

CURVATURE TRADING APPLICATIONS

Application #1: DIRECTIONAL 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.

In the early days of fixed income trading, traders made a fortune from understanding that the price of a bond has a nonlinear relationship to the underlying yield. By definition, a Eurodollar future price has a linear relationship to yield – a 0.01 increase in yield results in a 0.01 decrease in price. However, you can construct a Eurodollar futures butterfly that has a nonlinear price relationship to yield that offers attractive benefits.

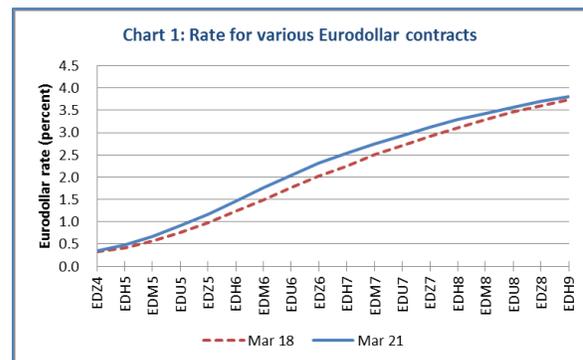
WHAT IS CURVATURE?

When looking at Eurodollar futures, we typically look at the price of a particular contract. Some may look at the first order derivative, the slope between two points. But even fewer look at the second order derivative, the curvature around a point. Curvature can be traded as a butterfly. For example, a long position in the equally-weighted 6 month butterfly around EDU5 would be constructed as: buy 1 EDH5 contract, sell 2 EDU5 contracts and buy 1 EDH6 contract.¹ There is an active market for butterflies on the

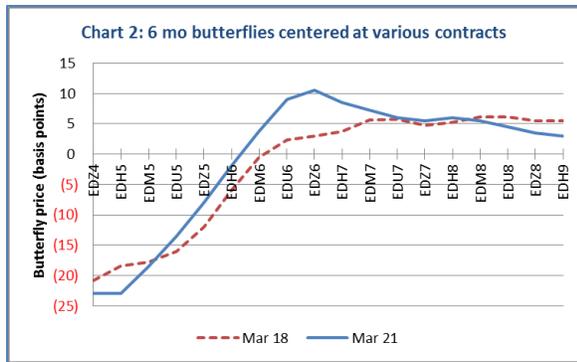
¹ I prefer to look at equally-weighted butterflies to compare various historical periods, as well as for execution purposes: (1) it is easier for the locals to make and maintain a market and (2) you can trade equally-weighted butterflies as a structure on Globex. Trading non-equally weighted flies can have advantages, but weightings can vary based on your choice of the historical comparison period (which can be tricky), weightings can change over time, and it takes a little more work to manage a book of weighted butterflies.

CME's Globex trading system. This particular butterfly has the ticker "GEH15:U15:H16". Trading a butterfly via Globex or via the open outcry market is as easy as trading a single contract.

Looking at a graph of the Eurodollar strip contains limited information. From Chart 1 below, we can see that the sell-off in the days after the March 19, 2014 FOMC meeting occurred mostly in the belly of the curve, but that is about all.



Looking at the graph of butterflies derived from the same curve provides additional information. Chart 2 shows the 6 month butterflies around each of the same contracts from the same two days. March 19 was the infamous FOMC press conference where Yellen attempted to define "considerable time" used in the FOMC statement by saying it "probably means something on the order of around six months."



One common interpretation of curvature in this current market environment² is as an *indicator* of FOMC liftoff and landing probabilities³ around various contracts. The points of negative curvature (where the curve is convex) at the front of the curve is a function of when the markets expect the FOMC to start hiking. It should be no surprise that the negative curvature got lower around EDH5, as many people expected the FOMC liftoff to occur in the second quarter of 2015. The negative curvature after EDU5 was reduced, as hikes were moved forward. Similarly, the points of positive curvature (where the curve is concave) is a function of when the markets expect the FOMC to stop hiking.⁴ After Yellen’s press conference,

² The interpretation of curvature can vary based on the environment. Currently, we are in an environment where the next rate moves are most likely a series of hikes. The degree of negative curvature is related to liftoff probabilities and the degree of positive curvature is related to landing probabilities at various points on the curve. If we were in an environment where the next move could be either a hike or an ease, negative curvature could result from eases being priced in the near term, or hikes being priced in further out the curve.

³ Note that these are not actual probabilities.

⁴ Positive curvature (especially in the whites or reds) can also be a function of the certainty of near-term hikes vs the uncertainty of later hikes. Positive curvature could also result if there is a chance the first move could be larger than the others (i.e. a 50bp move instead of a 25bp move). Market supply and demand could also affect curvature. There are many factors affecting curvature. This is why I have stressed words like “indicator,” “function of,” “related to” and have emphasized that curvature measures are not probabilities.

curvature between M6 and M7 increased dramatically and curvature between M8 and H9 decreased, as people expected the hiking cycle to end sooner rather than later.

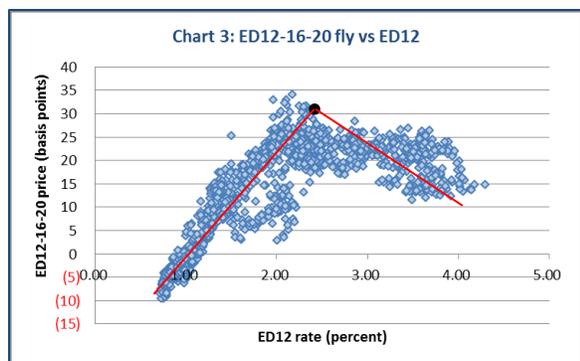
Looking at curvature provides more granularity and provides more insight into what is priced in the curve. In addition, you have more trade alternatives with curvature. For example, there are three main ways to represent a bearish view using butterflies: (1) increased negative curvature at the front of the curve, (2) increased positive curvature at the middle of the curve, or (3) decreased positive curvature at the back of the curve. You can also trade combinations of the above, by buying (or selling) one butterfly and selling (or buying) another butterfly on a different part of the curve.

Before implementing a trade view, it is prudent to consider *all* the alternatives for direction, slope and curvature, in both futures and options, to choose the optimal structure that provides the best reward to risk profile. I generally favor curvature trades to express my directional views because butterflies have an important property: NONLINEARITY – the change in the price of a butterfly is nonlinear with the change in rates.

EXAMPLE OF NONLINEARITY

Chart 3 shows the 5 year scatter plot⁵ of an equal-weighted ED12-16-20 butterfly (sell ED12, buy 2x ED16, and sell ED20) from earlier this year. As you can see, the relationship between the yield and the price of the structure is not linear.

⁵ Each point on the scatter plot represents a day’s close. The y-axis has the butterfly price and the x-axis has the rate implied by ED12. I have plotted 5 years’ worth of data. This plot will show the historical relationship of the structure to the change in rates. It will also show how far above or below the current point is to the historical points. The black dot is the sample day’s close. The past dots are adjusted to be “constant maturity” – that is, all previous dots are adjusted to be the same term to maturity as the current contracts.



This phenomenon is not a coincidence. From the zero bound, the next move in rates by the FOMC should be a series of hikes. The markets will price in a hiking cycle lasting anywhere from 1-3 years. When rates are extremely low (i.e. the FOMC not perceived to hike in the next four years), the ED12-16-20 butterfly may get negative, as the FOMC will be perceived to hike less in the ED12-16 period than the ED16-20 period. You can see this in Chart 3, around the points where the ED12 rate is 1% or lower. As rates increase, more hikes will be anticipated in the ED12-16 period than the ED16-20 period, and the butterfly will gradually increase. You can see this around the points where the ED12 rate is between 1% and 2.25%. At some point, rates will be so high that less of the hiking cycle will be captured in the ED12-16 spread, and the butterfly will start going back towards zero. You can see this as the rate starts increasing from 2.25%. You would expect this nonlinearity to be true conceptually, and you can see from the graph that it holds empirically.

Any time you have a structure whose price is nonlinear with the movement in rates, you have an opportunity to improve your returns. Just as bond traders used to benefit from the convexity of a bond, you can benefit from the nonlinearity of butterflies. From the black dot on Chart 3 (a settlement from the beginning of the year), selling the ED12-16-20 butterfly should perform well on a rally, and perform reasonably on the selloff as well.

THE FINE PRINT

Unlike options, there is no *direct cost* involved to benefit from nonlinearity. The *indirect cost* of this benefit is P&L “noise.” When you take an outright long position, you know exactly what your P&L is. When you buy a call structure, you have a pretty good idea what your P&L is for a given change in rates. While the correlation with direction on curvature trades can be over 90%⁶, that still leaves room for P&L noise.

But don’t think that noise is all bad. Noise can be good! More often than not, the noise will be in your favor, because we will generally choose entry points where the structure is extended to the limits of its historical and fundamental norms. Consider the previous example. The trade may still be considered “good” if the ED 12-16-20 butterfly was 10bps lower - you generally will break-even on a selloff and gain on a rally. But I would be very reluctant to put out a recommendation for such a trade, unless the circumstances were right. There is just too much potential for negative P&L noise.

Favorable noise allows you to size the trade smaller than the historical beta would indicate, which leads to lower risk relative to the reward. Most importantly, favorable noise allows you to gain when rates do not move or when rates move the wrong way. The reward to risk profile on some curvature trades can be extremely attractive, so consider adding a percentage as a *complement* to your book. Just as diversification for a portfolio makes a lot of sense, diversification of your (directional) view makes sense as well.

Curvature trades can be excellent contributors to your portfolio if you know what to look for. Historicals may be good at flagging curvature trades, but you need to understand when historicals can be wrong or misleading. As they say in finance, “past performance is not an indicator of future success.” Just because the historicals point in a certain direction does not

⁶ It is not uncommon for “directional” butterfly trades to have a sub-50% correlation to rates.

mean we couldn't get other outlier outcomes. A six sigma event may only be a one sigma event when all the correct factors are taken into account.

You need to consider a number of factors including: the current fundamentals, the current curve shape, the relevant comparison period, the direction and magnitude of the error skew, and the carry considerations. But once considered, curvature trading can be a powerful tool in your arsenal. We will discuss some of these factors in the following example.

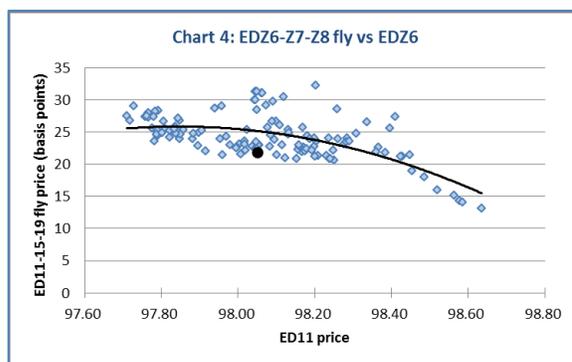
CURVE ADVISOR EXAMPLE

Here is a basic butterfly trade Curve Advisor clients did earlier this year: Prior to the market open on May 27, we saw a huge short squeeze where the market rallied 44.5bps in 5 weeks. As an aside, I alluded to a short squeeze on 4/28 and again on 5/8. My trade recommendation at the time was to buy the EDZ6-Z7-Z8 1 year butterfly @ 22 as a longer term bearish position (reference EDZ7=97.285). The structure had a 15% beta and an 89% correlation (three month) with the direction of rates.

There were several reasons I liked taking a bearish position from those levels. The biggest reason was the extreme spread between the markets and the FOMC projected Fed Funds rates. The spread between the FOMC projections and the comparable rates implied by Eurodollars had gotten to 70bps, which was the widest in 17 months. The trade had positive carry, which is unusual for a bearish trade.

There were two other reasons to like bearish positioning around EDZ7 in particular. This fit with my longer term view that when the 2017 FOMC projections come out in the fall, they would show a much higher rate than was priced into the markets. The second reason was that the large bulls in the market had started developing a massive open interest position in the red pack contracts. The blue pack appeared to be a safer choice for the bears to target, with a patient FOMC and improving data.

Chart 4 shows that the 6 month historical scatter plot was not particularly attractive at the time. The key thing to note was that most of the points below 20 on the right side of the chart were from November 2013, when the unemployment rate was still 7.2% – almost 100bps higher than the current level. Those dots did not appear to be relevant comparables and the structure had otherwise held up well when ED11 was higher. Having a bearish trade with 30bps of “historical protection” seemed like good risk/reward. If we started rallying too much, we could get out with a reasonable probability of scratching the trade. I strongly felt that buying the butterfly was a superior bearish trade to going short EDZ7 outright.



Within three days, EDZ7 rallied 13 more basis points to a 97.415 intraday high. If you had taken an outright short position, you would have taken that mark-to-market loss. You may have even stopped out. Had you bought the Z6-Z7-Z8 year fly, you would have... MADE 1bp on the further rally! Five days later, on June 5, clients took profit at 27 when EDZ7 closed at 97.16.

Our bearish curvature trade held up well on the rally and outperformed on the selloff, relative to the beta. On the 12.5bp net selloff from inception to unwind, you would have expected less than a 2bp gain based just based on the beta. We made 5bps. It was the second time this year we profited on this trade.

SUMMARY

Looking at curvature can give you a better picture of what is going on with the Eurodollar strip. More importantly, the nonlinearity of butterfly structures allows you to take better risk/reward positions – gaining more when you are right and/or losing less when you are wrong. And sometimes, the imbedded alpha “noise” in a butterfly trade can result in a gain even when you are wrong. If you are not trading curvature, 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, curvature trading basics, the top curvature trading misconceptions, and more. For additional information, contact Joseph Choi at jchoi@curveadvisor.com

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