Using Treasury Futures to Replace Swap Exposure in a Low Interest Rate Environment

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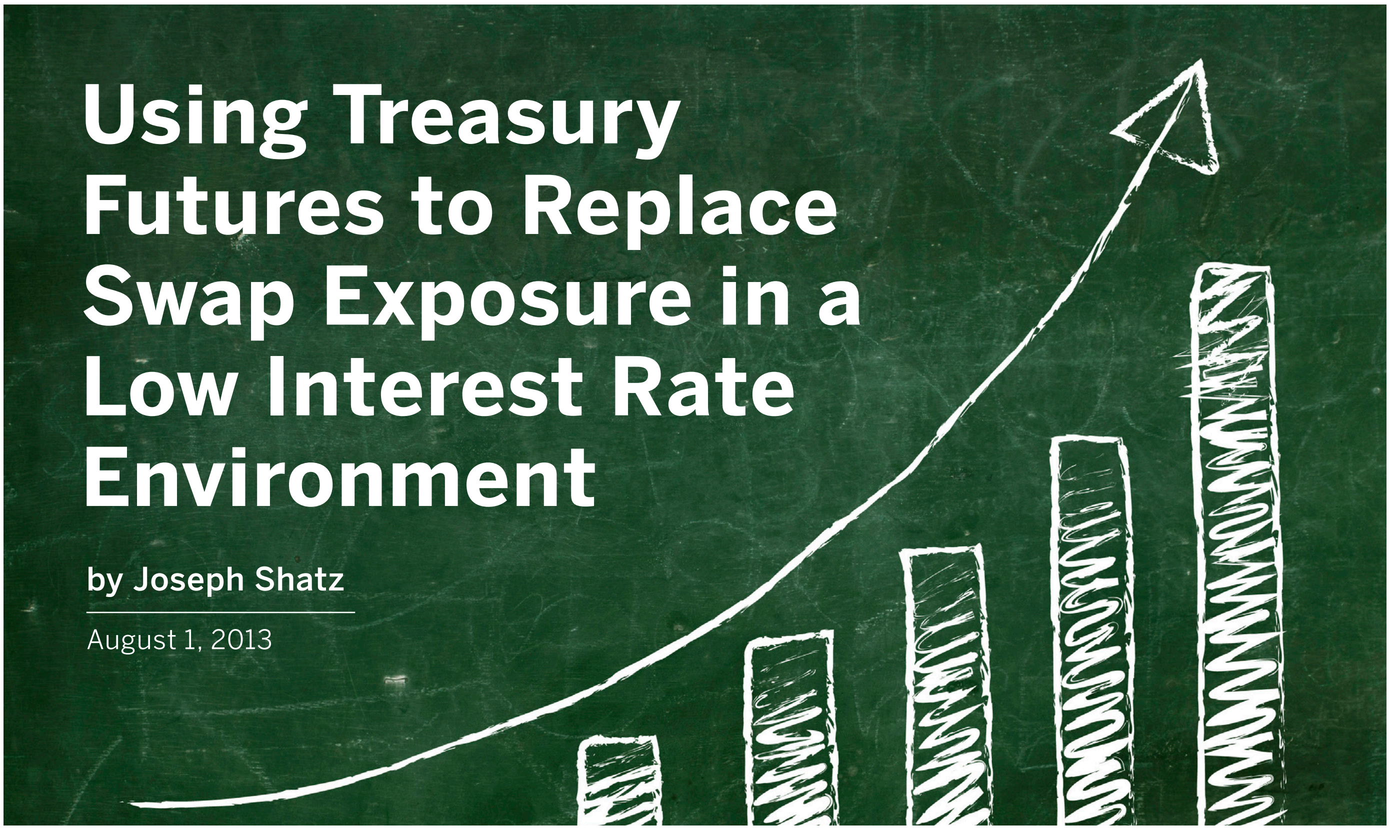


Title VII of the Dodd–Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank) has introduced major legal, operational, and regulatory challenges associated with continuing to trade swaps. With the second phase of the Commodity Futures Trading Commission's (CFTC's) implementation of Title VII of Dodd-Frank with regards to swaps clearing just having ensnared the next round of market participants (Category 2) as of June 10, 2013, we examine how investors could use Treasury note futures contracts to replace over-the-counter interest rate swap (OTC IRS) positions while achieving a similar interest rate risk exposure.

Replacing swaps with futures is attractive due to Dodd-Frank

In its quest to increase transparency and regulatory oversight in the swaps market, the new regulation introduced many new rules regarding swaps such as:

1. Mandatory centralized clearing of certain standardized swaps
2. Margin requirements for both cleared and uncleared swaps
3. Swap transaction reporting requirements
4. Required trading on regulated electronic platforms, either on Designated Contract Markets (DCMs) or Swap Execution Facilities (SEFs)
5. Many new regulations for key market participants (swap dealers and major swap participants), including required registration, capital and margin requirements, and massive new internal and external business requirements

Under Dodd-Frank, interest rate swaps fall under the regulatory purview of the CFTC, which also regulates the exchange traded futures market, while some other swaps such as equity swaps fall under the SEC's jurisdiction. The CFTC is implementing the OTC clearing mandate in three phases, with each phase encompassing another subset of market participants. In phase 1, Category 1 market participants (e.g. swap dealers and "major swap participants") were required to comply with the OTC clearing mandate for interest rate and credit default swaps as of March 11, 2013. Category 2 market participants (e.g. commodity pools, hedge funds, asset managers, and regional banks) were required to comply in phase 2 which began on June 10, 2013. Phase 3 for category 3 market participants (all others that are not exempted from clearing) is scheduled to begin on September 9, 2013.

The new regulatory regime has made participating in the swaps market more expensive relative to exchange traded futures. This has resulted in the "futurization" of swaps to benefit from the regulatory advantages of futures such as capital efficiency. As new regulations on swaps are more onerous than on futures, futures exchanges have begun to introduce new swap futures contracts designed to help market participants capitalize on this shift. These contracts are designed to allow market participants to essentially achieve swaps exposure in a futures contract, and are certainly one way to replace interest rate swap exposure as liquidity in the new product grows. But extremely liquid existing exchange traded futures, such as Eurodollar futures and Treasury bond and note futures, also can be used to achieve similar interest rate swap (IRS) exposure with the regulatory advantages of futures.

In this article, we specifically discuss using Treasury note futures (2-yr, 5-yr, and 10-yr) to replace interest rate swap exposure, primarily in the current low interest rate environment. We also briefly discuss the adjustments to this strategy that would need to be made in a substantially higher interest rate environment than currently exists. In a later paper, we plan to discuss the adjustments in more detail.

Replacing Interest Rate Swaps with Treasury Futures

An interest rate swap (IRS) is a contract between two parties to exchange cashflows based on a notional amount until a specified maturity date. In the most commonly traded and most liquid plain "vanilla" fixed for floating interest rate swap, one counterparty (the "receiver") receives fixed rate payments in exchange for paying floating rate payments based on LIBOR (London InterBank Offered Rate), while the other counterparty (the "payer") pays the fixed rate payments in exchange for receiving the floating rate payments based on LIBOR. Interest payments are determined by applying the respective interest rates to the notional principal of the swap, but no principal is generally exchanged. LIBOR is the interest rate at which certain banks can borrow unsecured money from other banks for a specified amount of time and is the most commonly used benchmark rate for swaps (especially 3-month LIBOR).

Treasury note futures can be used in many cases to replace swap exposure. A long position in Treasury futures can be used to obtain similar interest rate exposure as a receive fixed (vs. pay floating) position in a swap, while a short position in Treasury futures can be used instead of a pay fixed (vs. receive floating) swap position.

In an interest rate swap, the fixed rate receiver generally benefits from a decline in interest rates and is harmed by an increase in rates, similar to a long Treasury futures position. The fixed rate payer generally benefits from an increase in interest rates and is negatively impacted by a decrease in rates, similar to a short Treasury futures position.

When attempting to replace a swaps position with a Treasury futures position, it is necessary to determine which Treasury futures (i.e. 2-yr, 5-yr, or 10-yr) should be used and how many contracts are needed to most closely replicate the swap position performance. There are many issues to consider when using Treasury bond and note futures to replace swap exposure such as the following:

1. Treasury futures may be "tracking" a different sector of the yield curve than indicated by its "name". For example, the 10-yr Treasury (T-note) future is currently tracking a Treasury security with approximately 7 years to maturity. This is in contrast to a 10-yr swap which initially has a 10 year maturity.
2. Treasury futures may have different risk characteristics (e.g. duration, DV'01, convexity) than interest rate swaps depending on many factors including the level of rates, shape of the curve, volatility, etc.
3. The performance of Treasury futures is based on the underlying cash Treasury note market and its associated "repo" financing market while the performance of interest rate swaps is based on the swap rate market and its underlying LIBOR financing market.

In order to successfully use Treasury futures to replace interest rate swap exposure, it is important to understand some basic concepts. A Treasury futures contract is an agreement between a futures seller to sell, and a futures buyer to purchase, delivery-eligible Treasury securities at a future date, at a price agreed upon today. One can think of Treasury futures as similar to an exchange traded forward contract on a Treasury security, except that it is on a basket of deliverable Treasury securities rather than on just one. The short position in the futures contract determines which security to make delivery with. This "embedded option" held by the short position can at times greatly affect the risk characteristics of Treasury futures. We will discuss this effect later in this article.

Treasury futures tend to "track" the cheapest-to-deliver (CTD) bond/note.[1] The CTD is the bond/note that at the futures expiration provides the largest profit (or smallest loss) to the short position when this investor buys the bond at its market price and delivers it at the futures invoice price. Prior to expiry, the CTD is the deliverable Treasury security with the lowest "forward price divided by its conversion factor". Another way to determine the CTD prior to expiry is the security with the highest net implied repo or usually, but not always, the security with the lowest net basis. Determining the CTD into each futures contract is highly important when determining which Treasury futures and how many contracts to use to replace swaps exposure. The position of the CTD on the yield curve will help determine which Treasury futures to use, and the risk characteristics of the futures contract often will be largely determined by the CTD (adjusted for its conversion factor), especially in the current very low interest rate environment.

The 3.5% 5/15/20 Treasury note (T 3.5% 5/15/20), which has a maturity in the 7-yr sector of the yield curve, is currently the CTD into the September 10-yr T-Note futures contract (TYU3). Thus, if we were trying to replace the interest rate risk exposure of a 10-yr swap position using Treasury futures, we would likely use the TYU3 contract. Likewise, we would use the September 5-yr T-Note futures contract (FVU3), for which the T 0.625% 11/30/17 is CTD with a maturity in the 4-4.5 yr sector, to replace a 5-yr swap position. And we would use the September 2-yr T-Note futures contract (TUU3), with its T 1.875% 06/30/15 CTD with a maturity in the 2-yr sector, to replace a 2-yr swap position.[2]

[1] Officially, the US Treasury differentiates between Treasury bonds and notes based on maturity (at issuance) with Treasury notes defined as government securities that are issued with maturities of 2, 3, 5, 7, and 10 years and Treasury bonds defined as those maturing in 30 years on their website. The specifications for Treasury note futures contracts (2-yr, 5-yr and 10-yr) only include Treasury notes (not Treasury bonds) in the deliverable baskets. In this article, we sometimes use the words bond and note interchangeably for coupon bearing Treasury securities since "bond" is often used generically to refer to fixed income securities.

[2] The following are the deliverable grades of Treasury securities according the CME Group contract specifications for 10-yr, 5-yr, and 2-yr U.S. Treasury Note futures. For the 10-yr T-note futures, U.S. Treasury notes with a remaining term to maturity of at least six and a half years, but not more than 10 years, from the first day of the delivery month. For the 5-yr T-note futures, U.S. Treasury notes with an original term to maturity of not more than five years and three months and a remaining term to maturity of not less than four years and two months as of the first day of the delivery month. For the 2-yr T-note futures, U.S. Treasury notes with an original term to maturity of not more than five years and three months and a remaining term to maturity of not less than one year and nine months from the first day of the delivery month and a remaining term to maturity of not more than two years from the last day of the delivery month. There are also two Treasury futures, the "Classic" Treasury bond contract and the "Ultra" Treasury bond contract, consisting of longer maturity deliverable bonds. Although we do not specifically discuss these contracts in detail in this article, the Classic and Ultra contracts could be used to replace longer maturity swap exposure such as 30-year swaps. For the Classic T-bond futures, the deliverable securities are US Treasury bonds with a remaining maturity of at least 15 years, but less than 25 years, from the first day of the delivery month. For the Ultra T-bond futures, the deliverable securities are U.S. Treasury bonds with a remaining term to maturity of not less than 25 years from the first day of the futures contract delivery month.

Once we determine which Treasury futures contract to use to replace the interest rate swap exposure, we need to decide how many futures contracts to use. In order to do this, we need to first calculate a measure of how the value of both the interest rate swap position and the futures contract move relative to changes in interest rates. This measure is basis point value (BPV).

In its broadest terms, "basis point value (BPV)", which is also commonly referred to as "dollar value of 1 basis point (DV'01)", is the change in value resulting from a change in interest rates of 1 basis point (.01%).[3] For bonds/notes, BPV or DV'01 is typically more narrowly construed as the change in full price resulting from a change in the yield to maturity of 1 basis point (.01%). But for other instruments such as futures and swaps it is prudent to think of BPV or DV'01 under its broader definition to make clear which interest rate(s) are being shifted to determine the price change. To construct the most basic hedging or replacement strategies, which assume that all yields shift up and down equally together, one typically divides the BPV of the security being hedged/replaced by the BPV of the security that is hedging/replacing it.[4]

Basic CTD Method

Let's start with a very simple example of trying to replace a $10 million notional 10-yr receive fixed (versus pay floating) swap position with a long position in September 10-yr Treasury note futures (TYU3) on 6/12/13. Market levels from 6/12/13 are used in all our examples here and throughout this article (with the exception of the daily performance example in Chart 1). The first step is to calculate both the BPV of the swaps position and the BPV of the September 10-yr T-note futures.

As of our 6/12/13 trade date, with the 10-yr swap rate at 2.420734%, the net BPV of the swap is $9131.26. The net BPV of a swap is equal to the BPV of the receive fixed leg minus the BPV of the pay floating leg. We use the "SWPM" function on Bloomberg to get our swap BPVs (although this number could be calculated in a spreadsheet by building the swap curve and then shocking the underlying market rates in the curve by 1bp). It's important to note that on the Bloomberg "SWPM" function the PV'01 of a swap is the present value of a 1 basis point (bp) change in the swap coupon while the DV'01 is the change in the swaps value for a 1 bp change in the underlying interest rates. These two should be approximately equal for a par coupon swap if the underlying interest rate curve being shocked in the model is essentially the par coupon swap curve. If the underlying interest rate model being shocked is a series of forwards such as Eurodollar futures, the PV'01 and DV'01 can differ even for par coupon swaps. Based on a market convention of using Eurodollar futures to build the front end of the curve (often for the first three years of the yield curve structure as is the default settings convention for the Bloomberg "SWPM" function) but using par coupon swap rates for the longer end, the PV'01 and DV'01 of a 2-yr par coupon swap differ while they are almost equivalent for a 5-yr par coupon swap or for a 10-yr par coupon swap.

The BPV convention for Treasury bonds and notes, which are the underlying securities of Treasury futures, is based on the change in full price resulting from a change in the yield to maturity of 1 basis point. Therefore, since we are looking to replace swap interest rate exposure using Treasury futures, we try to use a measure of risk for swaps that is similar. For the 5-yr swap and 10-yr swap, we use the DV'01 on the SWPM page with the default Bloomberg swap curve settings convention. But for our examples with the par coupon 2-yr

[3] Basis Point value (BPV) is just a more generic term for Dollar Value of a .01 (DV'01) which can be used for either dollar or non-dollar products. We use the terms BPV and DV'01 interchangeably here since we are discussing US dollar denominated products.

[4] "Hedging" a position's exposure and "replacing" a position's exposure is very similar, except whether you need to buy or sell. The quantity needed is the same. For example, if you need to sell 100 contracts of a Treasury future to hedge a certain size receive fixed swaps position exposure, it means you would need to buy 100 contracts to instead replace the receive fixed swaps position exposure.

swap, we get the DV'01 on the SWPM page using an older Bloomberg swap curve model that does not incorporate Eurodollar futures. We do this because we are replacing the swap exposure with an instrument (TUU3) that moves based on the yields in the 2-year sector of the curve. Another method that would give almost the same result for a par coupon 2-yr swap would be to stick with the default Bloomberg swap curve settings convention on SWPM, but use the PV'01 on this page rather than the DV'01.

The easiest way to calculate the BPV of a Treasury futures contract is to use the basic CTD method. In this simplistic method, we assume that the CTD is the only security eligible for delivery (i.e. there is absolutely no chance of a switch in the CTD). Thus, the futures are basically equivalent to a mark-to-market forward on the CTD (adjusted for its conversion factor). Under this method, the Futures BPV = BPV of CTD / CF of CTD where CF stands for conversion factor.

The CTD into the September 10-yr T-Note futures (TYU3) contract is the 3.5% 5/15/20 Treasury note. The T 3.5% 5/15/20 has a BPV of $69.92 per $100,000 face value. The conversion factor for this CTD security into TYU3 is 0.8671. Thus the BPV of the September 10-yr T-note future (which has a $100,000 face value per contract) using the basic CTD method would be $69.92/0.8671 = $80.64 per contract. Since the $10 million notional receive fixed swaps position has a net DV'01 of $9131.26 and September 10-yr T-note futures have a BPV of $80.64, we could buy $9131.26/$80.64 = 113.24 or 113 (rounded) September 10-yr T-note futures as a basic substitute for the interest rate risk exposure of our swaps position (see Table 1 in appendix for full example). Similarly, if we were trying to replace a $10 million notional pay fixed (versus receive floating) swaps position, we could sell 113 September 10-yr T-note futures.

The futures BPV in this basic CTD method is actually the forward BPV of the CTD divided by its conversion factor using a "constant basis" assumption. But there are many assumptions that can be made as to how forward yields move relative to spot yields, depending on how the yield of the CTD moves relative to the repo financing rate to expiry. Thus there are many different methods to calculate forward BPV depending upon these assumptions such as "constant basis", "constant repo", "parallel repo" and "forward yield". In order to make the hedging process as simple and transparent as possible for investors, we use a "constant basis" assumption. Under this assumption the basis of the CTD remains unchanged, making the forward BPV of the CTD equal to its spot BPV. Thus, the futures BPV is just equal to the spot BPV divided by its conversion factor under this "constant basis" assumption. Specifically for the September Treasury note futures (TYU3, FVU3, and TUU3), this happens to result in a futures BPV that is for all practical purposes almost equivalent to that obtained through a "constant repo" assumption also.[5]

The CTD into the September 5-yr T-Note futures (FVU3) contract is the 0.625% 11/30/17 Treasury note. The 0.625% 11/30/17 has a BPV of $43.10 per $100,000 face value. The conversion factor for this CTD security into FVU3 is 0.8044. Thus the BPV of the September 5-yr T-note future (which has a $100,000 face value per contract) using the basic CTD method would be $43.10 /0. 8044 = $53.58 per contract. Since the $10 million notional receive fixed swaps position has a net DV'01 of

[5] A slightly more complicated version of the basic CTD method could instead be used to calculate the futures BPV as the "constant repo" forward BPV of the CTD divided by the conversion factor of the CTD. In this method, we assume that the short term financing rate (i.e. repo) remains unchanged in different interest rate scenarios. One would anticipate that this method should provide a slightly more accurate description of how September Treasury futures prices are likely to move currently, as the Fed is unlikely to raise the funds rate in the near term, in our view. The "constant repo" assumption that repo is unchanged as Treasury yields rise and fall causes forward yields to move more than spot yields due to the increase in carry in a selloff and the decrease in carry in a rally. Thus, using the basic CTD method with a "constant repo" assumption usually results in a somewhat higher futures BPV than the "constant basis" assumption, although the difference is negligible for the September Treasury note futures (TYU3, FVU3, and TUU3). For example, it would result in a futures BPV of $80.66 per contract using a "constant repo" assumption rather than $80.64 per contract using a "constant basis" assumption for TYU3. Thus, the number of futures required would be unchanged. With the Fed unlikely to raise the funds rate in the near term, we would not recommend using a "parallel repo" assumption or a "forward yield" assumption since the futures BPV for each of the Treasury note futures would be substantially lower using these assumptions and thus too many futures would likely be used. For example, the futures BPV for TYU3 under a "parallel repo" assumption would be only $66.53/0.8671 = $76.73 per contract, and thus $9131.26/$76.73 = 119 TYU3 futures would be used to replace the swaps position.

$4876.35 and September 5-yr T-note futures have a BPV of $53.58, we could buy $4876.35 /$53.58 = 91.01 or 91 (rounded) September 5-yr T-note futures as a basic substitute for the interest rate risk exposure of our swaps position (see Table 2 in appendix for full example). Similarly, if we were trying to replace a $10 million notional pay fixed (versus receive floating) swaps position, we could sell 91 September 5-yr T-note futures.

The CTD into the September 2-yr T-Note futures (TUU3) contract is the 1.875% 06/30/15 Treasury note. The 1.875% 06/30/15 has a BPV of $20.78 per $100,000 face value. The conversion factor for this CTD security into TUU3 is 0.9324. Since the September 2-yr T-note future has a $200,000 face value per contract (unlike the 5-yr and 10-yr futures which are only $100,000), the BPV using the basic CTD method would be 2*$20.78 /0. 9324 = $44.57 per contract. Since the $10 million notional receive fixed swaps position has a net DV'01 of $1988.78 and September 2-yr T-note futures have a BPV of $44.57, we could buy $1988.78 /$44.57 = 44.62 or 45 (rounded) September 2-yr T-note futures as a basic substitute for the interest rate risk exposure of our swaps position (see Table 3 in appendix for full example). Similarly, if we were trying to replace a $10 million notional pay fixed (versus receive floating) swaps position, we could sell 45 September 2-yr T-note futures.

In Tables 4, 5, and 6 in the appendix, we examine parallel rate shift scenarios for the IRS position versus the replacement futures position for the 10-yr, 5-yr and 2-yr, respectively, using the basic CTD method. It is clear that the basic CTD method does a good job of determining the number of futures needed to replace an interest rate swap position for relatively small parallel shifts in rates (we assume here that the underlying rates of the entire interest rate swap curve as well as the yield of the CTD Treasury move together in parallel). The slight outperformance of swaps in each scenario is due to the slightly higher convexity of the position.

Yield Beta Adjustment

One problem with using the basic CTD method above is that it assumes that the yield of the CTD Treasury security into the futures contract moves one for one with the interest rate swap that the futures contract is replacing. In our example above of replacing a 10-yr swap with September 10-yr T-note futures, it roughly assumes that the yield of the CTD 3.5% 5/15/20 Treasury note (a security in the 7-yr sector of the Treasury yield curve) and 10-year swap rates move together in a one to one ratio. It roughly assumes, for example, that the 10-year swap rate rises 1 basis point (bp) when the 3.5% 5/15/20 T-note yield rises 1 bp, and the 10-year swap rate falls 1 bp when the 3.5% 5/15/20 T-note yield falls 1 bp. As we know, this is certainly not always the case.

Thus, it is prudent to adjust our hedge/replacement ratio to reflect the different yield volatilities between Treasuries and swaps and between different sectors of the yield curve. A way to do this is to use a "yield beta" or the expected change in the yield of the security being replaced, the 10-yr swap in this example, relative to the replicating vehicle underlying CTD, the 3.5% 5/15/20 Treasury note in this example. One way these yield betas can be calculated is through regressions which examine the historical relationship between changes in the 10-year swap rate and the CTD 3.5% 5/15/20 T-note. If we run a 1-month historical change regression, we get that the yield beta of the 10-yr swap rate relative to the 3.5% 5/15/20 T-note is 1.16 meaning that the 10-yr swap rate is more volatile than the 3.5% 5/15/20 T-note and tends to move about 1.16 bp for every 1 bp the 3.5% 5/15/20 T-note moves.

In our yield beta adjusted basic CTD method, we would then adjust our basic hedge/replacement ratio by this yield beta to better account for the different yield volatilities of the interest rate swap and the futures contract that is replacing it. Using the basic CTD method, 113.24 TYU3 contracts (before rounding) were used to replicate the $10 million notional 10-yr swap position. We would adjust this amount by multiplying it by the yield beta. Thus, we would need 113.24* 1.16 = 131.35 or 131 (rounded) TYU3 contracts under a yield beta adjusted method. We use more contracts under this method because we are trying to account for the fact that the 10-yr swap rate has been more volatile than the 3.5% 5/15/20 T-note yield.

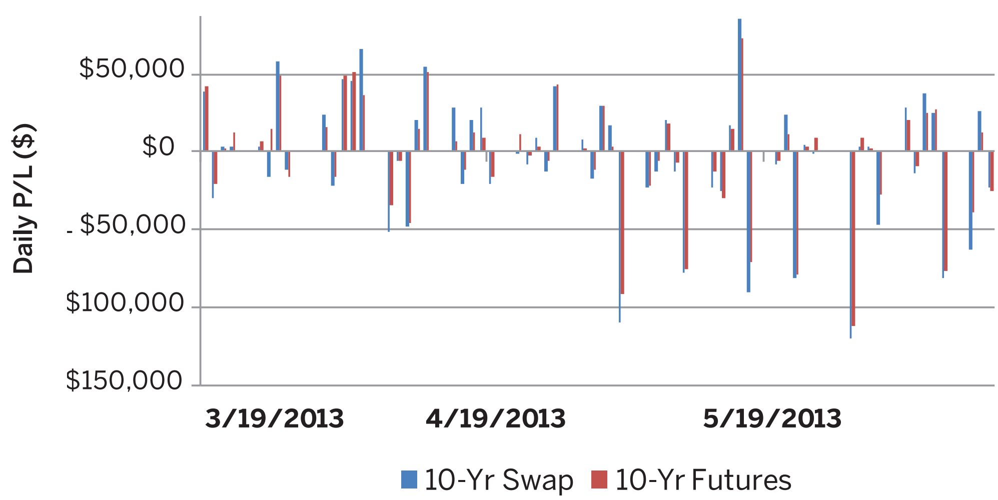
In Chart 1, we compare the daily performance from 3/19/13 to 6/12/13 of a $10 million 10-yr receive fixed swaps position (using the June 10-yr deliverable swap future on the CME Group as a rough proxy) versus a yield beta adjusted basic CTD method replacement long position of 117 June 10-yr T-note futures. The replacement position size of 117 futures is calculated as of 3/18/13 using the basic CTD method and then yield beta adjusted using a 1 month historical regression leading up to that date.

We can use this same methodology to adjust the number of FVU3 contracts we use to replace a $10 million notional 5-yr swap position. If we run a 1-month historical change regression, we get that the yield beta of the 5-yr swap rate relative to the CTD 0.625% 11/30/17 T-note is 1.22 meaning that the 5-yr swap rate is more volatile than the 0.625% 11/30/17 T-note and tends to move about 1.22 bp for every 1 bp the 0.625% 11/30/17 T-note moves. Using the basic CTD method, 91.01 FVU3 contracts were used to replicate the $10 million notional 5-yr swap position. We would adjust this amount by multiplying it by the yield beta. Thus, we would use 91.01 * 1.22 = 111.03 or 111 (rounded) FVU3 contracts under a yield beta adjusted method.

Similarly, we can use this same methodology to adjust the number of TUU3 contracts we use to replace a $10 million notional 2-yr swap position. If we run a 1-month historical change regression, we get that the yield beta of the 2-yr swap rate relative to the CTD 1.875% 06/30/15 T-note is 1.24 meaning that the 2-yr swap rate is more volatile than the 1.875% 06/30/15 T-note and tends to move about 1.24 bp for every 1 bp the 1.875% 06/30/15 T-note moves. Using the basic CTD method, 44.62 TUU3 contracts were used to replicate the $10 million notional 2-yr swap position. We would adjust this amount by multiplying it by the yield beta. Thus, we would use 44.62 * 1.24 = 55.33 or 55 (rounded) TUU3 contracts under a yield beta adjusted method.

Since these yield betas are based upon past relationships, they are only a "best guess" for how these two instruments will move relative to each other in the future. In our example, we used the most recent 1-month period to do our historical regression to determine the yield beta. But one could use a different length historical period (e.g. a 3-month regression, 6-month regression, etc.), and/or we could use a different period in history (e.g. do our regression over some period further in the past such as in 2012, 2011, 2010, etc.). The results can be quite significant. For example, if we had done a 3-month regression instead of a 1-month regression for the 5-yr replication, the yield beta would have been only 1.12 which would have resulted in using 102 FVU3 contracts versus

Chart 1: Daily Performance of $10m 10-yr Swaps versus Replacement Position of 10-yr Futures



the 111 FVU3 contracts obtained using the 1-month regression. The goal is to use a period in history that may be representative of how these two securities may behave relative to each other going forward.

Over the last few years, with the Fed making it very clear that they would be keeping the Fed funds target rate unchanged at 0-0.25% during this entire time period, the longer end of the yield curve has been more volatile than the short end. But the current relationship is not always the case. When the Fed is actively changing the Fed funds rate, the relationship is often the opposite, with the front end of the curve often more volatile than the back end. Thus, if the Fed were to begin raising the Fed funds rate, it would definitely be prudent to reconsider the historical periods used to calculate the yield betas used.

And it's not just that the futures contract is tracking a security in a different sector of the curve than the swap. Yield betas would be important even if the CTD of the futures contract was of a similar maturity to the swap (e.g. even if the current 10-yr Treasury was CTD into the 10-yr futures contract). This is because swap rates can sometimes move substantially different than Treasury yields for many reasons such as changes in credit spreads, supply/demand factors in each market, flight to quality flows, bank funding pressures, tax arbitrage, changes in levels of interest rates and shape of yield curves, LIBOR/repo spreads, etc.

A different method that could be used to determine yield betas is to look at ratios of implied normalized yield volatilities obtained from swaptions on the underlying interest rate swap relative to options on the CTD Treasury security or on the Treasury futures contract (still assuming one security is clearly 100% CTD). This method would be using the market's view of how the underlying CTD into the futures contract is likely to move relative to the swap rate going forward. The implied normalized yield volatility of the 1 month into 5 year swaption is about 1.13 times the implied normalized yield volatility of the August options (which actually expire in July) on the September 5-yr futures (FVU3). Although there are clearly some mismatches here including the exact length of each option expiry, this means that the market generally expects the basis point volatility of a 5-yr sector swap rate to be significantly higher than that of the FVU3 CTD 0.625% 11/30/17 Treasury note yield over a little more than the next month. Thus, under this method, we would use an implied yield beta of 1.13, which is lower than that obtained previously through a 1-month historical change regression.

The implied normalized yield volatility of the 1 month into 10 year swaption (about 93 bp as of 6/12/13) is only slightly higher than that of the August (expire in July) options on the September 10-yr futures (TYU3), resulting in an implied yield beta of approximately 1.02. We believe that the market may be pricing in a small risk of a switch in the CTD into a longer maturity/duration security for the options on TYU3, thus resulting in a higher implied volatility for TYU3 relative to 10-yr swaps than recent historical measures.[6] For those concerned about a dramatic upward move in Treasury yields in the 7-10 year sector of the curve, it may be wise to either use this lower yield beta (or no yield beta since it is close to 1.0) or to instead use a higher futures BPV (the "option adjusted BPV") for TYU3 when calculating hedge/replacement ratios.

The implied normalized yield volatility of the 1 month into 2 year swaption is about 1.21 times the implied normalized yield volatility of the August options (expire in July) on the September 2-yr futures (TUU3). Thus, we could use an implied yield beta of 1.21, which is only slightly lower than that obtained previously through a 1-month historical change regression.

Another way to try to account for the mismatch between the sector of the yield curve represented by the futures CTD and that of the interest rate swap could be to use a barbell/butterfly type of strategy. For example, one

[6] By assuming a possibility of a switch in the CTD into a longer duration security, the option adjusted BPV of the futures would be higher. The normalized yield volatility would be lower if obtained by using the higher option adjusted BPV when converting the price volatility. Thus, the implied yield beta would be higher (swaps more volatile than TYU3 CTD), putting it closer to the yield beta we obtained through historical regressions.

could use a combination of the 10-yr T-note futures (tracking a 7-yr sector Treasury note) and 30-yr Classic T-bond futures (tracking a 15-16 year sector Treasury bond) to replace a 10-yr swaps position. Or one could use a combination of the 5-yr T-note futures (tracking a 4-4.5 year sector Treasury note) and 10-yr T-note futures (tracking a 7 year Treasury note) to replace a 5-yr swaps position.

In the current extremely low interest rate environment, a yield beta adjusted CTD BPV hedge (assuming that the CTD and the interest rate swap yields move in similar fashion to the period used to obtain the yield beta), should do a good job of replacing interest rate exposure. But if interest rates were to rise dramatically, using a BPV for Treasury futures that is solely based on the CTD would no longer be appropriate. For this reason, market participants should be aware of a more sophisticated measure of futures BPV which is called the “option adjusted BPV” of a futures contract. The option adjusted BPV of a futures contract is roughly the probability weighted average of the “forward BPV divided by conversion factor” of each of the deliverable securities, with the probability weighting based on the chance of each security being CTD.

Option-Adjusted BPV Hedge:

The problem with the CTD hedging method, even if adjusted with yield betas, is that it assumes that there is one security which is clearly the CTD and will remain the CTD until maturity. This currently may be a very likely scenario for the September Treasury note futures contracts, especially FVU3 and TUU3, given the extremely low level of Treasury yields now. But if interest rates were to rise dramatically, especially if concurrent with a steepening of the yield curve and a rise in volatility, other securities would begin to have some probability of becoming CTD and a switch in the CTD could even occur eventually.

As we mentioned earlier, Treasury futures are on a basket of deliverable Treasury securities rather than on just one. The short position in the futures contract determines which security to deliver. This “embedded option” held by the short position can at times greatly affect the risk characteristics of Treasury futures. The risk characteristics , such as BPV and convexity, of a Treasury bond and note futures contract can either be very similar to or very different than that of a bond or swap position depending upon many factors including (but not limited to) the level of interest rates, shape of the curve, and volatility. In the current interest rate environment, with Treasury yields across the curve far below the 6% notional coupon of the Treasury futures contract, the shortest duration deliverable security is CTD for each September Treasury note futures contract and the chance of a switch in the CTD is unlikely, especially for FVU3 and TUU3. Thus, the contracts trade with relatively similar duration/BPV and positive convexity characteristics to the CTD security (adjusted for the conversion factor).

If rates were to rise substantially though, these risk characteristics could change significantly as other securities in the deliverable basket become more realistic “contenders” to become CTD. For example, the positive convexity of the futures contract could begin to decline and eventually even turn negative, with the option adjusted BPV of the futures contract eventually rising along with interest rates. This would be in contrast to a bond or swap where the duration/BPV generally falls as interest rates rise.

When the embedded options in the futures contract have no value (i.e. 100% chance the CTD will remain CTD), the futures price should approximately be equal to the forward price of the CTD divided by its conversion factor. But when the embedded options (which benefit the short position) have value, the futures price should trade at a lower price than it would have otherwise, thus reflecting the market value of this embedded option.[7]

[7] There are multiple options (that benefit the short futures position) embedded in the structure of the futures contract concerning the choice of which security to deliver and the timing of that delivery such as the “quality” or “switch” option, “End-of-month (EOM)” option, “wildcard” option, and “yield curve” option

As the probability of a switch in the CTD occurring increases due to various movements in the level of interest rates, shape of the curve, volatility, repo, etc., the value of the embedded option increases. This causes the risk characteristics of the futures contract to change and the futures price to move differently than predicted purely by the conversion factor adjusted BPV and convexity of the CTD.

When interest rates are so low that the shortest duration deliverable security is CTD, as is currently the case, the short futures position is essentially long a put while the long futures position is short that same put.[8] This put has minimal to no value for the September 2-yr and 5-yr Treasury note futures (TUU3, FVU3) and relatively low value for the September 10-yr Treasury note futures (TYU3) given current conditions (the level of Treasury yields, the shape of the Treasury yield curve, implied market volatility, etc).[9] But if interest rates were to rise dramatically, the option adjusted BPV of the futures would begin to rise relative to the futures BPV obtained through the basic CTD method (i.e. forward BPV of the CTD divided by its conversion factor) as the convexity of the contract would decline and eventually turn negative.

Based on 6/12/13 market levels, it would take a dramatic upward move in yields (assuming a parallel shift), to cause a switch in the CTD for the September Treasury note futures (2-yr, 5-yr, and 10-yr) contracts. Just as a rough estimate, it would take approximately a 200bp move upward in yields in the 7-10 year sector of the curve to cause a switch in the CTD for the September 10-yr T-note futures (TYU3). For the September 5-yr T-note futures (FVU3) and the September 2-yr T-note futures (TUU3), it would take even larger upward moves in yield to cause a switch. It would take a move of more than 300bp in the 4-5 year sector to cause a switch in the CTD for FVU3, and a move of more than 450bp in the 2 year sector to cause a switch in the CTD![10]

But scenarios in which the yields along the deliverable curves move exactly in parallel are unrealistic. For example, with the Fed funds rate currently pinned at 0-.25% for now, it is perfectly reasonable to expect the curve to steepen if yields further out the curve rise. If the curve were to steepen as interest rates rise, the switches would occur much more rapidly than in our parallel shift scenarios in the last paragraph. For example if the curve were to steepen in a way that the current 10-yr Treasury yield rose at a pace of 11 bp for every 10 bp that the CTD 3.5% 5/15/20 Treasury yield rose, it roughly would take only about a 150 bp rise for the current 10-yr Treasury, which is currently the longest duration deliverable security, to become CTD into TYU3. And a switch to another security in the deliverable basket with a duration that is somewhere in between the two would likely occur before that.

Additionally, even without a general change in the level of rates or curve shape, changes in the yield spread between the CTD and other Treasury notes in the deliverable basket can cause switches to occur more or less rapidly. For example, a cheapening of other Treasury notes in the deliverable basket relative to the CTD (or equivalently a richening of the CTD relative to them) can cause a switch in the CTD to occur much more rapidly also.

The price movement of the futures contracts also should begin to account for the possibility of a switch long before the switch actually occurs. Thus, market participants should monitor the more sophisticated futures contract risk metric, the option-adjusted BPV,

[8] In higher interest rate scenarios, where the shortest duration security is not CTD, the short futures position could be essentially long a call or long a straddle (call and put) with the long futures position again having the opposite position.

[9] The "perfect storm" of a substantial increase in 10-yr Treasury yields along with a steepening Treasury yield curve and a substantial increase in volatility could give this embedded put option for TYU3 value. Given that the Fed is unlikely to raise the Fed funds rate anytime soon, an increase in 10-yr yields would likely be accompanied by a curve steepening, making this scenario possible. This may be why TYU3 is currently trading cheap relative to the forward price divided by conversion factor of its CTD.

[10] For all of the examples in this paragraph, the numbers are extremely rough estimates (with a lot of rounding) assuming a parallel shift in yields across the deliverable curve, at a horizon of the last delivery date of each respective September futures contract.

as interest rates begin to rise. Investors should always actively monitor and adjust hedge ratios as market conditions change, but this is especially important if rates rise substantially from current levels.

For now, we believe that interest rates are low enough that investors do not need to be overly concerned about the embedded switch options in the September Treasury note futures contracts (2-yr, 5-yr and 10-yr), although the 10-yr Treasury note futures contract deserves closer monitoring if interest rates begin to rise rapidly. Thus, using a yield beta adjusted basic CTD method for calculating the BPV of these futures should work well for now. But it would be prudent to be aware of how the risk characteristics of futures contracts can change if interest rates begin to rise substantially. In a later article, we will explore how futures should perform in a higher interest rate environment in more detail and examine the calculation of different option adjusted BPVs to use in hedging or replication purposes.

In addition to the effect of changes in the level of rates, shape of the curve, deliverable security yield spreads and possible switches in the CTD, there also are many other factors that can affect Treasury futures performance such as fair value mispricing risk, repo specialness, when issued's/synthetics, squeezes, calendar spread rolls, etc. And when using futures to replicate swaps, there are additional hedging/replication risks based on the movement of swap rates relative to Treasury yields and Libor relative to repo.

Margin Requirements Lower for Futures than IRS

Exchange traded futures generally have substantially lower margin requirements than cleared over-the-counter interest rate swaps (OTC IRS). On November 8, 2011, the CFTC adopted final regulations to implement certain provisions of Title VII and Title VIII of Dodd-Frank Act governing derivatives clearing organization (DCO) activities. Within these final rules concerning Derivatives Clearing Organization General Provisions and Core Principles, Part 39, Subpart B, Section 39.13 (g) (2) discusses the core principles of risk management for DCOs specifically relating to margin requirements.

In accordance with these rules, cleared OTC swaps are margined on a 5 day liquidation basis while Treasury futures are margined on a 1 day liquidation basis. Essentially, the minimum initial margin requirements for exchange traded futures are based on the assumption that the position could be liquidated in only 1 day, whereas the minimum initial margin requirements for centrally cleared interest rate swaps are based on the assumption that the position could take 5 days to be liquidated. Thus, the initial margin requirements for exchange traded futures are much less onerous than for centrally cleared interest rate swaps. For non-centrally cleared swaps, it could be an even more onerous 10-day liquidation basis.

Adjusting for the square root of time, the initial margin requirement theoretically could be 2.24 times higher for centrally cleared interest rate swaps relative to exchange traded futures contracts if the same risk model was used. Since the CME Group uses a Historical Value at Risk (HVaR) model for swaps, but a Standard Portfolio Analysis of Risk (SPAN) model for futures, the math does not work out exactly, but it is safe to say that the initial margin requirements for exchange traded futures are substantially lower than for cleared OTC IRS.[11]

In an example for clearing on the CME Group on trade date 6/12/13, the initial margin requirement for a $10 million receive fixed position in a 10-yr OTC IRS swap

[11] CME Group margin requirements for cleared OTC IRS are currently substantially more than 2.24 times higher than for a BPV equivalent number of Treasury futures contracts. This is partly due to the recent higher yield volatility of interest rate swaps relative to the CTD of the equivalent futures contract. For example, as we discussed in our section on yield betas, 10-yr interest rate swaps have been substantially more volatile than the TYU3 CTD, the 3.5% 5/15/20 Treasury note, in part due to the Fed's on hold policy. Differences between the Historical Value at Risk (HVaR) model used to determine swaps margin and the Standard Portfolio Analysis of Risk (SPAN) model used to determine futures margin on the CME Group also are responsible for the discrepancy. When cross margining a portfolio with both cleared OTC IRS and interest rate futures (e.g. Eurodollar futures, Treasury futures) at the CME Group, the HVar system is used for calculation of the entire cross margined portfolio.

was $383,048, while the initial margin requirement for an BPV equivalent 113 contract long position in the September 10-yr Treasury Note futures was $124,300. In Table 7, we can see that the initial margin requirement for each OTC IRS swap is considerably higher than for its BPV equivalent futures position.

As another interesting point, there are massive capital efficiencies to cross margining a portfolio. The total margin required on a cross margined portfolio where one held both a $10m receive fixed position in 10-yr OTC IRS and a short position in 113 TYU3 futures (i.e. futures used as a hedge to offset swap rate risk rather than using futures to replace a position in swaps, so short the futures), for example, would have an initial margin of $211,081. This cross margined amount is much closer to the margin required for the futures position alone than to the amount required for the OTC IRS.

There are major capital efficiencies to using futures to create or to offset interest rate risk exposure rather than OTC IRS swaps. In addition to the lower margin requirements resulting from Dodd-Frank, there are likely higher risk capital requirements on banks trading swaps (and thus with costs passed on to their customers) from a combination of Dodd-Frank, Fed prudential regulation and Basel III.

Summary

For market participants using swaps to hedge LIBOR based risk for whom having an extremely precise hedge is much more important than regulatory and capital efficiency issues, using interest rate swaps rather than futures may still be necessary. But for market participants using swaps for speculative purposes or to hedge interest rate risk that is not specifically based on LIBOR, then Treasury futures provide a transparent, liquid, capital efficient way to obtain this exposure with regulatory ease.

Appendix:

Table 1: Replacing a 10-yr Interest Rate Swap Position with 10-yr T-Note Futures (based on 6/12/13 market levels)

10-yr Interest Rate Swap (IRS): Receive Fixed on $10 million BBA LIBOR interest rate swap	
Fixed Rate	2.420734%
Tenor	10-yrs
BPV (i.e. DV'01)	$9131.26

Sep 10-yr T-Note futures (TYU3):	
TYU3 Price	128-20 (e.g. 128+20/32)
CTD Treasury	T 3.5% 5/15/20
CTD BPV	$69.92 per 100,000 face value
CTD Conversion Factor (CF)	0.8671

Futures Contracts Needed to Replace Swap Exposure Using Basic CTD Method:	
Futures BPV	CTD BPV/CTD CF = $69.92/0.8671 = $80.64 per contract
Swap BPV / Futures BPV	$9131.26/$80.64 = 113.24. So, buy 113 TYU3 contracts to replace 10-yr IRS

Using Basic CTD Method with Yield Beta Adjustment:	
Yield Beta	1.16 (10-yr swap moves more than TYU3 CTD)(using 1-month historical regression)
(Swap BPV / Futures BPV) *Yield Beta	($9131.26/$80.64) * 1.16 = 131.35 So, buy 131 TYU3 contracts to replace 10-yr IRS

Note: For all our examples, we assume typical "vanilla" interest rate swaps with semiannual fixed payment dates (30/360 day count) and quarterly floating payment dates (Actual/360 day count). Floating Rate Reference: BBA 3-month USD LIBOR

Table 2: Replacing a 5-yr Interest Rate Swap Position with 5-yr T-Note Futures (based on 6/12/13 market levels)

5-yr Interest Rate Swap (IRS): Receive Fixed on $10 million BBA LIBOR interest rate swap	
Fixed Rate	1.342561%
Tenor	5-yrs
BPV (i.e. DV'01)	$4876.35
Sep 5-yr T-Note futures (FVU3):	
FVU3 Price	121-30+ (e.g. 121+30.5/32)
CTD Treasury	T 0.625% 11/30/17
CTD BPV	$43.10 per 100,000 face value
CTD Conversion Factor (CF)	0.8044
Futures Contracts Needed to Replace Swap Exposure Using Basic CTD Method:	
Futures BPV	CTD BPV/CTD CF = $43.10/0.8044 = $53.58 per contract
Swap BPV / Futures BPV	$4876.35/$53.58 = 91.01. So, buy 91 FVU3 contracts to replace 5-yr IRS
Using Basic CTD Method with Yield Beta Adjustment:	
Yield Beta	1.22 (5-yr swap moves more than FVU3 CTD) (using 1-month historical regression)
(Swap BPV / Futures BPV) *Yield Beta	($4876.35/$53.58) * 1.22 = 111.03. So, buy 111 FVU3 contracts to replace 5-yr IRS

Note: For all our examples, we assume typical "vanilla" interest rate swaps with semiannual fixed payment dates (30/360 day count) and quarterly floating payment dates (Actual/360 day count). Floating Rate Reference: BBA 3-month USD LIBOR

Table 3: Replacing a 2-yr Interest Rate Swap Position with 2-yr T-Note Futures (based on 6/12/13 market levels)

2-yr Interest Rate Swap (IRS): Receive Fixed on $10 million BBA LIBOR interest rate swap	
Fixed Rate	0.495825%
Tenor:	2-yrs
BPV (i.e. DV'01)	$1998.77

Sep 2-yr T-Note futures (TUU3):	
TUU3 Price	110-01 (e.g. 110+1/32)
CTD Treasury	T 1.875% 06/30/15
CTD BPV	$20.78 per 100,000 face value
CTD Conversion Factor (CF)	0.9324

Futures Contracts Needed to Replace Swap Exposure Using Basic CTD Method:	
Futures BPV	CTD BPV/CTD CF = 2 *$20.78/0.9324 = $44.57 per contract (we multiply by 2 because 2-yr T-note futures have $200,000 face value)
Swap BPV / Futures BPV	$1988.78/$44.57 = 44.6215.So, buy 45 TUU3 contracts to replace 2-yr IRS

Using Basic CTD Method with Yield Beta Adjustment:	
Yield Beta	1.24 (2-yr swap moves more than TUU3 CTD) (using 1-month historical regression)
(Swap BPV / Futures BPV) * Yield Beta	($1988.78/$44.57) * 1.24 = 55.33. So, buy 55 TUU3 contracts to replace 2-yr IRS

Note: For all our examples, we assume typical "vanilla" interest rate swaps with semiannual fixed payment dates (30/360 day count) and quarterly floating payment dates (Actual/360 day count). Floating Rate Reference: BBA 3-month USD LIBOR

Table 4: Scenario Analysis Comparing Performance of Long (i.e. Receive Fixed vs Pay Floating) $10 million 10-Yr IRS against Basic CTD Method Replacement of Long 113.24 TYU3[12]

	Long $10 million 10-Yr IRS		Long 113.24 TYU3 contracts		Performance Diff.
Rates (bp)	IRS NPV	IRS P/L	Fut Px	Fut P/L	Swap P/L-Fut P/L
-25	$231,321.00	$231,321.00	130.659015	$230,331.87	$989.13
-15	$138,058.04	$138,058.04	129.841067	$137,707.40	$350.64
-5	$45,776.36	$45,776.36	129.028916	$45,739.40	$36.96
No Change	$0.00	$0.00	128.625	$0.00	$0.00
5	($45,534.95)	($45,534.95)	128.222517	($45,577.16)	$42.21
15	($135,886.33)	($135,886.33)	127.421827	($136,247.31)	$360.98
25	($225,288.00)	($225,288.00)	126.626801	($226,276.02)	$988.02

Table 5: Scenario Analysis Comparing Performance of Long (i.e. Receive Fixed vs Pay Floating) $10 million 5-Yr IRS against Basic CTD Method Replacement of Long 91.01 FVU3[12]

	Long $10 million 5-Yr IRS		Long 91.01 FVU3 contracts		Performance Diff.
Rates (bp)	IRS NPV	IRS P/L	Fut Px	Fut P/L	Swap P/L-Fut P/L
-25	$122,776.00	$122,776.00	123.30094	$122,664.63	$111.37
-15	$73,456.90	$73,456.90	122.759823	$73,417.59	$39.31
-5	$24,416.43	$24,416.43	122.221363	$24,412.35	$4.08
No Change	$0.00	$0.00	121.953125	$0.00	$0.00
5	($24,346.89)	($24,346.89)	121.685546	($24,352.38)	$5.49
15	($72,834.67)	($72,834.67)	121.152357	($72,877.91)	$43.24
25	($121,049.00)	($121,049.00)	120.621782	($121,165.54)	$116.54

Table 6: Scenario Analysis Comparing Performance of Long (i.e. Receive Fixed vs Pay Floating) $10 million 2-Yr IRS against Basic CTD Method Replacement of Long 44.6213 TUU3[12]

	Long $10 million 2-Yr IRS		Long 44.6213 TUU3 contracts		Performance Diff.
Rates (bp)	IRS NPV	IRS P/L	Fut Px	Fut P/L	Swap P/L-Fut P/L
-25	$49,886.88	$49,886.88	110.590142	$49,877.01	$9.87
-15	$29,891.90	$29,891.90	110.366161	$29,888.32	$3.58
-5	$9,950.57	$9,950.57	110.142746	$9,950.17	$0.40
No Change	$0.00	$0.00	110.03125	$0.00	$0.00
5	($9,937.43)	($9,937.43)	109.919895	($9,937.58)	$0.15
15	($29,771.74)	($29,771.74)	109.697608	($29,775.08)	$3.34
25	($49,553.09)	($49,553.09)	109.475882	($49,562.49)	$9.40

[12] In Tables 4, 5, and 6, we assume an instantaneous parallel shift in which the underlying rates of the entire interest rate swap curve as well as the yield of the CTD Treasury move together in parallel. We use the unrounded number of futures contracts determined by the basic CTD method replacement/hedge ratio, even though in reality investors can only buy/sell a whole contract. We also do not round the futures prices in the scenario analysis even though in reality 10-yr Treasury futures trade in minimum increments of ½ a 32nd and 5-yr and 2-yr Treasury futures trade in minimum increments of ¼ a 32nd. The reason we do not round here is to better demonstrate that the slight outperformance of swaps in each scenario is due to the slightly higher convexity of the position. Since we are assuming a parallel shift in these examples, in order to maintain consistency, we do not apply a yield beta adjustment to calculate the replacement/hedge ratios here.

Table 7: CME Group Margin Requirements for Cleared OTC IRS versus BPV Equivalent Number of Treasury Futures (as of 6/12/13)[13]

Instrument	Position Size	Buy/Sell	Margin Required	Cross Margin
10-Yr Interest Rate Swap	$10 million	Receive Fixed	$383,048	$211,081
September 10-Yr T-Note Futures	113 contracts	Sell	$124,300	
5-Yr Interest Rate Swap	$10 million	Receive Fixed	$204,698	$83,901
September 5-Yr T-Note Futures	91 contracts	Sell	$50,050	
2-Yr Interest Rate Swap	$10 million	Receive Fixed	$80,693	$45,871
September 2-Yr T-Note Futures	45 contracts	Sell	$10,125	

Source: CME Group

[13] In Table 7, we show short futures positions versus receive fixed swaps positions in order to show the cross margins for hedged positions also. Obviously, if an investor was just looking to replace receive fixed swaps exposure, they would be long futures rather than short futures. The margin on the individual futures position is the same regardless of whether the position is long or short. The margin on a pay fixed swaps position is different than on a receive fixed swaps position, though, and the cross margins would be different also.

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