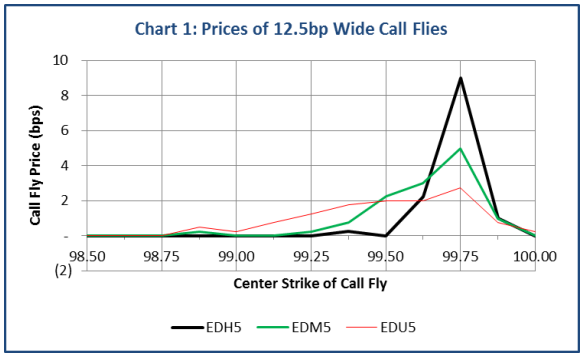

Chart 1 shows the prices of the 12.5bp wide butterflies for EDH5, EDM5 and EDU5, around various strikes. As you can see, the shapes of the graphs around the strikes resemble (discrete) "probability" distributions.[4] The interesting things to note about the Chart 1 are the following:

- **The distribution for EDH5 flies is extremely narrow.** There are only 1.6 months until expiry, and considering "patient" is still in the FOMC statement, you would not expect EDH5 to deviate much from the 99.75 strike. The 99.75 strike is the closest to where the contract would settle if the FOMC leaves rates unchanged.
- **The distribution for EDM5 and EDU5 flies get progressively wider.** As you go further out the curve, the range of possible terminal outcomes is greater, as the time to expiry increases.
- **Note that although EDU5 settled at 99.485 (closest to the 99.50 strike), the highest call fly is still the one around the 99.75 strike.** Typically, you would expect the highest call flies to be around the at-the-money strike, and lower in the tails. However, in the case of shorter term options in the white pack, it is not unreasonable to have the "no move" scenario still be most likely (mode) scenario.
- **Volatility skews show up as "probability" skews.** You can see the fat tails on the call flies centered around the lower strikes of EDM5 and EDU5.

Many market participants take a probability approach to trading options. They consider where a contract is likely to settle when expressing a view with options structures (such as a call fly or call spread). The focus is less on the implied level of volatility, and more on the cost of a structure and the probability of the contract settling above or below the strike(s). Value is determined by the potential reward at expiry vs the cost.

The key assumption that ties the volatility and probability interpretations of options is the random walk. Almost all options models assume some form of random walk, so the terminal probabilities will be a function of the volatility, in theory. But in practice, **there may be relationships between two (or more) contracts that supersede the standard random walk assumption.**

DRIFT

There are times when bps/day (or volatility) may not accurately represent the "drift" potential of a security, because how much something moves *per day* may not accurately represent where it can *move to*. All other things being equal, two contracts with the same bps/day should have the same drift potential, but this does not have to be the case. One way drift shows up in the world of volatility is in the volatility skew. However, there may be other constraints on the various contracts in the curve.

You can construct a hypothetical contract structure that restricts the random walk property. For example, say you have an upward-sloping yield curve, and two points A and B that are 45bps apart, with A having an earlier settlement date than B. If a central bank states that it is unlikely to hike rates more than 50bps in the period "covered" between the two contracts, you can still have each contract move a certain number of bps/day. However, the paths of the two contracts are now linked to each other. In particular, the upward drift potential of B (in

[4] You can interpret the terminal "probability" of the underlying contract settling around 99.75 as a *function of* the price of the 99.625-99.75-99.875 call fly divided by 12.5.

terms of rate) is limited by the move of A. Similarly, A's potential moves to the downside are limited by B. There are times where looking at the interest rate complex as a whole can provide additional insights and value.

CURVE ADVISOR EXAMPLE

In September 2014, the market was long hundreds of thousands of ED futures in the white and red contracts, and in particular EDZ5. A bulk of the exposure was unwound at the end of September and early October. The impact on the EDZ5 contract caused the EDZ4-Z5-Z6 year fly to trade to a level of -26 on October 6, 2014.

Typically, a year fly centered on the front of the reds trades very directionally. I had no interest in being short the volatile directional trade the underlying Z4-Z5-Z6 year fly would have been. As the selling pressure on EDZ5 began to wane I wanted to fade the move by selling the Z4-Z5-Z6 fly *using options*. On October 7, I recommended the following "butterfly" trade that developed into a short fly position, but *on a rally*: Buy 2x 0EZ5 99.125 call (red midcurve on EDZ5) vs Sell 1x 2EZ6 98.125 call (green midcurve on EDZ6) at 0. EDZ4 was effectively pinned, so we could disregard that contract.

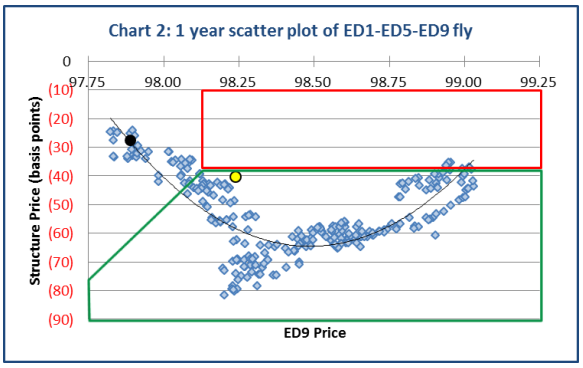

Chart 2 shows the one year scatter plot of the ED1-ED5-ED9 fly vs the price of ED9. The black dot on the upper-left of the chart shows the close on October 6. The strikes implied being short the Z4-Z5-Z6 fly at a level of -37.5. However, EDZ6 was at 97.88, and by the time we rallied another 24.5 bps to the 98.125 strike, I thought the fly should be much lower. The underlying structure looked like it could roll to -50 in three months, and my view on the curve implied that it could go even lower. Even if I was wrong on my directional view (that EDZ5 had sold off too much, in particular to the rest of the curve) and the FOMC looked like they may have to hike, the calls should have remained out-of-the money and the trade would have been flat.

The red box in Chart 2 shows the area where the trade would have lost value, and the green polygon shows the area where the trade would have profited. As you can see, based on the prior 1 year history, the number of dots in the green polygon far outnumbered the number of dots in the red box. You can also see from the pattern of dots on the left side of the graph that the fly was expected to fall noticeably on a rally. To be able to be short the Z4-Z5-Z6 fly *on a rally* for zero cost seemed like an excellent risk / reward trade both fundamentally and historically.

The yellow dot on Chart 2 shows where the underlying structure was one week later on October 14. We exited the trade on that day with a 6bp gain. On the 35bp rally in EDZ6, the butterfly sold off over 14bps, to below -40. This was not as much as I was expecting on that kind of rally, but still enough to make a tidy gain.

This trade was not necessarily a view that the daily volatility on EDZ5 options was mispriced. It was the view that twice as many EDZ5 could drift noticeably more relative to EDZ6 on rally.

SUMMARY

Understanding butterfly and spread structures can add additional insights into the options complex. The random walk is a cornerstone of options modelling. However, in practice, contracts do not always act independently of each other. Understanding which points on the curve are related can improve one's ability to profit on the curve. If you don't have an understanding of curvature and its effects on options, you are not making full use of the trading tools available to you.

Joseph Choi was a senior proprietary trader in J.P. Morgan's Global Currencies and Commodities Group. He was consistently profitable in trading Eurodollar butterflies over his seven year trading career. He was one of the largest discretionary users of Eurodollar futures and options, trading well over 10 million contracts a year. Mr. Choi started the Curve Advisor newsletter in 2011 to discuss trade-specific market views on the Eurodollar curve and to help clients explore opportunities in curvature trading.

Go to www.CurveAdvisor.com for newsletter excerpts, a Eurodollar discussion forum, the top curvature trading misconceptions, and other information on trading curvature. Contact Joseph Choi at JChoi@CurveAdvisor.com with any questions or comments.