CME Group

INTEREST RATES

Understanding Eurodollar Futures

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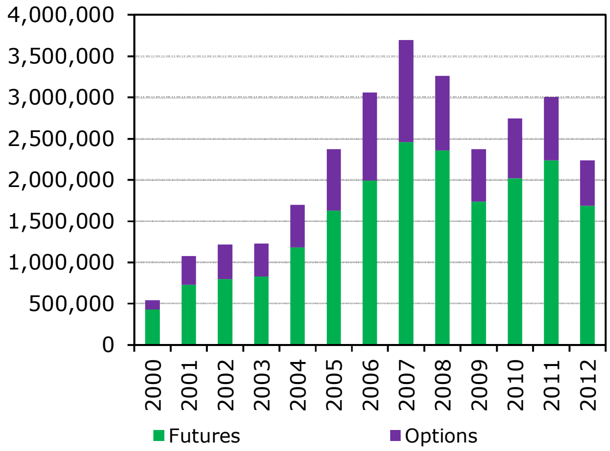
CME Eurodollar futures have achieved remarkable success since their debut in December 1981. Much of this growth may directly be attributed to the fact that Eurodollar futures represent fundamental building blocks of the interest rate marketplace. Indeed, they may be deployed in any number of ways to achieve diverse objectives.

This article is intended to provide an understanding regarding how and why Eurodollar futures may be used to achieve these diverse ends. We commence with some background on the fundamental nature of Eurodollar futures including a discussion of pricing and arbitrage relationships. We move on to an explanation of how Eurodollar futures may be used to take advantage of expectations regarding the changing shape of the yield curve or dynamic credit considerations.

Eurodollar Average Daily Volume



Finally, we discuss the symbiotic relationship between Eurodollar futures and over-the-counter (OTC) interest rate swaps (IRS). In particular, Eurodollar futures are often used to price and to hedge interest rate swaps with good effect.

Pricing and Quotation

Eurodollar futures are based on a $1 million face-value, 3-month maturity Eurodollar Time Deposit. They are settled in cash on the 2nd London bank business day prior to the 3rd Wednesday of the contract month by reference to the ICE Benchmark Administration Limited (ICE) Interest Settlement Rate for three-month Eurodollar Interbank Time Deposits.

These contracts mature during the months of March, June, September, or December, extending outward 10 years into the future. However, the exchange also offers "serial" contract months in the four nearby months that do not fall into the March quarterly cycle. See Table 1 below for contract specifications.

Where once trading was largely conducted on the floor of the exchange using traditional open outcry methods during regular daylight hours – today, trading activity is largely conducted on the CME Globex® electronic trading platform on nearly an around the clock basis.

These contracts are quoted in terms of the "IMM index."[1] The IMM index is equal to 100 less the yield on the security.

$$IMM\ Index = 100.000 - Yield$$

E.g., if the yield equals 0.750%, the IMM index is quoted as 99.250.

$$IMM\ Index = 100.000 - 0.750\% = 99.250$$

If the value of the futures contract should fluctuate by one basis point (0.01%), this equates to a $25.00 movement in the contract value. This may be confirmed by calculated the basis point value (BPV) of a $1 million face value, 90-day money market instrument into the following formula.

$$Basis\ Point\ Value = Face\ Value\ x \left(\frac{days}{360}\right)\ x\ 0.01\%$$
$$= \$1{,}000{,}000\ x \left(\frac{90}{360}\right)\ x\ 0.01\% = \$25.00$$

The minimum allowable price fluctuation, or "tick" size, is generally established at one-half of one basis point, or 0.005%. Based on a $1 million face-value 90-day instrument, this equates to $12.50. However, in the nearby expiring contract month, the minimum price fluctuation is set at one-quarter basis point, or 0.0025%, equating to $6.25 per contract.

[1] The IMM, or International Monetary Market, was established as a division of the CME many years ago. The distinction is seldom made today because CME operates as a unified entity, but references to IMM persist today.

As seen in Table 2 below, March 2014 Eurodollar futures advanced by 1.5 basis points on January 30, 2013 to settle the day at a price of 99.49. Noting that each basis point is worth $25 per contract based on a $1 million 90-day instrument, this implies an increase in value of $37.50 for the day.

Shape of Yield Curve

Pricing patterns in the Eurodollar futures market are very much a reflection or mirror of conditions prevailing in the money markets and moving outward on the yield curve. But before we explain how Eurodollar futures pricing patterns are kept in lockstep with the yield curve, let us consider that the shape of the yield curve may be interpreted as an indicator of the direction in which the market as a whole believes interest rates may fluctuate.

Three fundamental theories are referenced to explain the shape of the yield curve – (1) the expectations hypothesis; (2) the liquidity hypothesis; and, (3) the segmentation hypothesis.

Let's start with the assumption that the yield curve is flat. *I.e.,* short-term and longer-term interest rates are equivalent and investors are expressing no particular preference for securities on the basis of maturity. The expectations hypothesis modifies this assumption with the supposition that rational investors may be expected to alter the composition of their fixed-income portfolios to reflect their beliefs with respect to the future direction of interest rates.

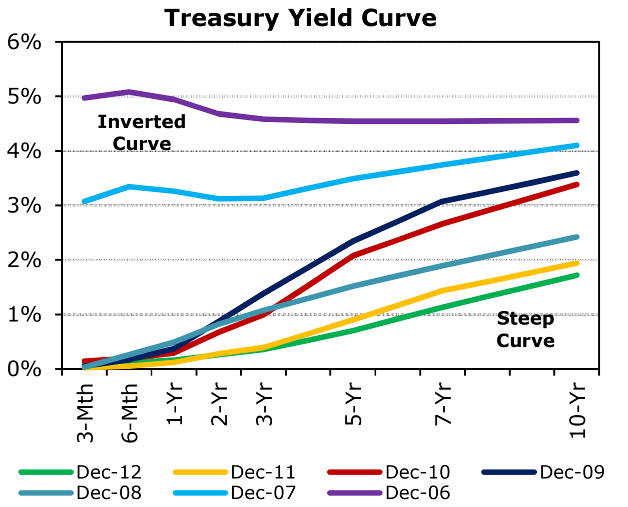
Thus, investors move from long-term into short-term securities in anticipation of rising rates and falling fixed-income security prices, noting that the value of long-term instruments reacts more sharply to shifting rates than short-term instruments or by moving from short-term into long-term securities in anticipation of falling rates and rising fixed-income prices.

Yields expected to rise	➔	**Yield curve is steep**
Yields expected to fall	➔	**Yield curve is flat or inverted**

In the process of shortening the maturity of one's portfolio, investors bid up the price of short-term securities and drive down the price of long-term securities. As a result, short-term yields decline and long-term yields rise - the yield curve steepens. In the process of extending maturities, the opposite occurs and the yield curve flattens or inverts. [2]

The liquidity hypothesis modifies our initial assumption that investors may generally be indifferent between short- and long-term investments in a stable rate environment. Rather, we must assume that investors generally prefer short- over long-term securities to the extent that short-term securities roll over frequently, offering a measure of liquidity by virtue of the fact that one's principal is redeemed at a relatively short-term maturity date.

As such, long-term securities must pay a liquidity premium to attract investment, and long-term yields typically exceed short-term yields, a natural upward bias to the shape of the curve.



Finally, the segmentation hypothesis suggests that investors may be less than fully capable of modifying the composition of their portfolios quickly and efficiently in order to take advantage of anticipated yield fluctuations. In particular, investors sometimes face internally or externally imposed constraints: the investment policies of a pension

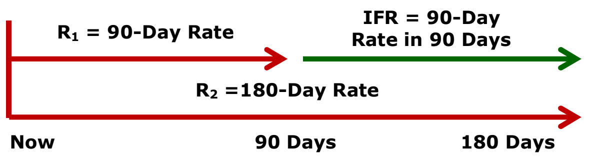
[2] Although these observations are generally true, they may not be absolutely true. *E.g.,* the Fed had been pushing short-term rates higher in early 2005 while longer-term rates remained relatively stable. As such, the yield curve was in the process of flattening while many analysts still expected the Fed to continue tightening.

fund or regulatory requirements. Thus, otherwise unexplained irregularities or "kinks" are sometimes observed in the yield curve.

Implied Forward Rates

Much useful information regarding market expectations of future rate levels is embedded in the shape of the yield curve. But how might one unlock that information? The answer is found in the *implied forward rate,* or IFR. An IFR might be used to identify what the market believes that short-term rates will be in the future (e.g., what will 180-day investments yield 90 days from now?).

Implied Forward Rate (IFR)



Timeline

The anticipated 90-day rate 90 days from now, or $IFR_{90,90}$ may be found as a function of the 90-day term rate R_{90} and the 180-day term rate R_{180}. Let's denote the length of each period as d_1=90 days; d_2=180 days, and d_3=90 days. A baseline assumption is that investors may be indifferent between investing for a 9-month term or investing at a 3-month term and rolling the proceeds over into a 6-month investment 90 days from now. As such, the IFR may be calculated as follows.

$$IFR = \frac{[1 + R_2\ (d_2/360)]}{(d_3/360)[1 + R_1(d_1/360)]} - \frac{1}{(d_3/360)}$$

E.g., assume that the yield curve is exhibiting normal "steepness" such that the 90-day rate equals R_{90} = 0.70% and the 180-day rate equals R_{180} = 0.80%. What is the IFR for a 90-day investment 90 days from now?

$$IFR = \frac{[1 + 0.0080\ (180/360)]}{(90/360)[1 + 0.0070\ (90/360)]} - \frac{1}{(90/360)}$$
$$= 0.898\%$$

E.g., the yield curve is inverted such that the 90-day rate equals R_{90} = 0.90% and the 180-day rate equals R_{180} = 0.80%. What is the IFR for a 90-day investment 90 days from now?

$$IFR = \frac{[1 + 0.0080\ (180/360)]}{(90/360)[1 + 0.0090\ (90/360)]} - \frac{1}{(90/360)}$$
$$= 0.698\%$$

E.g., the yield curve is flat such that the 90-day rate equals R_{90} = 0.80% and the 180-day rate equals R_{180} = 0.80%. What is the IFR for a 90-day investment 90 days from now?

$$IFR = \frac{[1 + 0.0080\ (180/360)]}{(90/360)[1 + 0.0080\ (90/360)]} - \frac{1}{(90/360)}$$
$$= 0.798\%$$

A steep yield curve suggests a general market expectation of rising rates. An inverted yield curve suggests a general market expectation of falling rates.

Calculating Implied Forward Rates

Shape of Curve	90-Day Rate	180-Day Rate	IFR
Steep	0.700%	0.800%	0.898%
Inverted	0.900%	0.800%	0.698%
Flat	0.800%	0.800%	0.798%

Finally, a flat yield curve suggests that the market expects slight declines in rates. This result may be understood by citing the compounding effect implicit in a rollover from a 90-day into a subsequent 90-day investment. Because the investor recovers the original investment plus interest after the first 90 days, there is more principal to reinvest over the subsequent 90-day period. Thus, one can afford to invest over the subsequent 90-day period at a rate slightly lower than 0.800% and still realize a total return of 0.800% over the entire 180-day term.

This result is also consistent with the liquidity hypothesis that posits a preference for short- over long-term loans in the absence of expectations of rising or falling rates. It is the slightly inclined yield curve that reflects an expectation of stable rates in the future.

Mirror of Yield Curve

The point to our discussion about IFRs is that

Eurodollar futures should price at levels that reflect these IFRs. *I.e.,* Eurodollar futures prices directly reflect, and are a mirror of, the yield curve. This is intuitive if one considers that a Eurodollar futures contract represents a 3-month investment entered into *N* days in the future. Certainly if Eurodollar futures did not reflect IFRs, an arbitrage opportunity would present itself.

E.g., consider the following interest rate structure in the Eurodollar (Euro) futures and cash markets. Assume that it is now December. Which is the better investment for the next six months - (1) invest for 6 months at 0.80%; (2) invest for 3 months at 0.70% and buy March Euro futures at 98.10 (0.90%); or (3) invest for 9 months at 0.90% and sell June Euro futures at 98.96 (1.04%)? Assume that these investments have terms of 90-days (0.25 years); 180-days (0.50 years); or, 270-days (0.75 years).

March Euro Futures	98.10 (0.90%)
June Euro Futures	98.96 (1.04%)
3-Mth Investment	0.70%
6-Mth Investment	0.80%
9-Mth Investment	0.90%

The return on the 1st investment option is simply the spot 6-month rate of 0.800%. The 2nd investment option implies that you invest at 0.700% for the 1st 3 months and lock in a rate of 0.900% by buying March Eurodollar futures covering the subsequent 3-month period. This implies a return of 0.800% over the entire 6-month period.

$$1 + \left(R\ x\ \frac{180}{360}\right) = \left[1 + \left(0.0070\ x\ \frac{90}{360}\right)\right]\left[1 + \left(0.0090\ x\ \frac{90}{360}\right)\right]$$

$$R = \frac{\left[1 + 0.0070\ x\ \frac{90}{360}\right]\left[1 + 0.0090\ x\ \frac{90}{360}\right] - 1}{180/360} = 0.800\%$$

The 3rd alternative means that you invest for the next 270 days at 0.90% and sell June Eurodollar futures at 1.04%, effectively committing to sell the spot investment 180 days hence when it has 90 days until maturity. This implies a return of 0.83% over the next 6-months.

$$\left[1 + R\ x\ \frac{180}{360}\right]\left[1 + 0.0104\ x\ \frac{90}{360}\right] = \left[1 + 0.0090\ x\ \frac{270}{360}\right]$$

$$R = \frac{\left[1 + 0.0090\ x\ \frac{270}{360}\right] / \left[1 + 0.0104\ x\ \frac{90}{360}\right] - 1}{180/360} = 0.83\%$$

The 3rd alternative provides a slightly greater return of 0.83% than does the 1st or 2nd investment options with returns at 0.80%.

Eurodollar futures prices are a reflection of IFRs because of the possibility that market participants may pursue arbitrage opportunities when prices become misaligned. Thus, one might be recommended to execute an arbitrage transaction by investing in the 3rd option at 0.83% and funding that investment by borrowing outright at the term 6-month rate of 0.80%. This implies a 3 basis point arbitrage profit.

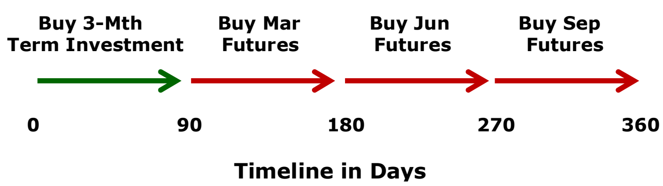
Presumably, arbitrageurs will continue to pursue this strategy until all the profitability has been "arbed" out of the situation. In other words, the net result of such transactions is that these related cash and futures markets achieve a state of equilibrium pricing where arbitrage opportunities do not exist and the market is reflective of "fair values."

Strips as Synthetic Investments

A Eurodollar futures strip may be bought or sold by buying or selling a series of futures maturing in successively deferred months, often in combination with a cash investment in the near term. The initial cash investment is often referred to as the "front tail," or "stub," of the strip transaction.

Referring to the 2nd investment alternative evaluated earlier, we created a 6-month strip of rolling investments by investing at the spot or cash rate for the first 3-months while buying a March Eurodollar futures, effectively locking in a rate of return for the subsequent 3-month period.

1-Year Eurodollar Futures Strip



Similarly we could have created a 9-month strip by adding on a long June futures contract; or a 12-month strip by adding on a subsequent September futures contract.

The value of a strip may be calculated as the compounded rate of return on the components of the strip as follows.

$$Strip = \left(\prod_{i=1}^{n} \left[1 + R_i \cdot \left(\frac{days_i}{360} \right) \right] - 1 \right) \div \left(\frac{term}{360} \right)$$

Where R_i = rate associated with each successive period; $days_i$ = number of days in each successive period; and, term = number of days associated with the cumulative period over which the strip extends.

E.g., assume it is December and an asset manager wants to create a 1-year investment in the form of a strip. This may be accomplished by investing in a 3-month term instrument currently and buying March, June and September Eurodollar futures. The purchase of this series or strip of Eurodollar futures effectively "locks-in" an investment value over each subsequent 3-month period. The compounded yield associated with this hypothetical strip transaction, as shown in Table 3 below, equals 0.376%.

Investors often compare the value of "synthetic" investments created with Eurodollar futures strips to yields associated with comparable term investments in search of enhanced returns or "alpha." Frequently these strips are spread vs. comparable term investments to capitalize on perceived mis-pricings.

One may compare the yield on a strip vs. the yield on comparable term Treasury securities. This is known as a "TED" or Treasury vs. Eurodollar spread. Eurodollars represent private credit risks while Treasuries reflect public credit risk or the "risk-free" rate.

Compare strip yield to yields of comparable term securities ➔ **Buy "cheap" and sell "rich" instruments**

We normally expect strips to generate higher returns than comparable maturity Treasuries. But when the relationship between these securities departs from normally expected patterns, one may buy the instrument considered "cheap" and sell the instrument that is "rich" as a form of arbitrage transaction.

Packs and Bundles

Because strips have proven to be popular trading instruments and because of the complexities associated with their purchase or sale, the exchange has developed the concept of "packs" and "bundles" to facilitate strip trading. A pack or bundle may be thought of as the purchase or sale of a series of Eurodollar futures representing a particular segment of the yield curve.

Packs and bundles should be thought of as building blocks used to create or liquidate positions along various segments of interest along the yield curve. Packs and bundles may be bought or sold in a single transaction, eliminating the possibility that a multitude of orders in each individual contract goes unfilled.

Note that the popularity of these concepts is reflected in Eurodollar volume and open interest patterns. Unlike most futures contracts, where virtually all volume and open interest is concentrated in the nearby or lead month, Eurodollar futures have significant volume and open interest in the deferred months going out 10 years along the yield curve.

The exchange offers trading in 1-, 2-, 3-, 4-, 5-, 6-, 7-, 8-, 9-, and 10-year bundles. These products may be thought of as Eurodollar futures strips, absent the front tail or stub investment, extending out 1, 2, 3, … , 10 years into the future.

Eurodollar futures are sometimes color coded such that the 1st 4 quarterlies are referred to as "whites," the 2nd 4 as "reds," the 3rd 4 as "greens," etc. Thus, one might place an order by reference to the color code of the pack or bundle.

E.g., one may buy a 1-year or "white" bundle by purchasing the 1st 4 quarterly expiration Eurodollar futures contracts. Or, one may sell a "green" 3-year bundle by selling the 1st 12 quarterly expiration Eurodollar futures contracts.

The price of a bundle is typically quoted by reference to the average change in the value of all Eurodollar futures contracts in the bundle since the prior day's settlement price. For example, if the 1st 4 quarterly Eurodollar contracts are up 2 basis points for the day and the 2nd 4 quarterly Eurodollar contracts are up 3 basis points for the day, then the 2-year bundle may be quoted as + or up 2.5 basis points.

After a trade is concluded at a negotiated price, prices are assigned to each of the various legs or Eurodollar futures associated with the bundle. These prices must be within the daily range for at least one of the component contracts of the bundle. This assignment is generally administered through an automated system operated by the exchange.

Packs are similar to bundles in that they represent an aggregation of a number of Eurodollar futures contracts traded simultaneously. But they are constructed to represent a series of 4 consecutive quarterly Eurodollar futures.

E.g., one may buy a "white" pack by buying the 4 front contracts. Or, one may sell a "red" pack in the 2nd year by selling the 5th through 8th quarterly cycle month contracts. Packs are quoted and prices are assigned to the individual legs in the same manner that one quotes and assigns prices to the legs of a bundle.

Trading the Yield Curve

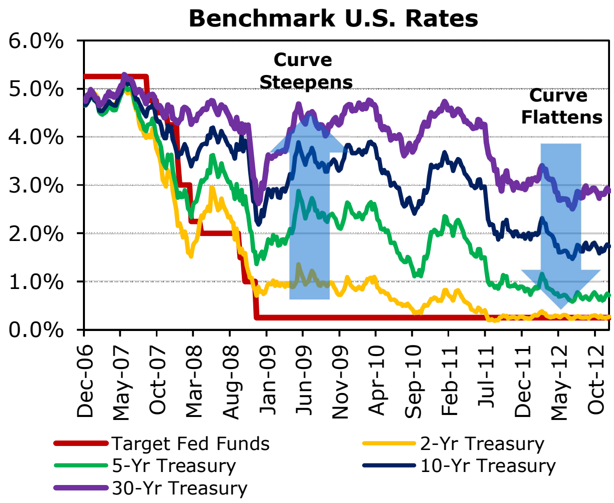
Because Eurodollar futures are a mirror of the yield curve, one may spread these contracts to take a position on the relative changes associated with long- and short-term yields, *i.e.,* to speculate on the shape of the yield curve.

If the yield curve is expected to steepen, the recommended strategy is to "buy the curve" or "buy a Eurodollar calendar spread" by purchasing near-term and selling longer-term or deferred Eurodollar futures. If the opposite is expected to occur, that is, if the yield curve is expected to flatten or invert, then the recommended strategy is to "sell the curve" or "sell a Eurodollar calendar spread" by selling near-term and buying deferred Eurodollar futures.

Expectation		Action
Yield curve expected to steepen	➔	**"Buy the curve," *i.e.,* buy nearby and sell deferred futures**
Yield curve expected to flatten or invert	➔	**"Sell the curve," *i.e,* sell nearby and buy deferred futures**

Let's examine how the shape of the yield curve has been fluctuating over the past few years. The key driving factor in the U.S. economy has been the subprime mortgage crisis, which reached a crescendo in 2008, and the subsequent protracted recovery.

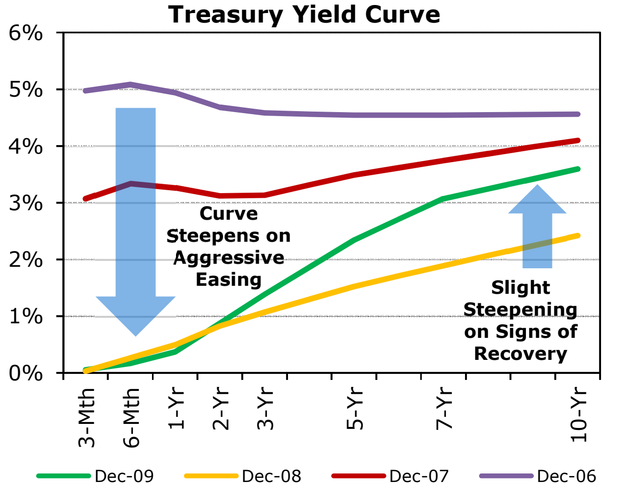
The Fed's initial reaction to the crisis was simply to inject the economy with tremendous liquidity. Thus, the Fed reduced the target Fed Funds rate, its primary monetary policy tool over the past few decades, from 5.25% in September 2007 to 0-25 basis points by December 2008. Interest rates along the entire course of the yield curve from overnight to 30-year rates followed suit accordingly. Still, the yield curve steepened on aggressive Fed easing at the short-end of the yield curve.



GDP declined significantly for six consecutive quarters from the Q1 2008 through Q2 2009 with a trough of -8.9% on an annualized basis observed in Q4 2008. Unemployment soared from only 4.4% in October 2006 to 10.0% by October 2009.

But by the Q4 2009, GDP had bounced back to +3.8% with unemployment rates starting to reverse downward. Short-term rates, anchored by Fed monetary policy, were maintained at very low rates. But long-term rates, driven by expectations of growth and inflation, started to advance on these signs of recovery. Thus, we saw some slight curve steepening during the course of 2009 on this economic optimism.

Had one anticipated these events, one might have capitalized by "buying the yield curve" using Eurodollar futures calendar spread.



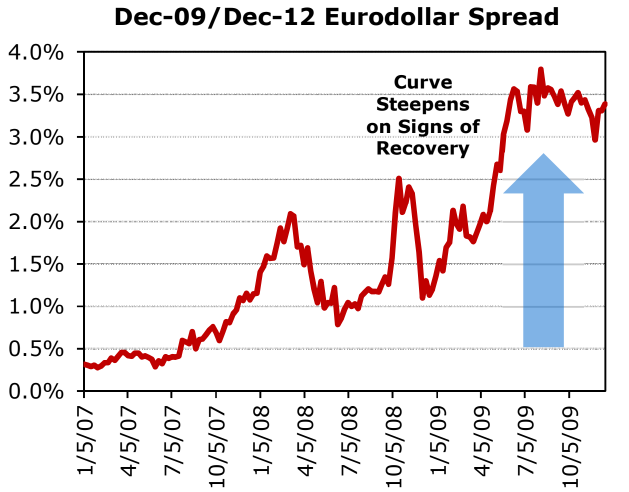
E.g., on March 13, 2009, one may have bought the curve by buying December 2009 and selling December 2012 Eurodollar futures. The spread was quoted on March 13th at 1.820%. By June 5th, the spread may have been liquidated at 3.445% for a profit of 161.5 basis points, or $4,037.50 per spread executed.

Buying the Yield Curve

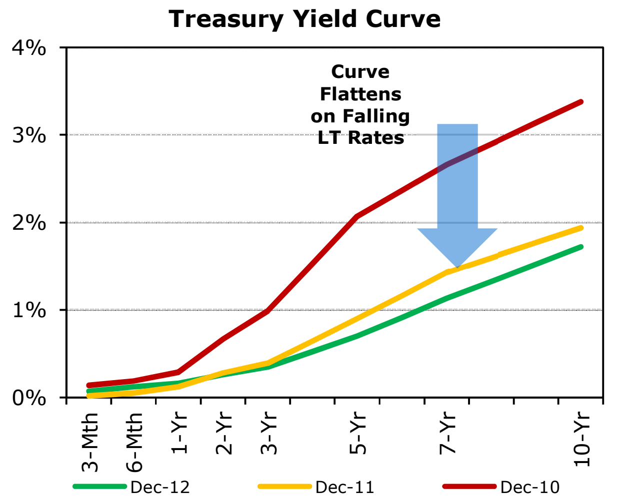
	Dec-09 ED Futures	Dec-12 ED Futures	Spread
3/13/09	Buy @ 98.415	Sell @ 96.595	1.820%
6/5/09	Sell @ 98.635	Buy @ 95.200	3.445%
	+0.220 or +550.00	+1.395 or +3,487.50	+1.615% or +$4,037.50

Interestingly, the yield curve steepened in our example while shorter-term rates represented in December 2009 Eurodollar futures declined a bit. This may be explained by frequent indications from the Fed that it intended to hold target Fed Funds at 0-25% for an extended period. Still, longer-term rates represented in December 2012 futures advanced on some economic momentum. This is unusual to the extent that a profit may have been realized on both legs of the spread.

But the economy could not sustain the rebound from late 2009. Rather, we saw GDP advance but at a rather decelerating rate throughout 2010 and throughout much of 2011. Unemployment continued to trend downward throughout this period but at an unacceptably slow rate. The Fed, having pushed the target Fed Funds rate to near zero and seemingly having expended its major monetary bullet, began to adopt new and inventive measures to promote growth.



Commencing in December 2008, the Fed introduced its "quantitative easing" (QE) program by purchasing some $1.7 trillion worth of U.S. Treasury, Agency, and mortgage backed securities (MBS). This 1st round was followed by a 2nd round of quantitative easing (QE2) in November 2010 as the Fed announced its intent to repurchase some $600 billion worth of Treasury securities over the forthcoming 8 months.



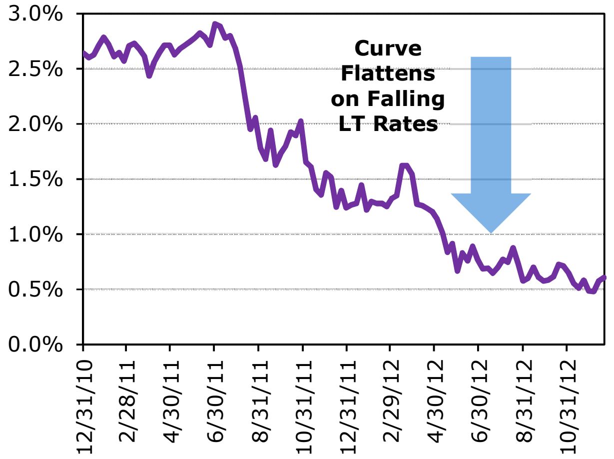
These ongoing programs to retire debt did indeed accomplish the Fed's objective of reducing interest rates on the longer-end of the yield curve and flattening the yield curve in the process. Had one anticipated these events, one might have capitalized by "selling the yield curve" using Eurodollar futures calendar spreads.

Selling the Yield Curve

	Dec-12 ED Futures	Dec-15 ED Futures	Spread
8/5/11	Sell @ 99.335	Buy @ 96.815	2.520%
11/18/11	Buy @ 99.190	Sell @ 97.785	1.405%
	+0.145 or +$362.50	+0.970 or +2,425.00	+111.5 or +$2,787.50

E.g., one might have sold the curve by selling December 2012 and buying December 2015 Eurodollar futures. The spread was quoted on August 5, 2001 at 2.520%. But by November 18th, the spread had declined 111.5 basis points to 1.405%. Liquidating the spread at that level would have resulted in a profit of $2,787.50 for each spread transacted.

Dec-12/Dec-15 Eurodollar Spread



This spread was unusual to the extent that both legs of the spread were associated with a profit. Clearly, the spread was generally driven by aggressive Fed action on the long-end of the yield curve to reduce rates. Still, short-term rates, represented by the December 2012 futures, advanced just a bit while longer-term rates represented by December 2015 futures declined rather sharply.

Eurodollars as a Risk Management Tool

In addition to providing arbitrage and speculative opportunities, Eurodollar futures are frequently deployed by institutions and corporations to address interest rate risks. Noting that rates are currently at very low levels, there remains little room for rates to decline further. But the prospect of economic recovery in coming months and years raised the specter of possible rate advances.

As such, financial institutions have started to hedge against the possibility that rising rates may adversely impact the liabilities on their books. Meanwhile, asset managers continue to search for investment opportunity in the fixed income and money markets.

CME Eurodollar futures represent an essential element of risk management programs on the part of borrowers such as corporations; and, investors including asset managers. Let's consider some common applications of Eurodollar futures and options for purposes of pricing and hedging floating rate loans, money market assets and over-the-counter (OTC) interest rate swap (IRS) transactions.

Measuring Risk

There is an old saying – "you can't manage what you can't measure." In the fixed income security markets, one generally measures interest rate risk exposure by reference to either duration or basis point value.

Duration is a concept that was originated by the British actuary Frederick Macauley. Mathematically, it is a reference to the weighted average present value of all the cash flows associated with a fixed income security, including coupon income as well as the receipt of the principal or face value upon maturity. Duration reflects the expected percentage change in value given a 1% or 100 basis point change in yield.

E.g., a 5-year note may have a duration that is close to 4 years, suggesting that it is expected to decline 4% in value given a 1% advance in yields. As such, duration represents a useful and popular measure of risk for medium to long-term coupon bearing securities.

But *basis point value* (BPV) is the preferred reference in the context of short-term, non-coupon bearing instruments, *i.e.,* money market instruments such as Eurodollars, Treasury bills, Certificates of Deposit (CDs), etc.

On-the-Run Treasuries
(December 12, 2012)

Tenor	Coupon	Maturity	Duration (Years)	BPV (per mil)
2-year	1/8%	12/31/14	1.996	$199
3-year	¼%	12/15/15	2.942	$293
5-year	¾%	12/31/17	4.899	$491
7-year	1-1/8%	12/31/19	6.711	$669
10-year	1-5/8%	11/15/22	9.058	$897
30-year	2-¾%	11/15/42	19.978	$1,926

BPV is a concept that is closely related to duration. It measures the expected monetary change in the price of a security given a 1 basis point (0.01%) change in yield. It may be measured in dollars and cents based upon a particular face value security, commonly $1 million face value. It is also referred to as the "dollar value of an 01" or simply "DV of an 01."

Basis point values may be calculated as a function of the face value and the number of days until maturity associated with a money market instrument per the following formula.

$$BPV = Face\ Value\ x\ \left(\frac{Days}{360}\right)\ x\ 0.01\%$$

E.g., a $10 million 180-day money market instrument carries a BPV= $500.

$$BPV = \$10{,}000{,}000\ x\ \left(\frac{180}{360}\right)\ x\ 0.01\% = \$500$$

E.g., a $100 million 60-day money market instrument has a BPV= $1,666.67.

$$BPV = \$100{,}000{,}000\ x\ \left(\frac{60}{360}\right)\ x\ 0.01\% = \$1{,}666.67$$

E.g., a $1 million face value, 90-day money market instrument may be calculated as $25.00.

$$BPV = \$1{,}000{,}000\ x\ \left(\frac{90}{360}\right)\ x\ 0.01\% = \$25$$

Note that Eurodollar futures contracts are based upon a $1 million face value 90-day instrument and that a one basis point (1 bp) change in yield is associated with a $25.00 fluctuation in the value of a single contract.

Basis point values may similarly be calculated for money market instruments of other terms and face values as shown in the table below.

Basis Point Value (BPV) of Money Market Instruments

Days	$500K	$1MM	$10MM	$100M
1	$0.14	$0.28	$2.78	$27.78
7	$0.97	$1.94	$19.44	$194.44
30	$4.17	$8.33	$83.33	$833.33
60	$8.33	$16.67	$166.67	$1,666.67
90	$12.50	**$25.00**	$250.00	$2,500.00
180	$25.00	$50.00	$500.00	$5,000.00
270	$37.50	$75.00	$750.00	$7,500.00
360	$50.00	$100.00	$1,000.00	$10,000.00

Hedging Short-Term Rate Exposure

The essence of any hedging or risk management program is to match up any change in risk exposures to be hedged ($\Delta Value_{risk}$) with an offsetting change in the value of a futures contract ($\Delta Value_{futures}$) or other derivative instrument.

$$\Delta Value_{risk} \sim \Delta Value_{futures}$$

The appropriate "hedge ratio" (HR) may be calculated as the expected change in the value of the risk exposure relative to the expected change in the value of the futures contract that is utilized to hedge such risk.

$$HR = \Delta Value_{risk} \div \Delta Value_{futures}$$

Change in value (denoted by the Greek letter delta or "Δ") is a rather abstract concept. But it may be measured by reference to the BPV as discussed above. Thus, we may "operationalize" the equation by substituting BPV for this abstract concept of change.

$$\Delta Value \sim BPV$$

Noting that the BPV of one Eurodollar futures contract is unchanging at $25.00, we may identify a generalized Eurodollar futures hedge ratio as follows.

$$HR = BPV_{risk} \div BPV_{futures} = BPV_{risk} \div \$25.00$$

The London Interbank Offering Rate (LIBOR) is a frequent reference to which floating rate bank loans are tied.[3] A corporation may arrange a commercial bank loan at LIBOR rates plus some (fixed) premium that reflects the credit status of the corporation, *e.g.,* LIBOR+50 basis points (0.50%), LIBOR+125 basis points (1.25%). As such, the corporation faces the risk of rising rates. On the other hand, an investor or asset manager planning to purchase the loan, may be concerned about the prospect of declining rates.

E.g., a corporation anticipates it will require a $100 million loan for a 90-day period beginning in 6 months that will be based on 3-month LIBOR rates plus some fixed premium. The BPV of this loan may be calculated as $2,500.

$$BPV = \$100{,}000{,}000 \ x \left(\frac{90}{360}\right) x \ 0.01\% = \$2{,}500$$

The corporation is concerned that rates may rise before the loan is needed and that it will, therefore, be required to pay higher interest rates. This exposure may be hedged by selling 100 Eurodollar futures that mature six months from the current date.

$$HR = \$2{,}500 \div \$25 = 100$$

E.g., similarly, the asset manager planning to purchase the $100 million loan may be concerned that rates will decrease. Thus, the asset manager might buy 100 Eurodollar futures as a hedge.

Sell Eurodollar futures ➔ **Hedge risk of rising interest rates**

Buy Eurodollar futures ➔ **Hedge risk of declining interest rates**

In these illustrations, we assume that the loan is tied to 3-month LIBOR rates. However, commercial loans are often based on alternate rates including prime rate, commercial paper, etc. Those rates may not precisely parallel LIBOR movements, *i.e.,* there may be some "basis risk" between the instrument to be hedged and the Eurodollar futures contract that is employed to execute the hedge.

It is important to establish a high degree of correlation between LIBOR rates, as reflected in Eurodollar futures prices, and the specific rate exposure to be hedged. In particular, use of a BPV hedge ratio implies an expectation that yields on both instruments fluctuate in parallel, *i.e.,* by the same number of basis points. Such correlation is central to the effectiveness of the hedge and to niceties such as qualification for hedge accounting treatment per FASB Statement No. 133.[4]

Hedging Floating Rate Loans

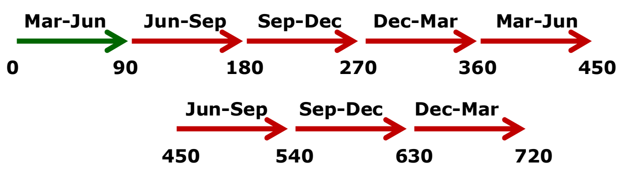
Many loans are structured such that the rate floats periodically as a function of LIBOR plus a fixed premium. This introduces a periodic risk that rates may fluctuate by the time of each periodic loan reset date. Eurodollar futures may be used to address this possibility to the extent that they are listed on a quarterly basis extending some ten (10) years out into the future.

E.g., assume that it is March and a corporation assumes a 2-year bank loan repayable in March 2 years hence for $100 million. The loan rate is reset every 3 months at LIBOR plus a fixed premium. As such, the loan may be "decomposed" into a series, or strip, of 8 successively deferred 3-month periods.

[3] The "benchmark" standard for LIBOR is found in the ICE Benchmark Administration Limited (ICE) 3-month Eurodollar Time Deposit Rate. This figure is calculated on a daily basis through a time-test survey process. It is accepted as the standard measure for short-term interest rates against which literally trillions of dollars of investments, loans and over-the-counter (OTC) derivatives including forward rate agreements (FRAs) and interest rate swaps (IRS) are pegged. This is the rate against which CME Group Eurodollar futures are cash settled.

[4] Statement of Financial Accounting Standards no. 133, "Accounting for Derivative Financial Instruments and Hedging Activities" (FAS 133) generally addresses accounting and reporting standards for derivative instruments in the United States. The Statement allows one to match or simultaneously recognize losses (gains) in a hedged investment with offsetting gains (losses) in a derivatives contract under certain conditions. But to apply such "hedge accounting treatment," it is necessary to demonstrate that the hedge is likely to be "highly effective" for addressing the specifically identified risk exposure. One method for making such demonstration is through statistical analysis. The "80/125" rule suggests that the actual gains and losses of the derivative(s) should fall within 80% to 125% of the gains/losses for the hedged item. This may be interpreted to require a correlation of 80% or better to qualify for hedge accounting treatment.

Structure of 2-Year Floating Rate Loan
(Assume it is March)



Timeline in Days

Note that if the loan is secured currently, the effective rate may be fixed at the current rate for the first 3 months. Thus, there is no risk over the first 3-month period between March and June. However, the corporation remains exposed to the risk that rates advance by each of the 7 subsequent loan rate reset dates.

If we assume that each 3-month period equates to 90 days, there are 630 days (=7 reset dates x 90 days) over which the loan rate is at risk. As such, the BPV of this loan equals $17,500.

$$BPV = \$100{,}000{,}000 \; x \left(\frac{630}{360}\right) x \; 0.01\% = \$17{,}500$$

This suggests that the corporation might sell 700 Eurodollar futures to address the risk of rising rates.

$$HR = \$17{,}500 \; \div \$25 = \; 700$$

But should the hedge be placed by selling 700 nearby or "white" June contracts; or, by selling 700 deferred or "red" December contracts? *I.e.,* should the hedge be "stacked" in the nearby month or in the deferred month? Consider the impact on the hedge if the shape of the yield curve were to change.

When the yield curve flattens or inverts, that implies that short-term yields rise relative to longer-term yields. If the corporation expected the curve to flatten or invert, stack the hedge in nearby white June futures that represent rates associated with the first of the decomposed 7 loan periods.

If yield curve expected to flatten or invert → **"Stack" short hedge in nearby futures**

If yield curve expected to steepen → **"Stack" short hedge in deferred futures**

When the yield curve steepens, this implies that short-term yields decline relative to longer-term yields (or, long-term yields rise more than short-term yields). If the corporation expected the curve to steepen, stack the hedge in deferred red December futures that represent rates associated with the last of the 7 loan periods.

But a more precise answer that minimizes yield curve "basis risk," is found by considering that the floating rate loan may be "decomposed" into seven successively deferred 90-day loans. The BPV associated with each of those 7 loans equals $2,500.

$$BPV = \$100{,}000{,}000 \; x \left(\frac{90}{360}\right) x \; 0.01\% = \$2{,}500$$

This suggests that, rather than stacking the hedge in any single contract month, the corporation might sell 100 Eurodollar futures in successive quarterly contract months to match the 7 successive quarterly loan reset dates.

Structuring Floating Rate Loan Hedge

Reset Date	Action to Hedge Rate Reset
White June	Sell 100 White Jun futures
White September	Sell 100 White Sep futures
White December	Sell 100 White Dec futures
White March	Sell 100 White Mar futures
Red June	Sell 100 Red Jun futures
Red September	Sell 100 Red Sep futures
Red December	Sell 100 Red Dec futures

As such, one might effectively hedge each of the 7 loan periods separately. This transaction is often referred to as a "strip," or a series of short (or long) Eurodollar futures in successively deferred contract months to hedge the risk of rising (declining) rates, respectively.

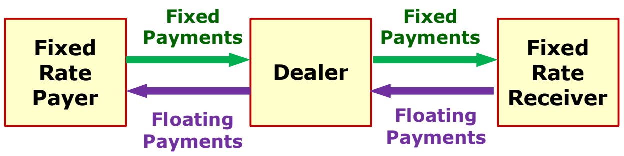
Interest Rate Swaps

An interest rate swap is a financial transaction that entails multiple, periodic payments (swaps) of a sum determined by reference to a fixed rate of interest and payable by one swap counterparty; vs. a sum determined by reference to a floating or variable rate of interest and payable by the other counterparty. The fixed rate payer (floating rate receiver) is generally referred to simply as the "payer" while the fixed rate receiver (floating rate payer) may be referred to simply as the "receiver."

E.g., one may swap a quarterly payment based upon a specified fixed rate of interest, such as 1%, applied to a principal value of $10 million for the next 5 years; for a quarterly payment based upon 3-month LIBOR rates applied to a principal value of $10 million for the next 5 years. These periodic fixed vs. floating rate payments are typically netted such that only the net amount due is passed between payer and receiver.

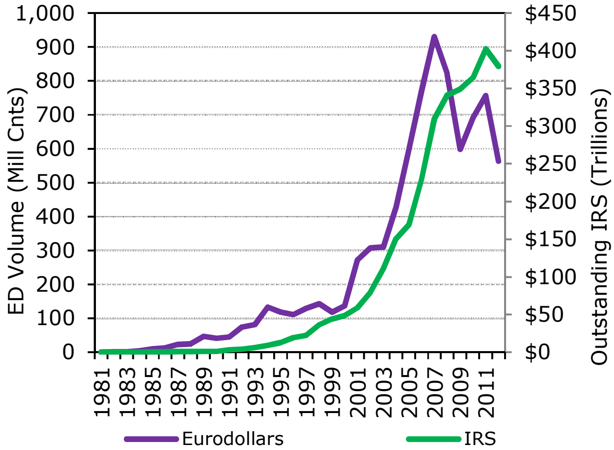
Clearly, the fixed rate payer hopes that floating rates rise such that his future receipts are increased. The floating rate payer, or fixed rate receiver, hopes that floating rates decline such that his future payments are diminished.

Interest Rate Swap (IRS)



The seminal interest rate swap transaction was concluded in 1980 while Eurodollar futures were originally introduced in 1981. Since that time the IRS market has grown to some $379.4 trillion in outstanding notional value as of June 2012. [5]

Eurodollar & IRS Growth



Volume in CME Eurodollar products have grown on a strikingly parallel path along with over-the-counter swaps. This underscores the fact that Eurodollar futures and inextricably intertwined with the IRS market as a source for pricing and a tool to hedge the risks associated with swaps. In particular, banks and broker-dealers making a market in over-the-counter (OTC) swaps represent primary Eurodollar market participants.

ICE LIBOR Swap

The ICE Benchmark Administration Limited (ICE) LIBOR fixings represent a benchmark against which many interest rate products including CME Eurodollar futures and interest rate swaps routinely are pegged. Because of this focus on the ICE LIBOR fixing rate and the liquidity associated with Eurodollar futures, a particular type of IRS – an "ICE LIBOR Swap" – is frequently traded in the over-the-counter (OTC) markets.

An ICE LIBOR Swap may be constructed to reference the 3-month ICE LIBOR fixing as the basis for the floating rate payments, frequently on the same dates as standard CME Eurodollar futures are settled (so-called "IMM dates").

As such, there is a closely compatible relationship between ICE LIBOR Swaps and CME Eurodollar futures that facilitates use of futures as a reference for pricing, and a tool for hedging, swaps. Further, this implies that futures may be used as a proxy to mimic the performance of a ICE LIBOR Swap, albeit with some qualifications. [6]

Pricing Swaps

Interest rate swaps are typically quoted (on an opening basis) by reference to the fixed rate of interest. That fixed rate is calculated as the rate that renders equivalent the present value of the anticipated periodic fixed rate payments (PV_{fixed});

[5] As reported by the Bank of International Settlements (BIS) in its semi-annual survey of the over-the-counter (OTC) derivatives marketplace.

[6] Note that, unlike OTC swaps, CME Eurodollar futures do not exhibit convexity, or a non-linear relationship between price and yield. Rather, futures exhibit a linear relationship such that a one basis point (0.01%) change in yield uniformly represents a monetary change of $25.00 in the value of a single futures contract. This lack of convexity implies that one must adjust one's Eurodollar position periodically in order to achieve a similar effect.

with the present value of the anticipated periodic floating rate payments ($PV_{floating}$).

Those floating rate payments may be estimated by examining the shape of the yield curve, or more practically, by referencing the rates associated with Eurodollar futures prices which reflect the shape of the curve.

$$PV_{Fixed} = PV_{Floating}$$

When an IRS is transacted such that the present value of the estimated floating rate payments equals the present value of the fixed rate payments, no monetary consideration is passed on the basis of this initial transaction. This is also referred to as a "par swap." In other words, the "non-par payment" (NPP) is set at zero ($0).

$$NPP = 0 = PV_{Floating} - PV_{Fixed}$$

The fixed rate (R_{fixed}) associated with a swap may be calculated by reference to the following formula.

$$R_{fixed} = \frac{4 \cdot \sum_{i=1}^{n}\left[PV_i \cdot R_i \cdot \left(\frac{days_i}{360}\right)\right]}{\sum_{i=1}^{n} PV_i}$$

Where PV_i = present value discounting factor; R_i = rate associated with each successively deferred period; $days_i$ = number of days in each successively deferred period. Note that those rates may be determined by reference to Eurodollar futures pricing.

E.g., find the value of a 2-year swap where the floating rate is estimated by reference to the ICE 3-month Eurodollar time deposit rate as of January 30, 2013. Table 4, found in the appendix below, provides details regarding the calculations. The fixed rate of interest associated with the swap may be calculated as 0.3861%.

The present value of the fixed and floating rate payments given a fixed rate of 0.3861% may be calculated as $76,934.49. The equivalence of these two cash flow streams may be established by reference to Table 5 found in the appendix. As such, this is a par swap that may be transacted with no up-front monetary consideration.

$$\begin{aligned} R_{fixed} = 4 \cdot \Big(&\left[0.9997 \cdot 0.002265 \cdot \left(\frac{47}{360}\right)\right] \\ &+ \left[0.9989 \cdot 0.003000 \cdot \left(\frac{91}{360}\right)\right] \\ &+ \left[0.9981 \cdot 0.003300 \cdot \left(\frac{91}{360}\right)\right] \\ &+ \left[0.9972 \cdot 0.003650 \cdot \left(\frac{91}{360}\right)\right] \\ &+ \left[0.9962 \cdot 0.004050 \cdot \left(\frac{91}{360}\right)\right] \\ &+ \left[0.9950 \cdot 0.004500 \cdot \left(\frac{91}{360}\right)\right] \\ &+ \left[0.9938 \cdot 0.005100 \cdot \left(\frac{91}{360}\right)\right] \\ &+ \left[0.9923 \cdot 0.005800 \cdot \left(\frac{91}{360}\right)\right]\Big) \\ &\div (0.9997 + 0.9989 + 0.9981 + 0.9972 \\ &+ 0.9962 + 0.9950 + 0.9938 + 0.9923) \\ &= 0.3861\% \end{aligned}$$

Note that, once transacted, an IRS might be rather unique to the extent that there are a plethora of variables associated with the transaction. These include features such as the specific floating reference rate, the periodic reset dates, the date conventions, etc. Because there are a large number of variable features associated with an IRS, the market for swaps is fragmented amongst many outstanding swaps with divergent contract terms and conditions.

Because the swap market is rather fragmented, bi-lateral counterparties who wish to close or retire an outstanding swap transaction frequently must negotiate such a "close-out" or "tear-up" directly with the original counterparty. These closing transactions are typically quoted by reference to the non-par value of the swap at the time of such close-out.

E.g., interest rates may have advanced since the original transaction was concluded at a NPP=0. As such, the fixed rate payer is advantaged while the floating rate payer is disadvantaged. Thus, the floating rate payer may be required to compensate the fixed rate payer with a NPP that reflects the difference between the $PV_{floating}$ and PV_{fixed} per current market conditions.

E.g., interest rates may have declined since the original transaction was concluded at a NPP=0. As such, the fixed rate payer is disadvantaged while the floating rate payer is advantaged. Thus, the fixed rate payer may be required to compensate the floating rate payer with a NPP that reflects the difference between the $PV_{floating}$ and PV_{fixed} per current market conditions.

Hedging Swaps

Just as interest rate swaps may be priced by reference to Eurodollar futures values, they may also be hedged with Eurodollar futures positions. This is, of course, facilitated to the extent that the swap is structured to parallel the characteristics of Eurodollar futures contracts.

E.g., basis risk is reduced to the extent that the floating rate associated with the swap is based on the same ICE 3-month Eurodollar time deposit rate that is used to cash-settle the futures contract, an "ICE swap." Basis risk is further reduced to the extent that the swap is reset on dates corresponding to the quarterly expiration of the futures contracts. [7]

As a general rule, the fixed rate payer is exposed to the risk of falling rates and rising prices. This suggests that fixed rate payers generally buy Eurodollar futures as a hedging strategy. Similarly, fixed rate receivers (floating rate payers) are exposed to the risk of rising rates and falling prices. Thus, fixed rate receivers may sell Eurodollar futures as a hedging strategy.

Fixed rate payers exposed to risk of falling rates	→	**Buy Eurodollar futures**
Fixed rate receivers exposed to risk of rising rates	→	**Sell Eurodollar futures**

Just as we might identify the BPV of a loan instrument to assess the magnitude of risk, we might also calculate the BPV of a swap. Unfortunately, there is no simple, deterministic formula to reference in this regard. But we may nonetheless estimate the BPV of a swap by comparing its non-par value given yield levels spaced 1 basis point apart.

[7] Eurodollar futures expire on the 2nd business day prior to the 3rd Wednesday of the contract month. These dates are referred to as "IMM dates" with a nod to the International Monetary Market or the nomenclature that was once associated with the division of the Chicago Mercantile Exchange on which financial products were traded. The reference endures even though the Exchange no longer categorizes its products into an IMM division.

E.g., find the BPV of a 2-year IMM-dated swap with a $10 million notional amount, as discussed above. Note that the swap is originally transacted at par such that the $PV_{floating} = PV_{fixed}$ = $76,934.49. Thus, the original non-par payment, or difference between the present value of the fixed and floating payments, totaled zero (NPP = $0).

Assume that yields advance by 1 basis point (0.01%) at all points on the yield curve. Per this scenario and as detailed in Table6, found in the appendix, PV_{fixed} = $76,926.70 while $PV_{floating}$ = $78,687.26. Thus, the non-par value of the swap increase from $0 to $1,760.56 (=$78,687.26 - $76,926.70).

I.e., the fixed rate payer profits by $1,760.56 in the market or non-par value of the swap; the floating rate payer loses $1,760.56 in value. As such, the swap has a BPV=$1,760.56. This suggests that the swap may be hedged using 70 Eurodollar futures.

$$HR = \$1{,}760.56 \div \$25 = 70\ contracts$$

But in which contract month should the hedge be placed? The short or floating rate payer might sell 70 futures in a nearby contract month if the yield curve were expected to flatten or invert. Or, one might sell 70 futures in a deferred month if the yield curve were expected to steepen. (The implications of a change in the shape of the yield curve are discussed in some detail above.)

Structuring the IRS Hedge

But a more precise hedge may be achieved if one were to sell futures in Eurodollar months that match the swap reset dates and risk exposures. This may be accomplished by comparing the PV_{fixed} and $PV_{floating}$ cash streams at each reset date.

E.g., in reference to the December 2013 payment date and as shown in Table 7 below, $PV_{floating} - PV_{fixed}$ = $9,200.50 - $9,624.42 = -$423.92. Assuming a 1 basis point advance in yields, the difference now becomes $PV_{floating} - PV_{fixed}$ = $9,451.73 - $9,623.57 = -$171.84. This suggests that the floating rate payer is exposed to a risk in December 2013 that may be quantified with a BPV = $252.08 (=-$423.92 less -$171.84). This further suggests that the floating rate payer may hedge that particular reset date by selling 10 Dec-13 Eurodollar futures.

$$HR = \$252.08 \div \$25 = 10.1$$

Similarly, the floating rate payer might sell various amounts of Eurodollar futures in successively deferred months to hedge the risk of rising rates and falling prices as calculated in Table 7 below.

Action
Sell 10 Mar-13 futures
Sell 10 Jun-13 futures
Sell 10 Sep-13 futures
Sell 10 Dec-13 futures
Sell 10 Mar-14 futures
Sell 10 Jun-14 futures
Sell 10 Sep-14 futures
Total 70 Contracts

This hedge is "self-liquidating" in the sense that every 3 months as the rate over the subsequent 3-month period is established, the Eurodollar futures sold to hedge that specific risk are cash-settled. However, this does not imply that the hedge requires no maintenance.

Convexity

The BPV associated with Eurodollar futures is unchanging at $25/contract. However, like coupon bearing fixed income instruments, swaps experience "convexity." *I.e.*, the responsiveness or BPV of the swap's value fluctuates as yields rise and fall. Convexity generally increases as a function of the tenor of the swap.

Thus, it is advisable periodically to quantify the swap structure and determine if the recommended hedge structure might have changed as a function of fluctuating rates and swap convexity. [8]

Margins per Dodd-Frank

The Dodd-Frank Wall Street Reform and Consumer Production Act was endorsed by President Obama on July 21, 2010 ("Dodd-Frank bill" or "the Bill"). The Bill enacts sweeping reforms affecting the over-the-counter ("OTC") derivatives markets and reverses the portion of the Commodity Futures Modernization Act ("CFMA") of 2000 that had largely exempted OTC derivatives from significant regulatory oversight.

The broad provisions of the Bill will be supported and implemented by myriad specific and detailed regulations currently under development by the two primary agencies, the Commodity Futures Trading Commission ("CFTC") and the Securities Exchange Commission ("SEC"). It remains unclear exactly what will eventually emerge as the regulatory framework per which OTC derivatives will be regulated. But the picture is starting to come more clearly into focus.

On November 8, 2011, the CFTC issued final rules pertaining to the general provisions and core principles of a Derivative Clearing Organization ("DCO"). In particular, these rules stipulate the performance bond (or "margin") requirements for financial futures, centrally cleared swaps, and swaps that are not centrally cleared.

According to Part 39, Subpart B, Section 39.13(2)(ii), which governs risk margin methodology and coverage, a derivatives clearing organization:

"…shall use models that generate initial margin requirements sufficient to cover the derivatives clearing organization's potential future exposures to clearing members based on price movements in the interval between the last collection of variation margin and the time within which the derivatives clearing organization estimates that it would be able to liquidate a defaulting clearing member's positions (liquidation time); provided, however, that a derivatives clearing organization shall use:

(A) A minimum liquidation time that is one day for futures and options;
(B) A minimum liquidation time that is one day for swaps on agricultural commodities, energy commodities, and metals;
(C) A minimum liquidation time that is five days for all other swaps; or
(D) Such longer liquidation time as is appropriate based on the specific characteristics of a particular product or portfolio; provided further that the Commission, by order, may establish shorter or longer liquidation times for particular products or portfolios."

In short, under the new rules, market participants must post initial performance bonds to cover a one-

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8 The convexity associated with a strip of Eurodollar futures may be assessed using various electronic calculation tools. Please refer to the "EDS" functionality on the Bloomberg system. Or, one may refer to CME Group's "Swap Equivalents" tool found on the www.cmegroup.com website.

day liquidation timetable for financial futures transactions, a 5-day liquidation timetable for centrally cleared financial swaps, and a 10-day liquidation timetable for non-centrally cleared financial swaps.

With respect to non-cleared financial swaps, the 10-day liquidation timetable is only proposed. These rules will mandate that previously uncleared, bilaterally executed, plain vanilla financial swaps be cleared by a qualified central counterparty ("QCCP") and become subject to a 5-day liquidation timetable.

Margin requirements for standardized, liquid futures contracts, such as Eurodollars, will generally be less onerous than margins required for an analogous position in a cleared, plain vanilla interest rate swap. This is intuitive to the extent that IRS instruments are customized transactions which typically cannot be liquidated in times of market stress with equal facility to futures.

E.g., the margin requirements for a structured 2-year Eurodollar futures strip that mimics a 2-year interest rate swap may be estimated as of December 2012 as 0.255% of notional value. By contrast, the margin requirements associated with a cleared 2-year interest rate swap are estimated at 0.420%. Thus, use of Eurodollar futures to create a similar risk exposure to an IRS instrument equals 0.165% of notional value.

E.g., the margin requirements for a structured 5-year Eurodollar futures strip that mimics a 5-year IRS are estimated as 0.785% less than that of the IRS.

E.g., the margin on a 10-years structured Eurodollar futures strip is estimated at 1.335% less than that of a comparable 10-year IRS.

Estimated Margin Requirements as % of Notional Value
(As of December 2012)

Tenor	Cleared IRS	Equivalent ED Strip	Savings
2-Year	0.420%	0.255%	0.165%
5-Year	1.580%	0.795%	0.785%
10-Year	3.250%	1.895%	1.335%

Caps, Floors, Collars

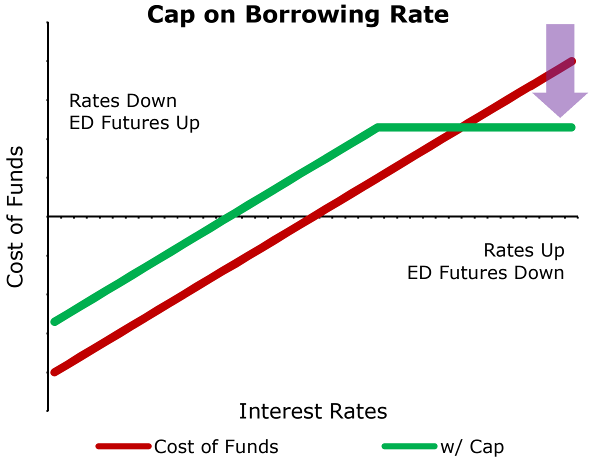
In addition to offering Eurodollar futures, CME also offers options that are exercisable for Eurodollar futures. This popular product is useful in restructuring risk in a variety of interesting and practical ways.

One may wish effectively to restructure an asset or a liability by establishing a minimum rate, a maximum rate or possibly to limit the rate on both the upward and downward side. There are a variety of over-the-counter option instruments that are referred to as caps, floors and collars that accomplish these objectives. Or, one may readily utilize options on Eurodollar futures to accomplish the same purposes.

Cap – Assume that a corporation securing a floating rate loan is concerned that rates will advance over time, driving the cost of funds to untenable levels. But the corporation may wish to retain the benefits potentially associated with declining rates. By buying an over-the-counter (OTC) derivative known as a "cap," the corporation may accomplish its objectives.

When buying a cap, the borrower pays a fee or premium to the cap provider up-front. Subsequently, the cap provider compensates the borrower if rates advance above an agreed-upon strike price over the term of the cap agreement.

Cap on Borrowing Rate



E.g., a cap is struck at 4% when the loan rate is at 3%. If rates advance above 4%, the cap buyer will be compensated for his increased borrowing costs. Thus, the borrower may fix the maximum loan rate while retaining the benefits of possible rate decline.

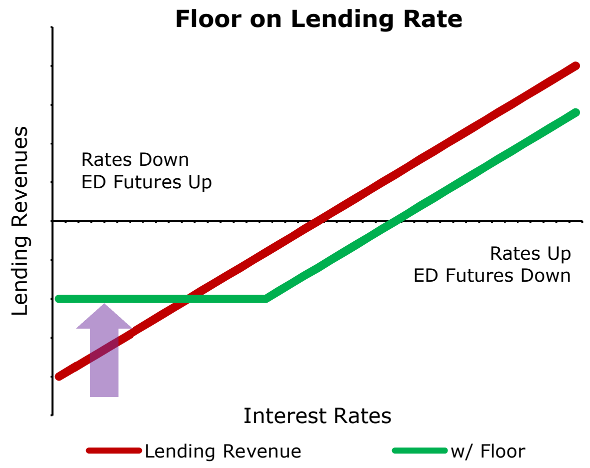
But this comes at the cost of paying the upfront fee or premium.

As an alternative, one might buy out-of-the-money put options exercisable for Eurodollar futures to create a synthetic long cap. Just like a long cap, the purchase of puts entails the payment of a negotiated premium. The puts advance in value as rates rise and Eurodollar futures decline.

Unlike a cap that may be available on an over-the-counter (OTC), privately negotiated basis, Eurodollar options are traded openly and competitively on the Exchange. Further, these options are processed through the Exchange's central counterparty (CCP) clearing and subject to the attendant financial sureties.

Buy out-of-the-money Eurodollar puts ➔ **Provides a "cap" on cost of borrowing**

Creating a Investor Floor - Assume that a asset manager purchases a floating rate asset or loan but wants to lock-in a minimum return in the event that interest rates generally decline. The asset manager may buy another variety of OTC derivative known as a "floor" to accomplish this objective.

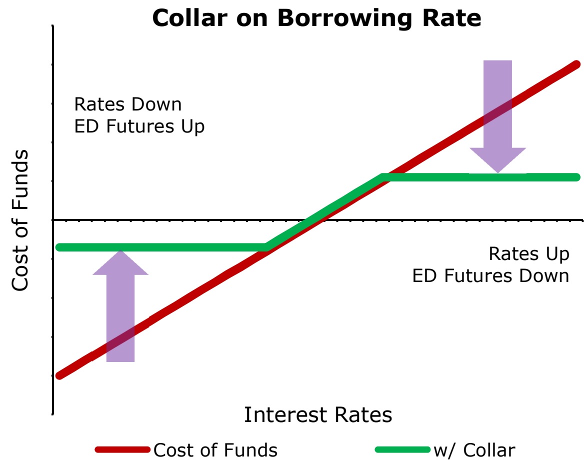


A floor means that the floor provider will compensate the floor buyer if the adjustable loan rate should decline below an agreed-upon strike price. *E.g.,* a lender might purchase a floor at 2.5%. If rates fall to 2%, the floor provider is required to compensate the buyer for that 0.5% shortfall below the 2.5% strike price.

Or, one might buy out-of-the-money call options exercisable for Eurodollar futures to create a synthetic long floor. Just like the long floor, the purchase of calls entails the upfront payment of a negotiated premium. Calls will rise in value as rates decline and Eurodollar futures prices rise.

Buy out-of-the-money Eurodollar calls ➔ **Provides a "floor" on lending revenues**

Creating a Collar - Assume that a borrower is interested in purchasing a cap but believes that the cap premium is too high. Thus, he may transact yet another variety of OTC derivative known as a "collar." A collar represents a combination of a floor and a cap that effectively limits both upside and downside rate changes.



Borrowers may purchase a cap and sell a floor to create a collar. The sale of the floor is used to fully or partially fund the purchase of the cap. This strategy allows the borrower to limit the negative impact of rate advances. But it comes at the cost of limiting the advantageous effects of rate declines.

A collar may likewise be created by a borrower by buying out-of-the-money put options (analogous to buying a cap); and, selling out-of-the-money call options (analogous to selling a floor).

Buy out-of-the-money Eurodollar puts & sell out-of-the-money Eurodollar calls ➔ **Provides a "collar" on cost of borrowing**

Similarly, asset managers might purchase a floor and sell a cap. The sale of the cap by the lender is used to fully or partially fund the purchase of the floor. This allows the investor to limit the negative impact of rate declines. But it comes at the cost of limiting the advantageous effects of rate advances.

Buy out-of-the-money Eurodollar calls & sell out-of-the-money Eurodollar puts ➔ **Provides a "collar" lending revenues**

A collar may likewise be created by an asset manager by buying out-of-the-money call options (analogous to buying a floor); and, selling out-of-the-money put options (analogous to selling a cap).

Concluding Note

Eurodollar futures and options represent a flagship CME product because of the tremendous utility they offer to institutional market participants. As discussed above, they may be used as tool for arbitrage activity, as a synthetic investment in the form of a strip to be compared to other term investments, as a tool for hedging commercial loans and as a means to price and hedge interest rate swaps.

Historically, Eurodollar futures have been heavily patronized by interest rate swap dealers. But the Dodd Frank financial reform bill is introducing significant change within the over-the-counter derivatives industry including mandated clearing of standardized IRS instruments. Eurodollar futures may be deployed effectively as a proxy for IRS positions with significant capital efficiencies.

To learn more about this product, visit www.cmegroup.com/eurodollar.

Table 1: Eurodollar Contract Specifications

Unit	$1 million face-value, 90-day Eurodollar Time Deposits.
Cash settlement	Cash settlement based on ICE Benchmark Administration Limited (ICE) Rate for 3-month Eurodollar Interbank Time Deposits.
Quote	In terms of the "IMM index" or 100 less the yield (e.g., a yield of 3.39% is quoted as 96.61).
Minimum price fluctuation, or "tick"	One-half basis point (0.005) equals $12.50; except in nearby month where tick is one-quarter basis point (0.0025) or $6.25.
Months	March quarterly cycle of March, June, September, and December, plus the first four "serial" months not in the March quarterly cycle.
Hours of trade	Trading on the floor is conducted from 7:20 ~AM to 2:00 ~PM. Trading on the CME Globex electronic trading platform is conducted on Mondays to Thursdays from 5:00 ~PM to 4:00 ~PM; shutdown period is from 4:00 ~PM to 5:00 ~PM, Sundays and holidays from 5:00 ~PM to 4:00 ~PM.
Last trading day	The 2nd London bank business day prior to 3rd Wednesday of contract month. Trading in expiring contract closes at 11:00 a.m. London Time on last trading day.

Table 2: Eurodollar Futures Activity
(January 30, 2013)

Month	Open	High	Low	Settlement	Change	RTH Volume (1)	Globex Volume	Open Interest
Feb-13				99.7025	+0.25		4,531	67,238
Mar-13	99.7000	99.7000	99.7000	99.7000	+1.0	1,281	134,520	850,097
Apr-13				99.6950	+1.0	1,100	10,354	18,301
May-13				99.6800	+0.5			255
Jun-13	99.6700	99.6700	99.6700	99.6700	+1.0	335	165,580	744,538
Sep-13	99.6300	99.6350	99.6300	99.6350	+1.0	156	153,030	680,032
Dec-13		99.5950B	99.5900A	99.5950	+1.0	2,718	187,643	713,542
Mar-14		99.5500B	99.5400A	99.5500	+1.5	1,163	191,542	635,353
Jun-14		99.4850B	99.4800A	99.4900	+1.5	100	207,730	571,722
Sep-14	99.4100	99.4200B	99.4100	99.4200	+1.5	147	181,535	481,246
Dec-14	99.3300	99.3350B	99.3300	99.3350	+1.0	5,784	211,414	546,213
Mar-15		99.2550B	99.2400A	99.2500	+1.0	6,105	143,883	433,157
Jun-15	99.1450	99.1550B	99.1350A	99.1450	+0.5	5,332	152,526	586,423
Sep-15		99.0450B	99.0200A	99.0300	Unchg	5,310	150,117	412,714
Dec-15		98.9100B	98.8800A	98.8900	-0.5	485	169,145	502,691

Table 2: Eurodollar Futures Activity, cont.
(January 30, 2013)

Month	Open	High	Low	Settlement	Change	RTH Volume(1)	Globex Volume	Open Interest
Mar-16		98.7600B	98.7250A	98.7400	-1.0	657	101,553	309,890
Jun-16	98.5750	98.6000B	98.5600A	98.5750	-1.5	9,571	80,186	199,702
Sep-16		98.4300B	98.3350A	98.4050	-1.5	78	68,591	196,503
Dec-16		98.2550B	98.2050A	98.2300	-2.0	803	66,845	132,846
Mar-17		98.0850B	98.0350A	98.0650	-2.5	72	47,247	117,287
Jun-17	97.8850	97.9150B	97.8600A	97.8900	-3.0	10	34,373	76,520
Sep-17		97.7550B	97.6950A	97.7300	-3.0	190	27,109	62,086
Dec-17		97.5900B	97.5300A	97.5600	-3.5	2	21,645	85,797
Mar-18			97.4250A	97.4300	-3.5	378	3,715	18,298
Jun-18			97.3000A	97.3000	-4.0	2	2,404	17,102
Sep-18			97.1850A	97.1800	-4.5	190	1,982	10,007
Dec-18	97.0550	97.0550	97.0500	97.0600	-4.5	8	2,138	8,120
Mar-19			96.9800A	96.9750	-4.5	7	413	6,156
Jun-19			96.8900A	96.8850	-4.5	7	132	4,364
Sep-19			96.8050A	96.8000	-4.5	7	161	2,217
Dec-19	96.7100	96.7100	96.7100	96.7100	-4.5	11	162	2,524
Mar-20			96.6550A	96.6500	-4.5		76	1,463
Jun-20			96.5950A	96.5900	-4.5		12	2,030
Sep-20			96.5250A	96.5200	-4.5		36	931
Dec-20			96.4500A	96.4450	-4.5		43	891
Mar-21			96.4050A	96.4000	-4.5		32	737
Jun-21			96.3650A	96.3600	-4.5			528
Sep-21			96.3200A	96.3150	-4.5		2	422
Dec-21			96.2650A	96.2600	-4.5		21	444
Mar-22			96.2300A	96.2250	-4.5			140
Jun-22			96.1900A	96.1850	-4.5			334
Sep-22			96.1400A	96.1350	-4.5			401
Dec-22			96.0900A	96.0850	-4.5			31
TOTAL						**40,909**	**2,507,545**	**8,415,499**

(1) "RTH" = Regular Trading Hours and is a reference to open outcry or ex-pit executed transactions

Table 3: Find Value of (Hypothetical) Strip

(Assume it is December)

Instrument	Day Span	Cumulative Term	Eurodollar Price	Rate (R)	Compound Value	Strip Yield
3-Mth Investment	90	90	99.7000	0.300%	1.0008	0.300%
March Eurodollars	90	180	99.6500	0.350%	1.0016	0.325%
June Eurodollars	90	270	99.6000	0.400%	1.0026	0.350%
September Eurodollars	90	360	99.5500	0.450%	1.0038	**0.376%**

Table 4: Find Swap Value

(As of 1/30/13)

Instrument	Expiration Date	Days	Day Span	Price	Rate (R)	Compound Value (CV)	Discount Factor (PV) (1/CV)
3-Month LIBOR			47		0.2265	1.0003	0.9997
Mar-13 Eurodollars	3/18/13	47	91	99.7000	0.3000	1.0011	0.9989
Jun-13 Eurodollars	6/17/13	138	91	99.6700	0.3300	1.0019	0.9981
Sep-13 Eurodollars	9/16/13	229	91	99.6350	0.3650	1.0028	0.9972
Dec-13 Eurodollars	12/16/13	320	91	99.5950	0.4050	1.0038	0.9962
Mar-14 Eurodollars	3/17/14	411	91	99.5500	0.4500	1.0050	0.9950
Jun-14 Eurodollars	6/16/14	502	91	99.4900	0.5100	1.0063	0.9938
Sep-14 Eurodollars	9/15/14	593	91	99.4200	0.5800	1.0078	0.9923
	12/15/14	684					

Table 5: Confirm Par Value

(As of 1/30/13)

Payment Date	Fixed Payments	Discount Factor	PV of Fixed Payments	Floating Payments	Discount Factor	PV of Floating Payments
3/18/13	$9,651.50	0.9997	$9,648.65	$2,957.08	0.9997	$2,956.21
6/17/13	$9,651.50	0.9989	$9,641.34	$7,583.33	0.9989	$7,575.35
9/16/13	$9,651.50	0.9981	$9,633.30	$8,341.67	0.9981	$8,325.94
12/16/13	$9,651.50	0.9972	$9,624.42	$9,226.39	0.9972	$9,200.50
3/17/14	$9,651.50	0.9962	$9,614.58	$10,237.50	0.9962	$10,198.34
6/16/14	$9,651.50	0.9950	$9,603.66	$11,375.00	0.9950	$11,318.61
9/15/14	$9,651.50	0.9938	$9,591.29	$12,891.67	0.9938	$12,811.24
12/15/14	$9,651.50	0.9923	$9,577.25	$14,661.11	0.9923	$14,548.32
			$76,934.49			**$76,934.49**

Table 6: Find BPV of Swap
(As of 1/30/13)

Payment Date	Fixed Payments	Discount Factor	PV of Fixed Payments	Floating Payments	Discount Factor	PV of Floating Payments
3/18/13	$9,651.50	0.9997	$9,648.52	$2,957.08	0.9997	$2,956.17
6/17/13	$9,651.50	0.9989	$9,640.97	$7,836.11	0.9989	$7,827.56
9/16/13	$9,651.50	0.9981	$9,632.69	$8,594.44	0.9981	$8,577.69
12/16/13	$9,651.50	0.9971	$9,623.57	$9,479.17	0.9971	$9,451.73
3/17/14	$9,651.50	0.9961	$9,613.48	$10,490.28	0.9961	$10,448.95
6/16/14	$9,651.50	0.9949	$9,602.32	$11,627.78	0.9949	$11,568.52
9/15/14	$9,651.50	0.9936	$9,589.71	$13,144.44	0.9936	$13,060.29
12/15/14	$9,651.50	0.9921	$9,575.43	$14,913.89	0.9921	$14,796.34
			$76,926.70			**$78,687.26**

Table 7: Structuring Hedge
(As of 1/30/13)

	Original Scenario			Rates Increase 1 Basis Point				
Payment Date	(1) PV of Fixed Payments	(2) PV of Floating Payments	(3) Fixed – Float (2-1)	(4) PV of Fixed Payments	(5) PV of Floating Payments	(6) Fixed-Float (5-4)	Difference in Cash Flows	Hedge Ratio (HR)
3/18/13	$9,648.65	$2,956.21	($6,692.44)	$9,648.52	$2,956.17	($6,692.35)	$0.09	0.0
6/17/13	$9,641.34	$7,575.35	($2,065.99)	$9,640.97	$7,827.56	($1,813.41)	$252.58	10.1
9/16/13	$9,633.30	$8,325.94	($1,307.37)	$9,632.69	$8,577.69	($1,055.00)	$252.37	10.1
12/16/13	$9,624.42	$9,200.50	($423.92)	$9,623.57	$9,451.73	($171.84)	$252.08	10.1
3/17/14	$9,614.58	$10,198.34	$583.75	$9,613.48	$10,448.95	$835.47	$251.72	10.1
6/16/14	$9,603.66	$11,318.61	$1,714.95	$9,602.32	$11,568.52	$1,966.20	$251.25	10.1
9/15/14	$9,591.29	$12,811.24	$3,219.95	$9,589.71	$13,060.29	$3,470.58	$250.63	10.0
12/15/14	$9,577.25	$14,548.32	$4,971.07	$9,575.43	$14,796.34	$5,220.91	$249.84	10.0
	$76,934.49	**$76,934.49**	**$0.00**	**$76,926.70**	**$78,687.26**	**$1,760.56**	**$1,760.56**	**70.4**