CME Group

INTEREST RATES

Treasury Futures Delivery Options, Basis Spreads, and Delivery Tails

September 2016

As a Treasury futures contract nears expiration, the delivery invoice amounts implied by its price tend to converge toward cash market prices of the Treasury securities eligible for delivery in fulfillment of the contract. The path to convergence is revealed in the dynamics of the Treasury basis spread (or "basis").

All that makes the basis financially interesting is rooted in the Treasury futures delivery process –

- This includes various tactical decisions controlled by the short futures position holder (the "short") who makes delivery. The long futures position holder (the "long") assigned by CME Clearing to take delivery must abide by the short position holder's choices. In effect the short is implicitly the owner, and the long implicitly the seller, of a set of options embedded in the delivery process.
- It comprises short-term interest rate exposure through the interval culminating in futures delivery, via the relationship between coupon income paid out by a delivery-eligible Treasury security and the cost of financing ownership of the security.
- It extends to the concept of balance in the relative-value spread between the futures contract and the deliverable security. Prior to delivery, balance is achieved in terms of their relative interest rate sensitivities. At the moment that physical delivery on the expiring contract becomes the intent, balance is abruptly redefined in terms of face value – notional in the case of futures, actual in the case of the deliverable security. The shift in definition of balance is the point at which "delivery tails" emerge, requiring attentive management by the holder of basis exposure.

This note reviews the mechanics of the basis spread. It starts with an overview of the Treasury futures delivery process, and a summary of the options embedded therein. It then defines the structure of the Treasury basis spread, reviews basis nomenclature and arithmetic, and discusses how delivery tails arise. After reconnoitering the embedded delivery options from the basis spread holder's point of view, it concludes with a discussion of tactics for managing basis spread exposures and delivery tails in delivery.

TREASURY FUTURES DELIVERY OPTIONS, BASIS SPREADS, AND DELIVERY TAILS

September 2016

TABLE OF CONTENTS

CONTRIBUTORS

Jonathan Kronstein, Research & Product Development
Agha Mirza, Interest Rate Business Line Management
Frederick Sturm, Research & Product Development

THE BASICS OF TREASURY FUTURES DELIVERY

Most expiring Treasury futures[1] are fulfilled by physical delivery of $100,000 face value of contract grade Treasury securities at the contract delivery invoice price. Exceptions are 3-Year Note ("Z3N") futures and 2-Year Note ("ZT") futures, for which contract size requires delivery of $200,000 face value of eligible securities. See Exhibit 1.

The exchange clearing house, CME Clearing, is solely responsible for assigning and processing Treasury futures deliveries.[2] Each contract delivery is accomplished through a three-day process:

1 ***Intention Day***

On Intention Day the owner of a short position in an expiring contract who wants to make delivery instructs her clearing firm to notify CME Clearing of intent to deliver. The deadline for such notification is 6:00 p.m. Chicago time ("CT").

For Ultra Bond ("UB") futures, Bond ("ZB") futures, Ultra 10-Year Note ("TN") futures, or 10-Year Note ("ZN") futures, a clearing firm can declare intent to deliver on any day from the second business day prior to the first business day of the delivery month (First Intention Day) through, and including, the second business day before the last business day of the delivery month (Last Intention Day).

For 5-Year Note ("ZF") futures, Z3N futures, or ZT futures, First Intention Day is the second business day before the first business day of the delivery month, and Last Intention Day is the first business day of the next following calendar month.

After close of business, CME Clearing matches each clearing firm making delivery on short positions held by its accounts ("short clearing firm") to one or more clearing firms carrying long positions in the contract held by their accounts ("long clearing firms"). Any long clearing firm so assigned is obligated to accept delivery.

Exhibit 1 – Deliverable Grades for Treasury Note and Bond Futures

	Contract Size ($ Face Value)	Deliverable Grade
Ultra Bond (UB)	100,000	Treasury bonds. Remaining term to maturity: at least 25 years.
Bond (ZB)	100,000	Treasury bonds. Remaining term to maturity: at least 15 years and less than 25 years.
Ultra 10-Year Note (TN)	100,000	Treasury notes. Remaining term to maturity: at least 9 years 5 months and not more than 10 years.
10-Year Note (ZN)	100,000	Treasury notes. Remaining term to maturity: at least 6 years 6 months and not more than 10 years.
5-Year Note (ZF)	100,000	Treasury notes. Original term to maturity: not more than 5 years 3 months. Remaining term to maturity: at least 4 years 2 months.
3-Year Note (Z3N)	200,000	Treasury notes. Original term to maturity: not more than 5 years 3 months. Remaining term to maturity: at least 2 years 9 months and not more than 3 years.
2-Year Note (ZT)	200,000	Treasury notes. Original term to maturity: not more than 5 years 3 months. Remaining term to maturity: at least 1 year 9 months and not more than 2 years.

1 "Treasury futures" comprise Long-Term US Treasury Bond ("Ultra Bond") futures, US Treasury Bond ("Bond") futures, 10-Year US Treasury Note ("Ultra 10-Year Note") futures, Long-Term US Treasury Note ("10-Year Note") futures, Medium-Term US Treasury Note ("5-Year Note") futures, 3-Year US Treasury Note ("3-Year Note") futures, and Short-Term US Treasury Note ("2-Year Note") futures. All rules and procedures for Treasury futures, including those for making or taking delivery, are established by the Board of Trade of the City of Chicago, Inc. ("CBOT" or "exchange"), one of four designated contract markets owned and operated by CME Group Inc., subject to regulation by the US Commodity Futures Trading Commission.

For a complete account of the process by which a Treasury futures contract goes to delivery, see The Treasury Futures Delivery Process, 6th Edition, CME Group, July 2016.

2 CME Clearing is a division of Chicago Mercantile Exchange Inc. ("CME"), one of four designated contract markets owned and operated by CME Group Inc. CME Clearing is a derivatives clearing organization registered with and subject to regulation by the US Commodity Futures Trading Commission.

2 *Notice Day*

On Notice of Intention Day (or simply Notice Day) the short clearing firm that declared intent to deliver on the previous business day prepares an invoice detailing the Treasury security to be delivered, including its CUSIP number, coupon rate, and maturity date. No later than 2:00 p.m. CT (3:00 p.m. CT on Last Notice Day), the short clearing firm and CME Clearing confirm the delivery invoice amount, after which CME Clearing transmits the invoice to the long clearing firm it has assigned to take delivery.

3 *Delivery Day*

On Delivery Day the short clearing firm must have the specified Treasury securities in its bank account no later than 10:00am CT. The securities are then delivered to the long clearing firm's bank account, upon which the long clearing firm must remit the correct invoice amount to the short clearing firm. The process must be completed by 1:00 p.m. CT.

For expiring UB, ZB, TN, or ZN futures, the first (last) eligible delivery day is the first (last) business day of the contract delivery month.

For ZF, Z3N, or ZT futures, the first eligible delivery day is the first business day of the contract delivery month, and the last eligible delivery day is the third business day of the next following calendar month.

Summary of Similarities and Differences among Contract Critical Dates

For all Treasury futures:

First Intention Day occurs on the second business day before the first business day of an expiring contract's delivery month. *First Notice Day* is the next business day thereafter. *First Delivery Day* is the first business day of the contract delivery month.

For UB, ZB, TN, or ZN futures:

Although the delivery process continues until the end of the delivery month, *the last trading day – ie.* ,the termination of centralized competitive trading in the expiring contract on the CME Globex electronic trading platform ("CME Globex") – is the seventh business day before the last business day of the delivery month. *Last Intention Day* is the second business day before the last business day of the delivery month, *Last Notice Day* is the next-to-last business day, and *Last Delivery Day* is the last business day.

For ZF, Z3N, or ZT futures:

The *Last Trading Day* is the last business day of the delivery month. *Last Intention Day* is the first business day of the calendar month next following the contract's named delivery month. *Last Notice Day* and *Last Delivery Day* are, respectively, the second and third business days of the next following calendar month.

Delivery Invoice Price

For each contract that goes to delivery, the invoice amount is the sum of two components:

Invoice Amount =
Converted Futures Price + Accrued Interest

Converted Futures Price

...plays the same role in a Treasury futures delivery as the clean price (the price excluding accrued coupon interest to trade settlement date) plays in a cash transaction in Treasury notes or bonds. The converted futures price is the product of three elements: [3]

Converted Futures Price =
Contract Size x Futures Settlement Price x
x Conversion Factor

3 Normal rounding conventions apply to the converted futures price: After it is calculated, the amount gets rounded to the nearest penny, or rounded up to the nearest penny in the case of an amount ending in a half-cent ($0.005).

To be clear, all such rounding is applied per contract. Where a short holder makes delivery on, say, 100 contracts, the aggregate delivery invoice amount is the sum of 100 rounded per-contract amounts.

CONTRACT SIZE

For UB, US, TN, ZN, or ZF futures, contract size is $1,000 per contract price point (or $100,000 face value of deliverable grade securities per contract). For Z3N or ZT futures, contract size is $2,000 per contract price point (or $200,000 face value per contract).

FUTURES SETTLEMENT PRICE

…is expressed in price points and fractions of price points, with par equal to 100 points. If a short declares intent to deliver on an expiring contract at *any time prior to the contract's last trading day*, the delivery invoice amount is based on the futures daily settlement price for the Intention Day on which she declares. If she declares intent to deliver *at any time on or after the contract's last trading day*, the delivery invoice amount is based on the contract final settlement price.

CONVERSION FACTOR

Regardless of when the short chooses to make delivery, multiple Treasury issues will be available to her to use in fulfilling delivery. To make deliverable grade Treasury securities roughly comparable to one another, the futures settlement price that determines the invoice amount is adjusted to account for the characteristics of the Treasury issue tendered for delivery. The adjustment is made through a system of conversion factors, in which the conversion factor for any deliverable grade issue represents the price at which $1 face value, if transacted and settled during the futures contract delivery month, would yield 6 percent.[4]

Accrued Interest

The delivery invoice amount that the long clearing firm taking delivery pays to the short clearing firm making delivery includes any coupon interest that has accrued but has not been paid as of the delivery date. Determination of the accrued interest amount is identical in all respects to the calculation that would apply in a conventional cash market transaction in Treasury notes or bonds. In both cases coupon interest accrues evenly, on the basis of the actual number of days in the semi-annual interval between the date of the last coupon payment preceding delivery and the date of the next coupon payment following delivery. [5]

OPTIONS EMBEDDED IN FUTURES DELIVERY

At various points throughout an expiring contract's delivery month, the short making delivery holds the right to make certain tactical decisions. Acting on behalf of the long holder, the long clearing firm assigned by CME Clearing to take delivery is contractually bound to accept the outcomes of these decisions. In effect, the short owns an embedded American-style rainbow option that confers upon her two sets of privileges: timing of delivery and quality of delivery.

Timing of Delivery – The Carry Option

The embedded option permits American-style exercise [6] in the sense that the short has the privilege of deciding when to deliver, provided she does so during the interval allowed by contract terms.

4 Delivery invoice conversion factors for Treasury futures are established solely by the exchange. They are published by the exchange and are available from most quote vendors. For any Treasury futures contract for a given delivery month, the conversion factors for all deliverable grade securities are determined before the contract is listed for trading, and remain fixed (as contract terms) throughout the life of the contract. To obtain conversion factors, or to learn how they are determined, please visit ***http://www.cmegroup.com/trading/interest-rates/treasury-conversion-factors.html***

5 Coupon accrual conventions for Treasury bonds and notes are defined in the Code of Federal Regulations. See 31 CFR 306, General Regulations Governing U.S. Securities, Subpart E – Interest, and 31 CFR 356, Sale and Issue of Marketable Book-Entry Treasury Bills, Notes and Bonds, Appendix B (also available as Dept of the Treasury Circular, Public Debt Series No 1-93). See also The Treasury Futures Delivery Process, 6th Edition, CME Group, July 2016.

6 Strictly speaking, for a short futures position entered prior to the contract's First Intention Day, the embedded option is forward-starting. For a short position entered on or after the contract's First Intention Day, the embedded option behaves like conventional American-style exercise.

Prominent among considerations that might influence her choice of delivery date is the "carry" that she earns or pays on her holdings of cash Treasury securities. To see this, consider a short holder of expiring futures who acquires contract grade securities to use in delivery, and who finances ownership of the securities through repurchase agreements ("repo") until the anticipated delivery date. All other things being equal, if carry is positive – that is, if the coupon interest that the securities pay over the term from purchase to the prospective futures delivery date exceeds the repo interest cost of holding them over the same term – then the short has at least one reason to retain possession of the securities until the contract's last allowable delivery date. Conversely, if carry is negative – if the repo interest she pays exceeds the coupon interest she earns – by sufficient magnitude to nullify the value of other embedded delivery options, then she has an incentive to make delivery on her short futures position as early as possible. [7]

Quality of Delivery – The CTD Option

The embedded option is a rainbow option in the sense that the short is entitled to choose one of multiple eligible Treasury issues to deliver in fulfillment of contract. Provided that the issue meets contract standards for delivery eligibility, the long clearing firm assigned by CME Clearing to take delivery must accept the seller's selection.

At any point prior to futures expiration, some contract grade issues will be more economical to acquire than others for making delivery. For this reason, anyone who trades or holds a Treasury futures contract tends to monitor the price movements and the availability of the contract grade issue that is most profitable to acquire for making delivery (the "cheapest to deliver" or "CTD"), as well as the price action and availability of other delivery-eligible issues that might come into play as close alternatives or successors to the current CTD issue.

To make "most profitable to acquire" more concrete, consider a thought experiment in which you take a snapshot of market conditions at a given moment, including the price of the futures contract and the cash market prices of each of its deliverable grade securities. Pick an admissible contract delivery date. (For reasons discussed above in connection with timing of delivery and the carry option, this is apt to be either the first delivery date or the last.)

For each contract grade security, find the ratio of the futures contract delivery invoice amount at the futures price of the moment versus the invoice amount needed to acquire the security for spot (t+1) settlement at its going price in the cash market. [8] CTD status goes to the delivery-eligible issue with the maximum value of this ratio –

$$Ratio = [\ (\$1000 \times F \times cf) + AI(d)\ ]/[\ (\$1{,}000 \times P) + AI(t+1)\ ]$$

P is the price of the Treasury security for standard t+1 settlement, quoted in price points and fractions of points, with par on the basis of 100.

F is the price of the futures contract, likewise quoted in price points and fractions of price points, with par on the basis of 100.

cf is the conversion factor applicable to delivery of the security in fulfillment of the futures contract.

AI(t+1) is accrued coupon interest on $100,000 face value of the security from its most recent coupon payment date to the next business day (t+1), when the cash transaction settles.

AI(d) is accrued coupon interest on $100,000 face value of the security from its most recent coupon payment date to the prospective futures contract delivery date. [9]

That is, *at any given moment the CTD issue is the one for which the corresponding futures delivery invoice amount is largest relative to the issue's all-in price for spot settlement in the cash market.*

7 As will become clear presently, the motive to exercise by delivering early arises if carry is negative enough to cause the gross basis to be negative. *See The Basis Spread and Delivery Tails on page 7.*

8 In what follows, we assume for ease of presentation that the futures contract is one for which notional size is $100,000 face value, ie, $1,000 per contract price point. *See The Basics of Treasury Futures Delivery on page 2.*

9 This representation incorporates a further simplification, namely that the security at hand has no coupon interest payment dates between the next business day (t+1) and the prospective futures delivery date (d).

Market practitioners typically translate this ratio into its corresponding "implied repo rate," the hypothetical rate of return per annum that would result from purchasing the security at its prevailing cash market price and subsequently delivering it in fulfillment of the expiring futures contract. This translation enables them to assess CTD status in terms of the contract grade security with the highest implied repo rate:

Implied Repo Rate = (Ratio - 1) x 360 / (d - (t+1))

The source of value in the CTD option is the mobility of CTD status from one deliverable grade security to another. Irrespective of whether CTD status rotates among the contract's deliverable issues rapidly, slowly, or not at all, the contract price at any given moment reflects (a) prevailing prices of the deliverable grade issue(s) that market participants expect will play a material role in the physical delivery process, (b) the cost of financing ownership of such issue(s) until delivery, and (c) volatility in (a) and (b).

Contained within the CTD option are two subspecies, the End of Month option and the Wild Card option. Neither would exist if the futures contract and its deliverable grade issues were continuously available for trading. In such a fictive universe, the futures contract price – which ultimately serves as the CTD option's exercise price – would interact constantly with price dynamics of contract grade securities.

The End of Month option and the Wild Card option exist because, in reality, the interaction of the futures trading schedule and the physical delivery process creates brief spells within the contract's delivery month during which the delivery invoice price of each contract grade security is temporarily frozen at a known level.

Quality and Timing of Delivery – The End of Month Option

The CTD option is exercisable at any time between the contract's First and Last Intention Days, but the character of the option changes on the contract's last trading day. Between then and the contract's Last Intention Day – the *End of Month* interval – the delivery invoice amount for any delivery intent declared to CME Clearing is determined by reference to a single contract price level, the final settlement price. Because the futures contract price ceases to respond to market forces during the End of Month interval, it becomes a fixed point. All else – including movements in the prices of deliverable issues or financing rates that might cause shifts in CTD status – orbits around it.

For UB, ZB, TN, or ZN futures, the End of Month interval spans six business days, from the seventh-to-last through the second-to-last business days of the delivery month. For any contract declared for delivery during this spell, the delivery invoice amount for each contract grade security is fixed at a known value, determined by the contract final settlement price and the respective delivery conversion factor. Because contract grade securities continue to trade, the End of Month option gives the futures short position holder six business days in which to respond opportunistically to shifts in relative value among Treasury issues as she ponders which one to deliver.[10] The critical difference is that any decisions on when to deliver or what to deliver are assessed in light of static futures delivery invoice amounts.

For ZF, Z3N, or ZT futures, the interval from last trading day to Last Intention Day is a relatively brief two business days, from last business day of the nominal delivery month through first business day of the next following month. For these futures products, the End of Month option thus holds less value and plays a correspondingly smaller role in contract valuation.

10 To the extent that the value of the End of Month option is positive, its existence may prevent the basis spreads of expiring UB, US, TN, or TY contracts from converging to zero on their respective last trading days.

Quality and Timing of Delivery – The Wild Card Option

On any (regular) business day before an expiring futures contract's last trading day, the exchange determines and publishes that day's contract settlement price shortly after 2:00 p.m. CT. Moreover, on any business day between the expiring contract's First and Last Intention Days, at any time before 6:00 p.m. CT, a short holder of the contract may instruct her clearing firm to declare intent to deliver. Through this combination of circumstances, the *Wild Card* interval arises on any (regular) business day afternoon between the contract's First Intention Day and the day before its last trading day: For nearly four hours (from shortly after 2:00 p.m. until 6:00 p.m. CT) the short holder knows the invoice amount for each contract grade security, for any delivery intent declared to CME Clearing on that day.

The Wild Card Option Interval
(Central Standard Time) [11]

2:00 p.m.	Futures daily settlement
4:00 p.m.	Close of CME Globex trading session
4:30 p.m.	Treasury cash market trading winds down
5:00 p.m.	Start of CME Globex trading session for next US business day
6:00 p.m.	Deadline for declaring intent to deliver on expiring futures. Start of next Tokyo business day.

Because trading remains active in the cash Treasury securities market until around 4:30 p.m. CT, the Wild Card option effectively gives the short position holder a spell of two hours or more during which she may take advantage of large late-day shifts in value among contract grade issues, both relative to the futures contract daily settlement price and relative to each other. [12]

The crucial feature of the Wild Card interval is that all futures delivery invoice amounts for the day, for all delivery-eligible securities, are temporarily fixed at known values. [13] Any decisions on whether to declare intent to deliver and what to deliver are informed by movements in contract grade securities prices relative to the corresponding fixed delivery payoffs.

THE BASIS SPREAD AND DELIVERY TAILS

Gross Basis

For a futures contract for a given delivery month, and a security eligible for delivery in fulfillment of the contract, the gross basis is the difference between (a) the security's clean price for t+1 settlement and (b) its clean price for forward settlement via futures delivery, as indicated by the contract price:

Gross Basis = P minus (F x cf)

P is the price of the Treasury security for standard t+1 settlement, quoted in price points and fractions of points, with par on the basis of 100.

F is the price of the futures contract, also in price points and fractions of price points, with par on the basis of 100.

cf is the conversion factor applicable to delivery of the security in fulfillment of the futures contract.

Because its ingredients mix a standard t+1 settlement date with a remote futures contract delivery date, the gross basis incorporates the carry that accumulates between the two dates. As mentioned earlier, [14]

11 The Wild Card option timetable shown here is exemplary, but not definitive. Notably, it will not apply on regular business Fridays, for which both the start of the CME Globex trading session for the next US business day and the start of the next Tokyo business day will not occur until the following Sunday evening, CT. Worth mention is that the timetable may differ on business days when markets are subject to holiday-related early close. Finally, unlike the US, Japan does not observe Daylight Saving Time. During Central Daylight Saving Time, therefore, the start of the next Tokyo business day occurs at 7:00 p.m. CT rather than 6:00 p.m. CT.

12 The US government securities market is over-the-counter. In principle it remains active around the clock, but as a practical matter trading activity thins out between approximately 5:30 p.m. New York time (4:30 p.m. CT) and the start of the next business day in Asian trading centers, ie, around 9:00am in Tokyo (either 6:00 p.m. Central Standard Time, or 7:00 p.m. Central Daylight Saving Time). See, eg, Michael J Fleming, The Round-the-Clock Market for U.S. Treasury Securities, Federal Reserve Bank of New York, July 1997, available at: ***https://www.newyorkfed.org/medialibrary/media/research/epr/97v03n2/9707flem.pdf***

13 This stricture applies only to delivery invoice amounts for delivery intents made on the day in question. The futures contract continues to trade, and its price continues to respond to market forces until the close of the day's trading session, typically at 4:00 p.m. CT.

14 See Timing of Delivery – The Carry Option on page 4.

Carry is the difference between (a) accrued coupon interest that the security pays during the interval from standard t+1 settlement to the presumed futures delivery date minus (b) cumulative interest cost of financing ownership of the security (generally, as gauged by the applicable repo rate) over the same interval.

Example 1

Consider market conditions on Thursday, 7 July 2016:

Ultra 10-Year Note futures for September 2016 delivery (TNU6) trade at 147-00+ (147 and 0.5/32, or 147.015625 points).

The CTD Treasury issue for TNU6, 1-5/8 of 15 Feb 2026, is priced at 102-037 (102 and 3.75/32, or 102.1171875 points) for t+1 settlement on 8 July 2016.

The delivery invoice conversion factor assigned by the exchange for delivery of the 1-5/8 Feb 2026 note into TNU6 is 0.6928.

The gross basis is worth approximately 8.47 / 32nds of a point:

0.2647625 points =
102.1171875 points minus (147.015625 points x 0.6928)

Net Basis

...is an alternative representation of the basis spread (also called "basis net of carry", or "BNOC") in which the settlement date for the cash security aligns with the prospective futures delivery date. In the net basis, the security's clean price for spot settlement is replaced by an estimate of the clean price for forward settlement. Typically the estimate is made by reducing the spot settlement price by the amount of carry a buyer (or seller) would forego (or reap) by deferring purchase (or sale) of the Treasury security until the prospective futures delivery date:

Net Basis = (P minus Carry) minus (F x cf)

or simply

Net Basis = Gross Basis minus Carry

Although delivery is permitted on any eligible day during the futures delivery month, users of the net basis conventionally interpret "prospective futures delivery date" to be either the contract's first delivery day, if carry to delivery is negative, or its last delivery day, if carry to delivery is positive.

The comparative virtue of the net basis representation is that it forces the gross basis to split into two distinctly informative components. One is the magnitude of carry expected to be earned or paid on the cash leg of the basis spread. The other, the net basis itself, is viewed as signifying the value of the options embedded in the futures delivery process, described above.

Example 2

To find the net basis corresponding to the setup in Example 1, start by determining the magnitude of carry to futures delivery. For this, add a further premise:

The prevailing repo rate is 0.475 percent per annum to finance ownership of the CTD note from 8 July 2016 until futures delivery.

To finance purchase of $10 mln face value of the CTD note for settlement on 8 July, a trader would need to borrow $10,276,004.45, comprising a clean price amount of $10,211,718.75, plus $64,285.70 of interest accrued since the note's most recent coupon payment date, 15 February.

For delivery 55 days later, on TNU6's first allowable delivery date, Thursday, 1 September, the cost of repo financing is:

$7,457.24 = $10,276,004.45 x
x (55 days / 360 days/yr) x (0.475 pct/yr / 100)

Coupon income accruing to the buyer over the same term is: [15]

$24,471.10 = ($81,250 / semester) x
x (38 days / 182 days per semester +
+ 17 days / 184 days per semester)

It follows that the buyer of the note earns positive carry between 8 July and TNU6's first delivery day:

$17,013.86 per $10 mln face value =
($24,471.10 coupon interest) minus ($7,457.24 repo interest)

15 The expression in parentheses on the right hand side looks messy, because it accounts for the note's coupon interest payment that intervenes on 15 August. Coupon interest accrues more rapidly during the semester ending on 15 August 2016, which spans 182 days, than it does during the ensuing semester, which spans 184 days.

What if delivery occurs 84 days later instead, on TNU6's last allowable delivery date, Friday, 30 September? Similar arithmetic leads to the same qualitative conclusion. Carry to delivery is positive:

$25,887.55 per $10 mln face value =
($37,276.79 coupon interest) minus ($11,389.24 repo interest)

With these results in hand, a trader assessing fair value of the net basis likely would adopt the premise that market participants collectively view TNU6's last delivery day as the optimal moment for delivery, [16] and would proceed with an estimate of carry equal to 0.2588755 points (re-expressed in price points, with par equal to 100). It follows that the net basis – the imputed value of the futures contract's embedded delivery options – is 0.19 / 32nds (or 0.005887 price points), slightly less than one fifth of one tick:

0.005887 points =
(102.1171875 points minus 0.2588755 points)
minus (147.015625 points x 0.6928)

The Basis Spread Ratio

The structure of the Treasury basis spread is rooted in the definition of gross basis: *P minus (F x cf)*

To buy (sell) the basis between a given futures contract and a given delivery-eligible Treasury security, you buy (sell) the desired amount of the security and sell (buy) a conversion-factor weighted number of futures contracts.

As in Examples 1 and 2 above, to purchase the TNU6 basis spread scaled to $10 mln face value of TNU6's CTD Treasury note, you would sell 69 TNU6 futures, roughly equal to (100 units of $100,000 face value per futures contract) x (0.6928 cf). To sell the same basis spread scaled to the sale of $75 mln face value of notes, you would buy 520 TNU6 futures, roughly equal to (750 units of $100,000 face value per futures contract) x 0.6928.

Market practitioners tend to be more familiar with DV01-weighted spread ratios than with conversion-factor-weighted spread ratios. Where interest rate sensitivity is gauged as the dollar value of price change associated with a uniform shift of one basis point per annum ("bp") in market interest rates (the dollar value of a bp, or "DV01"), the transactor typically structures a cash-to-futures spread so that the DV01 of the cash leg of the spread is equal in size, and opposite in sign, to the DV01 of the futures leg. Though it may not be immediately obvious, conversion-factor weighting and DV01 weighting effectively result in the same ratio for any basis spread between a Treasury futures contract and its CTD security.

The Delivery Tail

Consider a long position in a Treasury basis spread during the interval between the futures contract's First Intention Day and its last trading day. The delivery tail arises at the moment the holder declares intent to deliver on the spread's short futures position. Up to that point, the ratio between the spread's cash leg and futures leg is weighted according to the applicable conversion factor. Thereafter the pertinent ratio between cash and futures is strictly 1-to-1.

Both the magnitude of the tail and the consequences for the basis position holder depend entirely upon the conversion factor's value. To see this, return to the setup in Examples 1 and 2, in which a long position in the TNU6 basis spread comprises $10 mln face value of the CTD note held long and 69 TNU6 contracts held short. At any time prior to notice of intent to deliver, the legs of the spread position are in balance, in the sense that their DV01s are almost equal and opposite.
At the point the futures position is declared for delivery, however, the holder is obliged to deliver $6.9 mln face value of Treasury notes – 69 units of $100,000 face value each, with one unit for each futures contract – at the contract delivery invoice price. Thus, the 1-to-1 matching imposed by physical delivery produces an unhedged delivery tail, the residual long holding of $3.1 mln face value of Treasury notes.

16 Recall that fair valuation of the basis typically observes the convention that if carry to delivery is positive (negative) for both the first and the last contract delivery days, then the long basis holder who aims to take her short futures position to delivery will do so on the last (first) delivery day. Else, she would forfeit carry income. In this example, if she elected to deliver on TNU6's first delivery day instead of its last delivery day, she would forego $8,874 of positive carry per $10 mln face value of the CTD Treasury note.

Suppose instead that the basis spread were constructed of a long position of $10 mln face value of some other (hypothetical) contract grade Treasury note for which the conversion factor is greater than one, say, 1.2000. As before, up to the point that the basis holder declares intent to make delivery on her futures position, the legs of the spread would be held in balance with DV01s set equal and opposite. The futures leg would be a short position of 120 contracts, equal to (100 units of $100,000 face value per contract) x 1.2000. At the moment the futures position is declared for delivery, the holder would be obliged to deliver $12 mln face value of Treasury notes at the futures delivery invoice price. The delivery tail that emerges in this case would be an unhedged short position of 20 futures contracts, for which the basis spread holder must acquire contract grade notes to fulfill delivery.

The only instance in which a basis spread leaves no delivery tail is where the deliverable grade Treasury security has a conversion factor equal to 1.0000, *ie.* where the Treasury security pays coupon interest at the rate of 6 percent per annum.

EMBEDDED DELIVERY OPTIONS FROM THE VANTAGE OF THE BASIS SPREAD HOLDER

The CTD Option Revisited

Consider a Treasury basis spread constructed with the futures contract's CTD security. A moment's reflection shows the key features of the long (short) basis exposure to be analogous to those of a long (short) position in an option: term to expiry, exercise price, and market price volatility –

- The analogue of option term to expiry is the time remaining to the futures contract's Last Intention Day.
- Until the last day of trading in the futures contract, the analogue of option exercise price is the delivery invoice amount determined by each day's contract settlement price. From the contract's last trading day through its last delivery day, the exercise price is frozen at the delivery invoice amount determined by the contract final settlement price.
- Whether an option is expected to expire in or out of the money is determined by the characteristics of the risk neutral probability density of price dynamics of the option's underlying asset (which distributional characteristics may include price volatility, skewness or kurtosis of price dynamics, multimodality, etc). So too for a Treasury basis spread, the joint probability distribution of price dynamics among the futures contract's deliverable securities informs the likelihood and frequency with which CTD status is expected to migrate from one contract grade issue to another. The greater the potential for switches in CTD status, the greater the value of the futures contract's embedded CTD option, and the greater the value of the basis spread.

How the embedded CTD option mimics a conventional option or option combination depends on whether market rates are above or below the 6% yield that serves as the futures contract delivery standard:

- If market yields are below 6%, CTD status tends to reside with the futures contract's deliverable grade issue with shortest duration. [17] Any shift in CTD status from the minimum-duration issue to another deliverable issue with longer duration will occur only if market yield levels rise (*ie.* Treasury securities prices fall). Thus, to a first order of approximation, buying (selling) the CTD basis spread is similar to purchasing (selling) a put option.
- If market yields are above 6%, CTD status tends to reside with the contract's deliverable grade issue with longest duration. CTD status will switch to alternatives with shorter duration only if market yield levels fall (*ie.* Treasury securities prices rise). Accordingly, buying (selling) the CTD basis spread in this case is analogous to purchasing (selling) a call option.
- If market yields are in the neighborhood of 6%, then migration of CTD status from one contract grade issue to another is apt to occur whether rates rise or fall, in which case buying (selling) the CTD basis spread is akin to buying (selling) an option straddle.

17 For ease of presentation, the following discussion is framed strictly in terms of uniform level shifts, up or down, in the term structure of interest rates. As a practical matter, for any futures contract, CTD status might also shift among delivery-eligible securities in response to volatility in the pitch and shape of the Treasury yield curve over the range of contract grade terms to maturity.

This framework is useful for many reasons. Among them is that it helps to explain the infrequency of Treasury futures deliveries. Over the last quarter century the share of open interest taken to delivery is less than three percent. In recent years it's around one percent (Exhibit 2).

Exhibit 2 – Treasury Futures Deliveries and Delivery Month Activity, 2011-2015

Futures Contract	Physical Deliveries as Percent of Mature Open Interest	Open Interest on First Intention Day as Percent of Mature Open Interest
Ultra Bond (UB)	0.9	16.1
Bond (ZB)	0.5	18.6
10-Year Note (ZN)	0.4	14.8
5-Year Note (FV)	1.0	15.7
2-Year Note (ZT)	1.0	16.3
Total	1.0	16.0

Note: Mature open interest in a futures contract for a given delivery month is defined as the median daily level of contract open interest during the 42 business days (approximately two months) ending on and including the contract's First Intention Day (ie. second business day before first business day of contract delivery month).

Time decay provides a compelling motive for the long holder of a Treasury basis spread to exit the position instead of taking it to futures delivery. The value of the embedded delivery options naturally diminishes as the futures contract approaches its Last Delivery Day. From this vantage, it is unsurprising that a long holder of a basis spread would likely find it more profitable to liquidate the embedded delivery options while they possess time value, rather than to exercise them.

Given that around one sixth of a futures contract's mature open interest typically remains open at the beginning of its delivery month (Exhibit 2), it is clear that most Treasury basis spread positions – as well as other Treasury futures exposures held long or short, for other strategic or tactical reasons – are exited through means other than physical delivery. These include, *eg*, rolling futures positions from the nearby delivery month into the next following delivery month, or liquidating through bilaterally negotiated Exchange for Related Position ("EFRP") trades. [18]

The End of Month Option Revisited

For any expiring ZN, TN, US, or UB futures contract, centralized competitive trading terminates at 12:01 p.m. CT on the seventh business day before the last business day of the delivery month. As observed earlier, this marks the start of the End of Month interval, [19] at which time two closely related developments take center stage. One is that any holder of an open basis spread position faces increasingly compelling motives to adjust her spread ratio. The other is that the character of the CTD option changes dramatically.

THE BASIS SPREAD RATIO

Although centralized and competitive trading of expiring futures on CME Globex has terminated, this does not mean that physical delivery is the only remaining avenue of exit for open futures positions. Until noon CT on the second business day after the last trading day (ie, noon on the fifth business day before the last business day of the delivery month) open interest holders have an alternative: They are permitted to liquidate futures positions through bilaterally negotiated EFRP trades. [20]

18 EFRPs, known familiarly as "Exchange for Physical" or "EFP" trades, have been a familiar feature of futures markets for many decades. Each EFRP transaction entails the "privately negotiated off-exchange execution of an exchange futures or options contract and, on the opposite side of the market, the simultaneous execution of an equivalent quantity of the cash product, by-product, related product, or OTC derivative instrument corresponding to the asset underlying the exchange contract." For more information, see Exchange for Related Positions, CME, CBOT, NYMEX & COMEX Market Regulation Advisory Notice RA1311-5RR, 4 August 2014, which is available at: ***http://www.cmegroup.com/rulebook/files/ra1311-5rr-rule538.pdf***

19 See Quality and Timing of Delivery – The End of Month Option on page 7.

20 It merits emphasis that the timetable described here applies only to expiring UB, ZB, TN, or ZN futures. For expiring ZF, Z3N, or ZT futures, by contrast, recall that the last trading day is the last business day of the delivery month. Positions held open thereafter may be liquidated through EFRP transactions executed and reported to the exchange no later than noon CT on the next following business day. In other words, for expiring ZF, Z3N, or ZT futures the EFRP alternative remains available until noon CT on the contract's Last Intention Day.

How market participants avail themselves of these alternatives bears upon what happens in the final minutes before termination of competitive trading in futures –

- Basis spread holders intending to take their futures positions to delivery are apt to focus their efforts on disposal of the delivery tails in their positions, using the final moments of CME Globex trade in expiring contracts as an opportunity to adjust their basis spreads from conversion-factor weighting to 1-to-1 weighting. [21]
- Those who intend to make the requisite tail adjustments via cash-market purchases or sales of deliverable grade Treasury securities may choose instead to maintain conversion-factor weighting through the termination of CME Globex trading in expiring futures.
- Likewise, those who plan to exit their basis positions via bilaterally negotiated EFRP trades are more likely to preserve conversion-factor-weighted spread ratios through termination of competitive futures trade.

As of noon on the second business day after the last trading day, the die is cast. The only remaining avenue for liquidation of an open futures position is to make or take delivery. Accordingly, the only circumstance in which an open basis spread ratio would be weighted other than 1-to-1 is if the holder of the basis position plans to use transactions in cash Treasury securities to achieve 1-to-1 weighting.

THE CTD OPTION

Because the futures contract price ceases to respond to market forces during the End of Month interval, [22] the nature of the CTD option changes dramatically. Until the last trading day, determination of CTD status pivots on proportional comparisons. As described above, [23] the CTD issue is the one for which the ratio of the futures delivery invoice amount to the invoice amount for standard t+1 cash market purchase achieves maximum value among all contract grade securities:

Ratio =
[($1000 x F x cf) + AI(d)] / [($1,000 x P) + AI(t+1)]

During the End of Month interval, with delivery invoice amounts fixed by reference to the futures contract's final settlement price, the rule for determination of CTD status abruptly shifts gears, from the maximum ratio among all contract grade securities to the maximum arithmetic difference among them –

Difference =
[($1000 x F x cf) + AI(d)] minus [($1,000 x P) + AI(t+1)]

The Wild Card Option Revisited

Consider a Treasury security that is CTD for an expiring futures contract, with a delivery invoice conversion factor less than unity (cf < 1). Suppose that:

- "Today" is an ordinary business day during the contract's delivery month, prior to the contract's last trading day.
- The hour is after 2:00 p.m. CT, and the exchange has already determined and published the contract's daily settlement price for the day.
- Prices of Treasury securities, including the CTD issue, have skyrocketed in late-day trading.
- Having rallied sharply, late-afternoon price levels of the CTD issue and other contract grade securities are anticipated to prevail throughout "tomorrow".
- Similarly, the CTD basis spread (ie, the CTD gross basis) is anticipated to persist throughout tomorrow at its value as of today's 2:00 p.m. CT futures daily settlement.

21 See The Delivery Tail on pages 9-10.

22 Apart from potential exceptions, discussed above, for bilaterally negotiated EFRP trades during the first 1-1/2 business days of the End of Month interval.

23 See Quality of Delivery – The CTD Option on pages 5-6.

In these circumstances a long basis holder might consider exercising the Wild Card option embedded in her short futures position by making early declaration of intent to deliver.[24] Her decision would depend on comparison of two magnitudes. One is the opportunity cost she would incur by declaring intent to deliver today at a futures invoice price lower than the price at which she could sell her security holdings in late-day cash market trade. The other is the loss she expects to realize tomorrow when her short futures position is marked to market. (This assumes that when futures trading reopens for the next trade date, the contract price will adjust to a new, higher level commensurate with today's late-day jump in cash prices, and will remain there at least through tomorrow's futures daily settlement.)

If the opportunity cost of declaring intent to deliver on the short futures position at today's daily settlement price is less than the expected loss due to tomorrow's mark-to-market on the short futures position, then exercising the Wild Card option becomes worthwhile. The following inequality summarizes the decision criterion –

$$P_{late} - (F_t \times cf) < E_{late} (F_{t+1}) - F_t$$

P_{late} is the CTD security's offered price between 2:00 p.m. and around 4:30 p.m. CT, after the late-afternoon rally in cash market prices.

F_t is today's futures daily settlement price, set at 2:00 p.m. CT.

$(F_t \times cf)$ is the invoice price of the CTD security implied by today's futures daily settlement price.

$E_{late} (F_{t+1})$ is the expectation of tomorrow's futures daily settlement price, conditional upon information available as of late afternoon today.

The assumptions above concerning current and prospective market conditions permit the inequality to be simplified to a long-established rule of thumb, according to which the long basis holder would exercise the embedded Wild Card option if: [25]

$$Gross\ Basis \times (cf / (1 - cf)) < P_{late} - P_{2\,pm}$$

The simplified representation spotlights the salient characteristic of the Wild Card option. Where the basis spread is constructed with a Treasury issue that is either CTD or near-CTD, the option exercise decision essentially pivots on whether the late-day movement in securities prices is sufficient to compensate the long holder of the basis for the carry income she will forego by exercising (ie, by making early delivery on her futures position). [26]

Conversely, from the vantage of a short basis spread holder (with cf futures contracts held long for every $100,000 face value of the same contract-grade Treasury security held short), the spread position is akin to a short gamma position in an option. Tactical decisions as to whether to hold the short basis position during the delivery month, and for how long, would be determined in light of the risk-free probability distribution of price dynamics in the underlying cash market, the premium from selling the basis, and the available (and practicable) dynamic hedging strategies.

24 *See Quality and Timing of Delivery – The Wild Card Option on pages 7.*

25 *If instead the relevant delivery invoice conversion factor is greater than unity (1 < cf), then the same rule of thumb says the Wild Card option becomes attractive for the long basis holder to exercise if the CTD security's price drops sharply in cash market trade after 2:00 p.m. Chicago time, by an amount sufficient to satisfy the following inequality --*

$$Gross\ Basis \times (cf / (cf - 1)) < P_{2pm} - P_{late}$$

26 *This statement applies as a practical matter. In theory, however, it does not rule out the possibility that a Wild Card option exercise could encompass a switch in the identity of the CTD issue. If the late-day move in Treasury securities prices is large enough, the long basis holder may find it profitable to swap from the CTD issue to an alternative, then to use the alternative issue to fulfill futures delivery. In all events, the objective for the long basis holder is to deliver whichever eligible security can be obtained at low enough cost to extract maximum net gain from Wild Card delivery.*

MANAGING BASIS SPREADS AND DELIVERY TAILS IN DELIVERY

Any Treasury basis spread that goes to futures delivery must be managed with care. To appreciate this, assume it is June 2016, on an arbitrarily chosen afternoon prior to the last trading day in expiring 10-Year Treasury Note futures (ZNM6). Assume the following hypothetical market conditions:

ZNM6's daily settlement price is 129-205 (129 and 20.5/32, or 129.640625) points,

ZNM6's CTD Treasury note, 2-1/8% of 31 Dec 2022, is priced at 103-02 (103 and 2/32, or 103.0625 points) for t+1 settlement. (In what follows, assume further for simplicity that the note is both bid and offered at 103-02.)

The conversion factor assigned by the exchange for delivery of the 2-1/8 Dec 2022 note into ZNM6 is 0.7939.

Consider a long holder of the ZNM6 CTD basis, who owns a long position of $100 mln face value of the CTD note (currently with a clean price of $103,062,500) and a short position of 794 ZNM6 contracts. Assume she decides to declare intent to deliver on all 794 contracts. [27]

Given the contract's daily settlement price, the converted price per contract for delivery invoicing will be: [28]

$102,921.69 =
(129.640625 price points) x 0.7939 x ($1,000 per price point)

The aggregate principal invoice amount for delivery is:

$81,719,821.86 = ($102,921.69 per contract) x 794 contracts

Unless the long basis position is adjusted either immediately prior to or very soon after the decision to declare delivery intent, it will leave an unhedged delivery tail, in the form of $20.6 mln face value of the CTD note held long (equal to $100 mln total face value minus $79.4 mln face value delivered into 794 ZNM6). At its going cash market price of 103-02, the tail is worth: [29]

$21,230,875 = ($20.6 mln face value) x
x ($1,030,625 per $1 mln face value)

In this basis trade, or any other, the excess exposure in the delivery tail can be managed in various ways. The objective in all instances is to maintain conversion-factor weighting of the basis spread ratio, and thereby to preserve its DV01-neutrality, until declaration of intent to deliver.

Long Basis Spread with cf < 1

For a long basis position (long cash, short futures) in which the delivery invoice conversion factor is less than 1.0000, as in this example, the tail will manifest as an unhedged residual of cash securities. The basis spread holder may:

1. *Retain the excess.* Because this leaves an unhedged long position in a Treasury note, it is recommended only if it comports with her overall trading or investment strategy and risk management objectives.

27 Let's allow that this assumption appears outwardly implausible, given that the basis spread holder's decision to deliver entails her forfeiture of roughly 4.5/32nds of gross basis:

4.5 /32nds ≈ 0.14081 points = 103.0625 cash price minus (129.640625 futures price x 0.7939 cf)

28 To be clear, this is the converted futures price – the clean price component of the delivery invoice amount – which excludes accrued coupon interest.

29 It is useful to reconcile what has become of the $100 mln face value of the CTD Treasury note. At its current cash market price, 103-02, the liquidation value of the position (excluding accrued coupon interest) is $103,062,500 --

$79.4 mln face value is pledged for delivery in fulfillment of the short position in ZNM6 at an effective clean price of 102.92169 points (approximately 102 and 29.49 / 32nds), equal to $81,719,821.86.

By delivering $79.4 mln face value of notes in fulfillment of her short holdings of futures, instead of selling the notes at their prevailing price in the cash market, the long basis holder forfeits approximately4.51 / 32nds, equal to $111,803.14.

At its current cash market price, the $20.6 mln face value of notes that she retains as the delivery tail is worth $21,230,875.

2. *Sell the excess in the cash market.* This makes sense if cash market liquidity is sufficient to permit the sale without excessive price slippage. In this example, the basis spread holder presumably would sell the remaining $20.6 mln face value of the Treasury note at the prevailing market price of 103-02, for a clean price amount of $21,230,875.

3. *Sell expiring futures in sufficient quantity to deliver the excess.* In this example, the basis spread holder would sell an extra 206 ZNM6, on which she would immediately declare intent to deliver, and which she would fulfill with her excess holdings of $20.6 mln face value of Treasury notes.

   This approach would be ideal if the basis spread were negative, ie, if the basis spread holder could buy the CTD note in the cash market at a price lower than the futures delivery invoice price. It holds less appeal if the gross basis is positive, as it is in this example.

   It remains attractive, however, if cash market liquidity is so thin as to threaten severe price slippage. Specifically, if avenue 2 is expected to result in an average (clean) sale price below the (clean) delivery invoice amount, then this avenue offers a useful alternative, ensuring that the tail exposure will be sold at no less than the futures delivery invoice price.

4. A variation that combines features of 1 and 3 is to retain the excess Treasury notes, and to hedge the exposure by selling a DV01-equivalent quantity of futures contracts for delivery in the next following ("deferred") delivery month. The virtue of this approach is that it capitalizes on the natural migration of liquidity out of expiring futures (here, ZNM6) and into the deferred futures (here, ZNU6) over the course of the current delivery month. The liquidity pool in the roll spread – the calendar spread between the expiring contract and the deferred contract – is often broader, deeper, and more reliable than the liquidity pool that supports outright transactions in the expiring contract in its last days of trading.

   A potential limitation is that it may be impossible to establish a new bona fide basis spread position in the deferred futures delivery month. This quandary arises if the cash securities in the delivery tail are ineligible for delivery into the deferred futures contract. The present example illustrates the point: The 2-1/8 Dec 2022 note, which is CTD for ZNM6, is not deliverable into ZNU6.

   If eventual liquidation of the delivery tail is the goal, rather than entry of a new deferred basis spread exposure, then a DV01-weighted position in a liquid deferred futures contract may fill the need for a tractable means of risk offset.

Long Basis Spread with 1 < cf

For a long basis position in which the delivery invoice conversion factor is greater than 1.0000, the delivery tail will take the form of an unhedged residual short futures position. In this circumstance, the basis spread holder may:

5. *Cover the tail by buying expiring futures.* Immediately before declaring intent to deliver, the basis spread holder would reduce the short futures position so that its aggregate notional face value matches the face value of her long position in cash notes.

6. *Roll the excess short futures into a short position in contracts for delivery in the next following (deferred) delivery month.* This avenue remains open until termination of trading in the expiring futures. Similar to approach 1 above, it leaves the basis spread holder with an unhedged directional exposure, in this case to the price of futures for the deferred delivery month.

   Its virtue is its practicality. Similar to approach 4 above, it takes advantage of the characteristically high liquidity in the roll spread between expiring futures and futures for the deferred delivery month.

7. *Buy cash Treasury notes in sufficient quantity to fulfill delivery in the expiring futures tail.* As in approach 2 above, the appropriateness of this avenue depends on the state of liquidity and pricing in the cash market for the CTD Treasury note at the crucial moment. It makes most sense if the basis spread holder can buy the requisite amount of the Treasury note at an average price lower than the delivery invoice price guaranteed by the expiring futures contract's daily settlement price.

Worth emphasis is that the basis spread holder has no choice but to cover the excess short futures position in the delivery tail, one way or another. If she holds it beyond the last day of futures trading, then she will be obligated to acquire contract grade securities with which to make delivery. [30]

Short Basis Spread

By contrast to the position management routes open to the long basis holder, there is scant maneuvering room for the short basis holder. For this reason, the short basis holder should have clear and concrete reasons for wanting to maintain, beyond the First Intention Day of the expiring futures contract's delivery month, what amounts to an open short position in the futures contract's embedded delivery options:

- She has no control over when she might be assigned to take delivery on her long futures position.
- If assigned to take delivery, she has no guarantee that the Treasury securities delivered to her will be the same as those she has sold short in constructing her short basis position.
- Unlike a conventional option contract – in which she might maintain a short position until expiry, on the hunch that the option will expire so far out of the money as not be exercised against her – her long futures position is guaranteed to be assigned to take delivery no later than the contract's Last Intention Day, unless it is liquidated sooner.

If she is lucky enough to take delivery of the Treasury securities she has sold short, on the delivery date she had anticipated when entering her short basis position, then she can use the notes to close out (at least in part) her short position in cash securities. Even in such fortunate circumstances, however, she too will confront delivery tail management challenges proportional to the applicable futures delivery invoice conversion factor –

a. If the conversion factor is less than 1.0000, the quantity of securities delivered to her will be insufficient by an amount comparable in scale to the delivery tail encountered by the long basis spread holder along avenues 1 and 2 above. Accordingly, the delivery tail is the uncovered remnant of her short position in Treasury securities, which she must cover by acquiring a corresponding amount of the Treasury issue at prevailing cash market prices.

b. If the conversion factor is greater than 1.0000, then the Treasury futures delivery will be the mirror image of the situation encountered by the long basis holder in approach 7 above. The delivery will award the short basis holder with more than enough of the Treasury security to close out her short position. The resultant delivery tail is an unhedged long exposure in the Treasury security that must either be liquidated at prevailing cash market prices or hedged by selling futures.

30 Apart from potential exceptions for bilaterally negotiated EFRP trades during the first one or two business days of the End of Month interval. See The End of Month Option Revisited on pages 11.

RESOURCES

Burghardt, Galen D, Terrence M Belton, Morton Lane, and John Papa
The Treasury Bond Basis, Third Edition, McGraw Hill, 2005.

Despite its age, still the magisterial presentation of Treasury futures and Treasury basis spreads.

Burghardt, Galen D, Terrence M Belton, Morton Lane, and John Papa
The Treasury Bond Basis, Revised Edition, McGraw Hill, 1994.

Out of print. The discussion of the Wild Card option in Appendix D (expunged from the Third Edition) stands unequalled.

CME Group
The Treasury Futures Delivery Process, 6th Edition, July 2016

The authoritative and comprehensive guide to the details of the Treasury futures delivery mechanism.

Plona, Christopher
The European Bond Basis, McGraw Hill-Irwin, New York, 1997

Out of print and, unsurprising for a text published almost two years before the euro's birth, teeming with anachronisms. Despite this handicap, chapters covering the analytics of basis spread relationships for government bond futures remain exceptional. The chapter on practicalities of basis trading and risk management is unrivalled for thoroughness, insight, and clarity.

CME GROUP HEADQUARTERS

20 South Wacker Drive
Chicago, Illinois 60606
cmegroup.com

CME GROUP GLOBAL OFFICES

Chicago
+1 312 930 1000

New York
+1 212 299 2000

London
+44 20 3379 3700

Singapore
+65 6593 5555

Calgary
+1 403 444 6876

Hong Kong
+852 2582 2200

Houston
+1 713 658 9292

São Paulo
+55 11 2787 6451

Seoul
+82 2 6336 6722

Tokyo
+81 3 3242 6228

Washington D.C.
+1 202 638 3838

Data sources: CME Group unless otherwise noted

PM1914/0617