US Rates

Primer: US Treasury futures and basis

Primer

10 July 2025

Rates Strategy
United States

Ralph Axel
Rates Strategist
BofAS
+1 646 743 7011
ralph.axel@bofa.com

US Rates Research
BofAS
+1 646 855 8846

See Team Page for List of Analysts

The basics of futures and CTD

We present a primer on US Treasury futures, including a discussion of what makes futures different from cash Treasury bonds. The futures basis has been a major topic for the official sector in recent years. Cash Treasuries are assets that store wealth while futures are derivatives that provide a price marker and close at 0 market value each day. We go over pricing of futures as forwards on cash bonds with embedded options. Futures always have 2 sides – a buyer and a seller - and the embedded options are held by the short side. We look at the types of options, their value, and the way they are traded. Treasury futures are cleared at the CME and benefit from offsets and netting, while only a small fraction of cash trading is cleared today.

The basis and calendar spreads

The basis is the price difference between cash Treasuries and futures, including the cheapest-to-deliver bond price vs futures price, with a specific weighting using "conversion factors" of deliverable cash bonds. Other weightings are possible. Gross basis uses the spot CTD price while net basis uses the forward CTD price. Net basis is a measure of option value and is often close to 0 today. Calendar spreads are price differences between same-maturity contracts expiring in different quarters. Calendar spreads trade during roll cycles when positions migrate into the next quarterly contract as the front contract expires. Actual bond deliveries are typically a very small fraction of maximum open interest.

Common futures trades

We look at common futures trades including outright duration, curve trades, various basis, calendar spreads, and swap spreads. Futures are appealing to different end users for varied reasons, which can sometimes provide opportunities for relative value trading.

CTD = cheapest to deliver

IRR = implied repo rate

AI = accrued interest

CME = Chicago Mercantile Exchange

Government bond futures

Treasury futures are a big fish in a big pond

The US Treasury bond and note futures complex is a major component of US rates markets and represents one of the most liquid markets to hedge and speculate in interest rates. Futures provide not only duration placeholders and portfolio replication, but also opportunities to trade the term structure of repo and the micro embedded delivery options related to how futures price versus a basket of underlying deliverable bonds associated to each contract. We focus on the US market, but there are similarly structured futures markets on government bonds issued by Germany, Japan, the UK, Italy, France, China, and others.

Futures initially began out of a need for standardization of forward agreements in grain trading of the 1860s. Futures provide a “commoditization” of the diverse underlying Treasury cash bond market as they 1) simplify the large array of off-the-run and on-the-run cash Treasury securities using a small set of benchmarks, 2) allow leverage without the use of repo markets, as futures require a small down payment in an exchange margin account. Margin is reduced by netting across other positions, including those in other asset classes like swaps, and possibly cleared repo in coming years. Using exchange-traded futures, the lion’s share of global macro trading is accessible on regulated centralized exchanges with cross-margining benefits.

Basics of bond futures and CTD

A US Treasury futures contract is a derivative that allows for purchase and sale of an underlying Treasury cash bond during a window of settlement dates in the future. They are similar to forward contracts, priced essentially by carry, but with a month-long delivery window each quarter to transact in the underlying cash bond as opposed to a single fixed forward date. Futures also allow the short to select from a set of bonds to sell into the contract to satisfy the long’s purchase. The most profitable selection (or least unprofitable) is the cheapest-to-deliver, or CTD. This generates the delivery options which can make futures cheap versus forwards. Today, futures are close to forwards as the optionality is not highly valued at the current low levels of interest rates.

Futures are derivative contracts entered into by 2 parties simultaneously, like an interest rate swap, with a long side and a short side. Each new long/short position adds a unit of open interest, but no net duration is added to the bond market. If bond markets are rallying and open interest rises, there are as many new longs as new shorts added in the rally. Futures are priced differently than swaps and represent true Treasury rate market risk rather than SOFR market risk in SOFR swaps. As a result, Treasury futures are best for those seeking Treasury replication in their hedging or speculative positions.

A Treasury cash bond, by contrast, is an asset (and a liability). It must be purchased in exchange of existing funds or borrowed funds and sits on the asset side of a balance sheet which consumes capital and for banks provides Level 1 liquidity. It pays interest in the form of coupons. While it is an asset of the holder, it is a liability of the US Government, a claim on Fed reserves. It is a store of wealth and can be sold in open markets or held to maturity to redeem reserves. A futures contract by contrast has no market value at each daily close and is not a liability of any entity and offers no claim on reserves. In a sense, Treasuries are money, futures are not money.

Taking a futures position provides a starting price point for bond price changes that accumulate as P&L over a holding period. The long’s P&L goes up if the futures price goes up (yields go down) while the short experiences the opposite. The 2 margin accounts at the CME (Chicago Mercantile Exchange) are credited and debited equally as prices move. While futures do not have a “cost”, there are fees and margins associated with trading them. The daily flow of funds into and out of margin accounts is a distinct difference from forwards which realize all of their P&L at the forward settle date.

7 main Treasury contracts along the curve

The main Treasury futures cleared at the Chicago Mercantile Exchange (CME) are 2y (TU), 5y (FV), 7y (TY), 10y (UXY or ultra 10y), 15y (US, also called “the bond contract”, or the classic) and 30y (WN or ultra long). Treasury futures exist only for one quarter and then expire: March, June, Sep, Dec. For example, a position in a March contract would represent a contract to buy (long position) or sell (short position) an appropriate cash Treasury bond during the month of March.

Every long contract position has an offsetting short position. Open interest counts one side. FV contracts have the largest open interest today of around 7 million contracts, ie 7 million longs against 7 million shorts, which represents obligation to transact in $700bn UST cash if held through delivery. 2y contracts represent the largest underlying notional exposure at close to $900bn with open interest at 4.3mm. While most Treasury futures correspond to $100,000 underlying cash bonds per futures contract, the 2y contract is double sized. According to CME, US Treasury futures had an average trading volume in 2023 of $645bn notional per day. This is larger than the approximately $460bn daily average of cash bonds (excluding Tbills) traded by primary dealers daily in 2023. While futures trade in large volumes relative to cash, they generally get closed out or rolled before any cash bonds are traded to settle them.

Delivery specifications determine which bonds are deliverable

The CME delivery spec for FV is “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.” This includes 2 parts: 1) a constraint on remaining life of the bond, and 2) a constraint on the original maturity when it was 1st issued. For example, a 7y or 10y note that has rolled down into the 5y sector would not be eligible for delivery in FV because the original term cannot be more than 5 years and 3 months. This effectively means that only original-issue 5y notes are deliverable. The remaining maturity requirement – which is measured as of the 1st day of the delivery month - eliminates much older 5y notes that have rolled down the curve into for example the 2y sector. The CME website has detailed information on contract specs, volumes, and other useful data and information on Treasury futures (U.S. Treasury futures, options and cash - CME Group).

Exhibit 1: Summary of contract specs across the maturity spectrum

Watch out for TU which has double the notional value compared to the others

	TU	FV	TY	UXY	US	WN
Face Amount	$200,000	$100,000	$100,000	$100,000	$100,000	$100,000
Deliverable Maturities	1 3/4 to 2 yrs	4 1/6 to 5 1/4 yrs	6 1/2 to 8 yrs	9 5/12 to 10 yrs	15 yrs up to 25 yrs	25 yrs to 30 yrs
Original maturity	<= 5 1/4 yrs	<= 5 1/4 yrs	none	<= 10 yrs	none	None
Price increment	1/8 of 32nd or $7.8125 per contract	1/4 of 32nd or $7.8125 per contract	1/2 of 32nd or $15.625 per contract	1/2 of 32nd or $15.625 per contract	1/ 32nd or $31.25 per contract	1 /32nd or $31.25 per contract
Last trade date	last biz day of deliv month		7 biz days prior to last biz day of deliv month			
Last day of delivery	3rd biz day after last trade		Last biz day of the deliv month			

Source: BofA Global Research, CME, Bloomberg

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As an example, the Sep 2025 FV contract, FVU5, currently has 8 cash bonds in the basket (function = DLV <GO> on Bloomberg) ranging from 11/30/2029 maturity to 6/30/2030. As of the 1st business day of Sep, the 11/30/2029 will have slightly more than 4 years and 2 months left to maturity. The monthly auctions of 5y notes will produce 7/31/30, 08/31/30, and 9/30/30 maturities that will also be eligible for delivery into the Sep contract. The first delivery date for FVU5 is 9/2/2025 and the last delivery date is 10/03/25. This info is available on the DES screen on Bloomberg for the FVU5 contract. The CT screen gives all open quarterly FV contracts. The deliverable basket specs for the major contracts are summarized in Exhibit 1.

Cash-futures basis: gross and net

A basis typically means a price or rate differential. With cash vs futures it is the cash price minus the futures price. The "CTD basis" is the cheapest-to-deliver bond price minus the conversion-factor weighted futures price:

B- c*F, where B= spot price of cash bond, c=fixed conversion factor, F=futures price.

Conversion factors are covered below; they are fixed for the life of the contract and are designed to minimize the price differences of bonds arising from coupon differences.

When selling a bond in the delivery month to close out a futures contract, the deliverable bond exchanges at its **invoice price**:

c*F + AI

where AI is accrued interest on the bond accumulated from the last coupon payment to the settlement date, F is the futures price, and c is the bond's conversion factor.

The **gross basis** uses B = spot cash bond price, while the **net basis** uses B= forward cash bond price, with forward settlement date set to the 1st or last date of delivery month (March, June, Sep, Dec).

The difference between spot and forward prices is, by definition, carry of the bond from spot through delivery date. The net basis is the gross basis minus carry. Eventually the spot and forward settle dates become the same date, and the gross and net bases converge to each other. They also converge to 0 for the final CTD as the delivery option value decays away. This convergence over time to 0 for some CTD basis is a key pricing concept for futures. If the optionality is worthless, the net basis will be 0 and the futures will essentially track the forward CTD price (to the appropriate delivery date). If the embedded options have positive value, the net basis will be positive and futures will price below the CTD forward. A positive net basis can be viewed as futures offering excess carry versus forwards.

Most of the gross basis = net basis + carry comes from the carry component today, but the wild card option can provide nets as high as 4-5 ticks for some contracts. When interest rates were close to 6%, net bases were often 10 ticks or more given the high value of the delivery options.

Delivery date = 1st date or last date of delivery month, depending on carry

Only a small fraction of open interest is held into delivery month and a fraction of that results in actual deliveries, ie bonds bought/sold to close out the positions. But the delivery mechanism links futures prices to Treasury bond prices.

When looking at futures settlement, the market assumes a single optimal delivery date for settlement. In a positive carry environment (when repo rates are below bonds yields, ie upward sloping curve) the delivery date is taken to be the last day of the delivery window. When carry is negative, it is normally taken to be the 1st day of the delivery period (or the next day when in the delivery window). Mid-month delivery dates are possible. Some contracts like today's FV can trade to 1st delivery date, as others like today's WN trade to last delivery date.

The CME provides a detailed guide on the delivery process (see The Treasury Futures Delivery Process, 8th Edition). It is a T+2 settlement process. On day 1 a short declares intention to deliver. On day 2 the long receives notice from CME of a pending purchase of a specific cash bond that short chooses on this day. On day 3, the selected bond is sold and the transaction is settled. When calculating carry over delivery periods, T+2 should be used.

Identifying the CTD = smallest net basis

One bond is typically the "cheapest to deliver" in the basket but there can be multiple CTDs. The CTD has the lowest net basis. Buying, financing and selling a cash bond into a short futures position (ie going long the basis and making delivery) normally generates a loss, as it is equivalent to buying the embedded delivery options and losing that option premium over time as they typically decay down to 0. If you buy the CTD net basis at 1 tick and deliver that CTD on the optimal delivery date, you will typically lose 1 tick. But you would lose more if you did that with any other deliverable that wasn't CTD.

Exhibit 2 shows the net basis in the last column for the FV deliverables ordered from low to high. The Nov 2029 maturity is the CTD as it has the lowest net basis (-0.5 ticks).

With a long bond basis, you might profit if the CTD switches before or during delivery month. Basis risk is active,at contract inception, not just in delivery month. Options may be exercised in the delivery month, but basis shifts can happen long before delivery.

The gross basis is the traded market in the broker screens, and net basis is derived from gross by subtracting carry of the bond to the delivery date. Carry is defined as spot price minus forward price of the bond where the term repo rate for the bond is required to calculate the forward price.

We recommend the industry standard "The Treasury Bond Basis, 3rd Edition" by Galen Burghardt and Terrence Belton for more discussion and examples of CTD, basis and valuation. This has been the classic basis book since 1989. The CME website is also an excellent resource and references on futures and basis, including hedging and calendars and option plays.

Net basis can be negative

Normally, when the embedded option value is positive, one would have a positive net basis and a positive repo- implied repo. Sometimes, as in the example shown in Exhibit 2, if the futures contract is relatively rich versus cash and the option value is close to 0, the CTD net basis can be negative and the repo-implied repo difference will also be negative. One can see this as an arbitrage if one can carry to delivery.

If you can buy the net basis at -0.5 ticks as in Exhibit 2, you are essentially getting paid to hold the delivery options. This happens today because the option value is near 0 given that rates are far below 6% (more on this below). With the fair value of the net basis close to 0, the net basis can drop below 0 if contracts are a bit rich to forwards. The richness today is likely due to excess futures demand from the asset manager community. The asset managers are essentially willing to sell the basis to leveraged funds at 0 or negative to the extent that 1) asset managers net benefit from holding futures instead of the actual cash bonds in their index, and 2) leveraged funds can access required funding from dealers or elsewhere. Leveraged funds provide a non-bank financial intermediation function similar to other non-bank Treasury funding arrangements available today.

Implied repo rate = another way to find CTD

The net and gross basis are quoted in ticks or 32nds of a percent. An equivalent expression of the net basis, but using rates, would be repo minus implied repo – this is an alternative for determining the CTD.

The IRR can be viewed as the return of buying the cash bond and delivering it into the contract. When there is no coupon payment in the period, this return can be expressed as:

Return = (Futures invoice price – full price of spot bond) / (full price of spot bond)

and the IRR would be an annualized version of this:

*IRR = Return * (365 / days to delivery)*

The implied repo rate (IRR) is the term repo rate that would make the bond's forward price equal to c*F, the conversion factor times futures. Higher financing rates mean less carry. IRR is the repo rate implied by futures, rather than the actual repo rate implied by forwards. The higher the repo rate, the lower the carry, the higher the forward price. The goal is to buy and finance a cash bond and sell it at the richest possible futures price – this would have the highest IRR or the least amount of carry compensation baked in.

Example of finding the CTD for FVU5

Exhibit 2 shows the existing (incomplete) set of deliverable bonds for FVU5 from Bloomberg's DLV screen. The CTD can be seen either as having the smallest net basis in the last column or the highest Implied Repo rate in the 3rd-to-last column.

Exhibit 2: FVU5 basket with 8 existing bonds has lowest-maturity bond as CTD with lowest net basis and highest implied repo rate

The repo rate is the same for all bonds and is general collateral to 9/2/2025. If different rates are traded per bond, they are input separately

Enter fields, or select a cash security for details

FVU5 Comdty | Export | Settings | Cheapest-to-Deliver

US 5YR NOTE (CBT) Sep25 Price 108-07 1/4 | Cheapest IRP 4.456 | Trade 07/07/25

Prices in Decimals | Private Bond | Small Issue | Days 56 Act / 360 | Settle 07/08/25

Sort By Net Basis Increasing | Delivery First 09/02/25

Cash Security	Price	Chg	Conven Yield	Conver Factor	Gro/Bas (32nds)	Implied Repo%	Actual Repo%	Net/Bas (32nds)
Adjust Value		Yld						
1) T 4 1/8 11/30/29	100-24 7/16	-.002	3.9331	0.9317	-2.250	4.456	4.340	-0.586
2) T 4 3/8 12/31/29	101-24	BAMT	3.9446	0.9397	1.584	3.890	4.340	2.282
3) T 4 1/4 01/31/30	101-07 3/4	BAMT	3.9493	0.9340	5.074	3.105	4.340	6.240
4) T 4 02/28/30	100-07 5/8	BAMT	3.9424	0.9234	9.660	1.943	4.340	12.130
5) T 4 03/31/30	100-05 7/8	BAMT	3.9559	0.9221	12.412	1.423	4.340	14.704
6) T 3 7/8 04/30/30	99-20+	BAMT	3.9567	0.9159	16.509	0.472	4.340	19.323
7) T 4 05/31/30	100-06 3/8	BAMT	3.9541	0.9196	21.570	-0.396	4.340	23.722
8) T 3 7/8 06/30/30	99-19	BAMT	3.9656	0.9132	24.360	-1.107	4.340	27.025

Source: Bloomberg

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Invoice price system creates CTD switches

Each futures contract has a set of fixed conversion factors for each deliverable bond. These are constant for the life of the contract and determine the invoice price of each bond that can be sold into the contract. The conversion factor is defined as the price of the bond at a 6% yield.

If a bond has a 6% coupon, the conversion factor would be 1. For bonds with coupons below 6%, like most Treasuries today, the conversion factors are below 1 (for a 4% coupon bond to yield 6%, it will price below par). Conversion factors are designed to even out price differences arising from coupon differences in the deliverables to make them closer to equally deliverable. High dollar price bonds are more expensive to buy but fetch more in the invoice price (c*F + AI) via the higher conversion factor.

Conversion factors are shown in the 5th column of Exhibit 2 above.

The Sep 2025 WN contract (WNU5) has factors from 0.43 for a 1.625% coupon to 0.83 for a 4.75% coupon bond. Conversion factors well below 1 are important for giving the wild card its value in the WN contracts.

A simplified example of why CTDs switch

If two bonds in the basket have the same coupon, they will have the same conversion factor and therefore the same invoice price. If all bonds happen to have 6% coupons, all conversion factors would be 1 and their accrued interest would about be the same. Imagine a US deliverable basket of 15y bonds through 25y bonds, all with a 6% coupon. The invoice price cF+ AI would be the same for all the bonds, no matter what their cash prices were. The cheapest bond to deliver bond would have the lowest dollar price/highest yield. If the curve were perfectly flat at 6%, the deliverables would all be

CTDs assuming they had the same term repo rates. If the curve titled upward so the basket had a positive slope then the longest bond would be CTD. If the delivery curve were inverted, the shortest bond would be CTD.

Assume the yield curve were flat at 6% and all were equally CTD. If yields move down in parallel to 5.5%, all bond prices would rise but not equally across the basket, yet the invoice price would not vary across bonds. The bonds that rallied the least – the lowest duration bonds in the basket – would become cheapest to deliver. By contrast, if yields moved up in parallel to 6.5%, the bonds with highest duration would becomes CTD.

This example shows how the definition of invoice price causes CTD switches from one end of the basket to the other as the level of yields change and the slope of the curve changes. The principle is the same with conversion factors different from 1. Lower duration bonds become CTD when yields fall below 6%, like today, and higher duration bonds become CTD when yields are above 6%, depending on the curve slope and the exact yield levels and prices of each deliverable.

The futures price will track just below the CTD forward price. As markets move, futures track the worst performing bond in the basket. This is what gives futures a lower convexity profile versus cash Treasuries: futures shorten in rallies and lengthen in selloffs. Futures can have negative convexity if the switches – and duration changes - are large enough.

Futures carry and roll

Futures do not generate carry via coupon payment, but they do have a deterministic trend in price due to passage of time as forward settlement approaches spot. This is economically equivalent to carry but does not include an actual cash flow. Futures also experience rolldown because they track the CTD which rolls down over time. For 1 month, the futures rolldown would be the 1-month rolldown of the CTD.

The cash flow of a basis position comes from the cash leg. A long basis position, long the cash bond and short futures, is earning daily carry on the cash bond in a positive carry environment. In a negative carry environment, with futures priced to 1st delivery date, a long basis position is costing carry each day and waiting for a delivery option to go into the money can be costly.

Embedded options in the contract

The embedded options in Treasury futures are only available to the short position. These options do not exist in the underlying cash markets and make futures distinctly different from cash bonds and forwards. In a sense, the short futures position “buys” options, and the long position “sells” them. To the extent that these options are valued above 0 by the market, the net basis will be positive and futures will trade below forwards. In this case, the contract offers more “carry” than a term-financed equivalent long in the cash CTD. If the option value is high enough, selling these options by holding long futures instead of long cash in a portfolio can generate excess return, ie excess carry. But this can go against the long if the options go into the money, in which case futures could underperform cash.

There is a parallel her to generic callable bonds, including mortgage-backed securities, where the long sells options to the short and hopes for time decay of option premium to generate excess carry. The “greeks” of the callable bond are the greeks of the bullet minus the greeks of the option. The more convexity embedded within the option, the lower the convexity of the callable bond (= bullet convexity – option convexity). This can make futures a better hedge for MBS because both have embedded options that depend on rate levels, making futures potentially a better convexity match than bullet swaps or Treasuries. But the option value in MBS is typically orders of magnitude larger than that embedded in futures, and so MBS securities can have deeply negative convexity, while futures convexity rarely will be negative.

Futures can be thought of as a forward price on a single bond minus embedded option value:

Futures price = forward price of CTD / c – total option value

where the forward price of the CTD is divided by the conversion factor c. The futures price generally hovers below the converted forward price of the CTD by an amount depending on the option value.

Quality and timing options

Delivery options come from 2 sources: 1) **Quality**: multiple Treasury securities in a basket of bonds are eligible to sell. This is the “quality” or “switch” option. The switch option is active long before delivery month and behaves differently before vs after the last trade date. After the last futures trade date, futures have a fixed price but cash continues to trade normally. 2) **Timing:** sale of bonds is available for approximately a month. The timing option includes a sub-option called the Wild Card: after futures markets close but cash markets continue trading, a delivery can be initiated at the futures settle price. The wild card can be valuable particularly in delivery months with an FOMC meeting because press conferences start at 2:30pm EST or 30 minutes before futures close. The 3pm EST closing price determines the T+2 invoice prices of the deliverable bonds which continue to trade freely in cash markets. If bond prices move enough after 3pm EST, a delivery process can be initiated before 7pm EST to declare a sale of cash bonds selected by 3pm EST the following day to be sold by 2pm EST the following day.

Wild card example

As an example of the wild card option, suppose one enters a long basis position in the WNU5 CTD during delivery month at a gross basis of 5 ticks (with say a net basis of 4 ticks). This would entail buying $100mm T4.75% 11/15/53 vs shorting 734 WNU5 contracts. Here the conversion factor is 0.7342 and 734 contracts corresponds to a notional amount of $100,000 * 734 = $73.4mm. Suppose the 3pm close on cash and futures gives an unchanged basis at 3pm EST. If the cash bond market rallies a point after 3pm, the trader can initiate delivery on 734 contracts at the 3pm futures closing price and sell the extra cash bonds (100-73.4 = 26.6mm, aka the “tail”) in the now-higher cash market. The delivery of 73.4mm bonds loses 5 ticks on 734 contracts as the invoice price is 5 ticks below the CTD price (gross = 5 ticks). At $31.25 per tick, this is a loss of 734*5*31.25 = $114,688. But the $26.6mm tail is sold a point above its close, generating $26.6mm * 1% = $266,000. This generates a net profit from the wild card. The larger the tail, or the smaller the conversion factor, the more profit can be realized. But the market will likely price the net basis higher to enter the trade, setting the threshold for profitability further out. The question of buying the option (net basis) is not just the payoff potential, but the cost to enter. The market trades the net basis as the fair value of the sum of all options.

Wild card rule of thumb

Delivery is a 1-1 process: $100 bonds are delivered into $100 notional contracts. This creates a need to “manage the tail” ie to rebalance from a conversion-factor weighted position to a 1-1 position before delivery. If the market rallies fast enough and far enough after the 3pm EST futures close, the cash tail can be sold (1 – C amount of bonds) and the remaining C bonds can be announced for delivery on T+2. This makes the wild card essentially a 3-hour call option on 1-C amount of the CTD that costs the gross basis on C bonds to exercise. A rule of thumb is that the loss on the gross basis on C contracts should be lower than the gain on 1-C cash bonds sold:

*Gross basis * (C) < (current cash price – 3pm close cash price) * (1 -C)*

If the net basis is positive, meaning embedded delivery options have value, then exercising the wild card gives up this remaining value, which is included in the full amount of gross basis along with the carry (gross basis = net basis + carry).

The wild card is not a switch option, but it is possible that the CTD also switches before the deadline to announce the specific bond delivery in the wild card. It is therefore plausible that the trader can sell the original CTD to buy the new one, and then deliver that into the wild card for more P&L.

Option acts like puts and calls depending on maturity

At the end of the delivery period, the option value decays down to 0 which causes the net basis of some CTD to go to 0. Non-CTDs will end with a basis larger than 0. If B-cF = 0, then F = B/c, meaning the futures price converges to the converted CTD bond price. Other bonds will have a basis of B-cF or B- c*(CTD price/CTD factor). This is helpful for looking at basis payoff scenarios.

Basis traders will often try to match the basis payout (using Bloomberg CMS screen or similar) with options on futures, and then compare the prices for similar payouts. If the option offered in the basis market is cheaper than a replicating put option, there may be an opportunity to buy the basis and sell the put.

Net basis payoff profiles: CMS Bloomberg screen

If you buy the net basis, you are buying bonds and selling futures, ie buying the options and hoping that realized rate moves are high and the option pays off. The fair value of the net basis is the probability-weighted sum of its payoff. If you sell the net basis, you are selling the option and hoping it expires worthless (or at least goes down). The payoff profiles of the net basis can be approximated by assuming various yield scenarios of the delivery bonds at delivery date and setting F = lowest(B/c) across all the bonds in the basket. A useful screen for this on Bloomberg is the CMS screen, which looks at simple up/down yield shifts to see how the net basis could go up or down by the delivery date. Curve twists should also be looked at and our BofA basis model report runs these scenarios daily.

An example of the CMS screen for the USU5 contract from Bloomberg is shown in Exhibit 3 below.

Exhibit 3: Scenarios of -100 to +100 move the CTD basis up, like an option straddle

Current CTD maturity is 11/43 but moves down to 11/41 in a rally and up to 11/44 an 8/50 in a selloff

VIEW B — B-Basis. C-basis Chg / H-Horizon bond price / V-BPV / S-CTD B.P. Spread / P-P&L 32nds

CTD Scenario Analysis — Pg1 of 4

CTD Basis 0. 32nds Stl 7/10/25 Dlv 9/30/25

USU5 113-04

PARALLEL YIELD SHIFTS (BP)	-100	-50	0	50	100
Price:	125-21	119-27	112-16	106-24	98-22
Chng:	+12-17	+6-22	+ 12	-6-12	-14-12
Risk:	14.02	12.14	12.27	14.21	17.50

	Issue	Price	Src	Yield	Basis	Basis at Contract Horizon (32nds) -100	-50	0	50	100
1)	T 4 ¾ 11/15/43	98-00⅛	BAMT	4.916	10.3	44.1	20.4	.2	5.9	60.9
2)	T 4 ¾ 02/15/41	99-14⅜	BAMT	4.800	10.5	.0	.0	.0	23.0	93.4
3)	T 4 ⅜ 08/15/43	93-16+	BAMT	4.920	10.0	46.4	22.3	1.5	5.5	56.7
4)	T 4 11/15/42	89-15⅞	BAMT	4.906	8.8	40.6	19.9	2.0	7.2	57.2
5)	T 4 ⅝ 05/15/44	96-08¼	BAMT	4.932	11.9	55.5	26.8	2.5	4.2	55.0
6)	T 4 ½ 02/15/44	94-26⅜	BAMT	4.928	12.0	54.0	26.5	3.1	5.1	55.4
7)	T 4 ⅜ 05/15/41	95-03	BAMT	4.821	11.2	12.6	7.3	2.5	20.4	84.0
8)	T 3 ⅞ 02/15/43	87-25⅝	BAMT	4.919	9.6	47.3	23.7	3.3	5.9	52.8
9)	T 3 ¾ 11/15/43	85-20⅜	BAMT	4.950	9.4	59.9	29.8	3.7	1.2	42.6
10)	T 3 ⅝ 08/15/43	84-09⅝	BAMT	4.948	9.1	58.1	29.1	3.9	1.6	42.6
11)	T 4 ¼ 11/15/40	94-02⅝	BAMT	4.799	11.5	6.8	5.0	3.3	23.3	88.3
12)	T 3 ⅞ 05/15/43	87-19⅞	BAMT	4.925	10.3	51.9	26.2	4.1	5.2	50.8
13)	T 4 ⅝ 11/15/44	96-03	BAMT	4.940	14.7	65.8	33.0	5.2	4.0	52.3
14)	T 3 ⅜ 08/15/42	82-09⅜	BAMT	4.918	8.9	48.3	25.2	4.8	6.1	48.8
15)	T 1 ⅜ 08/15/50	47-31¾	BAMT	5.055	60.2	212.0	131.2	62.8	15.7	.0
16)	T 3 11/15/44	75-15⅜	BAMT	4.990	16.8	93.2	50.8	14.1	.0	26.2

Source: Bloomberg, BofA Global Research

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Exhibit 3 shows the basis of each bond at the last delivery date when futures converge to some CTD. The CTD starts today at 11/43, but when yields shift up 50bp the CTD becomes the 11/44 maturity and today's CTD closes at almost 6 ticks (versus 7 ticks today). If rates selloff 100bp, the CTD moves out to the 8/50 maturity and the 11/53 basis would be worth 61 ticks. A decline in yields by 50bp or more shifts the CTD down to 2/41 maturity, and the current CTD basis would again widen. This shows that a long 11/43 CTD basis has a payout similar to a rate straddle. Looking at scenarios like this and their possible basis payouts can allow a fair value estimate of the basis today. The BofA basis model reports fair value and switch scenarios.

Futures duration also a function of switch scenarios

The BofA basis model report tracks frequency of occurrence of CTD for each deliverable in a grid of scenarios. This gives a probability of being CTD for each bond in the basket. These probabilities are multiplied by the forward PV01 of each deliverable to give an estimate of the PV01 of the futures contract. This is the typical way of calculating futures PV01.

Common futures trades

CTD or non-CTD basis

Outside of traditional duration and curve trades using futures, there is a set of basis and spread trades that form the core of futures RV trading. They fall roughly into 3 categories: futures vs cash bonds, futures vs futures, and futures vs swaps.

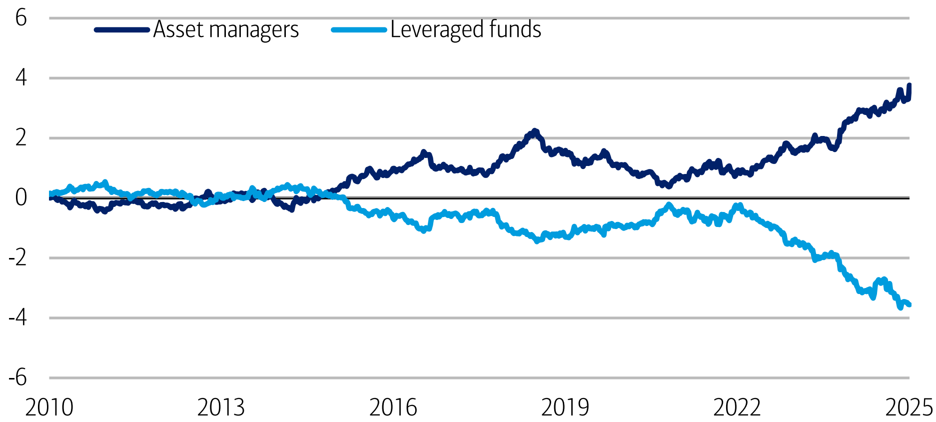
Futures vs cash: basis

Within the futures vs cash category, the main trade would be futures vs the CTD conversion-factor weighted. This is the traditional CTD basis trade, where longs are long the basis, long the optionality, long the cash bond, and looking for the basis to widen or to make profitable delivery plays. Short basis positions are short the options and generally seek excess carry generated from time decay of the option value. One can think of hedge funds as generally long the basis and asset managers as generally short the basis. While leveraged funds are often considered the main trader of basis, asset managers are essentially equal in size (Exhibit 4). There is always a long against a short.

Asset managers buy Treasury futures instead of Treasury cash bonds for their portfolios. This is a simple way for asset managers to introduce leverage into their portfolios without repo, which has unfavorable accounting. It frees up cash which might be invested in money markets at higher rates when the curve is inverted or can be placed into credit sectors to enhance returns. The periods with largest asset manager holdings occurred during inverted yield curves. Asset managers can replicate the risks of the Treasury cash index by buying futures across the curve. By doing this, however, they are taking a short basis position. Their performance versus a cash benchmark index will be a function of how the basis performs (assuming they are matching the index duration and curve exposures). If the net basis increases, futures underperform cash, and their portfolio could underperform the index.

Exhibit 4: Asset managers and leveraged funds are on 2 sides of the same FV basis trade (millions of FV contracts)

Asset managers access leverage with Treasury futures, leveraged funds buy cheap options



Source: CFTC, Bloomberg, BofA Global Research

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While asset managers are not explicitly selling a cash bond and buying futures, they are explicitly not buying a cash bond held in the index and instead buying futures. Even though asset managers roll their futures well before delivery month begins, they are exposed to basis risk for their entire holding period. The official sector has recently become concerned about basis positions held by leveraged funds, but the asset manager community carries the same basis trade as hedge funds, just in the opposite direction. Exhibit 4 shows the net FV position of asset managers and hedge funds over time. Because the asset manager does not buy the cash bond, someone else must. This creates need for repo funding, which acts as a constraint on how large the asset manager / leveraged fund basis positions can get.

Weightings other than conversion factor

Basis trades can incorporate non-CTD bonds and can also be done with weightings other than conversion factors. The quoted basis in the market is a conversion-factor weighted position (Bond price – C*Futures). Any other weighting will not necessarily track the quoted basis. If W is some other choice of weighting, then

$$B - W^*F = B - W^*F + C^*F - C^*F = B - C^*F + (C-W)^*F = \text{basis} + (C-W)^*F$$

This shows that any non-conversion factor weighting is a standard conversion-factor weighted basis plus some additional futures exposure.

Trading a non-CTD vs the futures is similar to a curve trade with a futures overlay. If the futures is tracking the shortest bond in the basket, and one trades a mid-basket or end-basket bond vs futures, the main driver of performance will generally be the slope between those two points of the curve. There can also be a component of futures performance vs the CTD which implicitly impacts the trade.

CTD relative value trades

Trading the cash bonds in the deliverable baskets is often done without trading futures. The typical expectation is that a bond will richen vs other cash bonds when it becomes a CTD and will cheapen when it "falls out of the basket", ie when it loses deliverable eligibility into any contract. Anticipation of richening and cheapening based on CTD status is often done by trading cash bonds vs swaps, as a matched-maturity swap spread. It can also be done vs futures. Bonds that won't become CTDs until years later most frequently would be purchased vs swaps, which is a relatively simple way to capture richening into CTD status well advance of the event.

Futures vs futures: calendar trades and curve trades

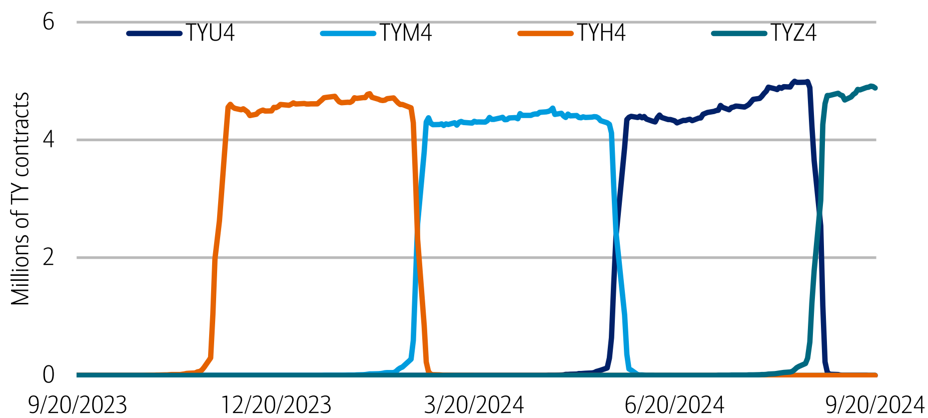
An example of a 2y-7y curve steepener using futures would be to buy TU contracts vs duration weighted TY contracts. The Bloomberg screen FHR is useful for these hedge ratios.

The calendar spread is the price differential between 2 different quarterly contracts of the same maturity, for example the Sep-Dec TY calendar, also called the Sep-Dec TY roll. This roll is the price of the Sep TY contract minus the price of the Dec TY contract (front minus back). The calendars trade most heavily during the roll season, which is roughly the month before the delivery month. By first delivery date. Most open interest has migrated to the next contract. Those who are long the front contract, which is generally the asset manager community, will need to sell it and buy the back. This is "selling the roll" and can put downward pressure on the calendar. Leveraged funds who are generally short the front, will need to buy it and sell the back, which is buying the roll.

The calendar spread can be volatile during the roll season and traders can speculate on which way the roll will go. Because liquidity in the upcoming contract is often low before the roll begins trading, traders can use the anticipated CTD of the deferred contracts as a proxy for the back contract. For example, a fund that wants to buy the Sep-Dec roll today could buy Sep contracts and sell the Dec CTD cash bond or a similar cash bond.

Because CTDs in the back contracts are often longer maturity and longer duration, a roll will often move into slightly fewer contracts than currently held. This is the tail of the roll and can vary depending on the end users needs.

Exhibit 5: Open interest transitions each quarter into the new contract during the roll cycle
Very few contracts are held into the delivery month



Source: BofA Global Research, Bloomberg

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Calendar trades can express other views as well. Today, the price of the front contract reflects a forward settle to Sep and the price of the back contract is a forward price to Dec (plus option values in each). When the CTD is shared between the 2 contracts, the main driver of the calendar would be the carry differential between Sep and Dec. This is mainly a function of the 3-month repo rate from Sep to Dec, or the "tail" repo of the full-term repo rate from today through Dec. If this tail repo rate falls – say based on changing Fed policy rate expectations or changing funding conditions - then the carry for Dec can increase relative to the carry to Sep. All else equal, this would lower the Dec contract price (more carry = lower forward price) relative to Sep, which would make the calendar widen (Sep price increases relative to Dec).

If the CTDs are different between the front and back contract, the yield spread between the CTDs will be an important factor in the roll. A steeper yield slope would richen the front CTD vs the back CTD. All else equal, this would increase or widen the calendar.

Invoice spreads = swap spreads using futures

Invoice spreads are like swap spreads, ie the difference between Treasuries and swaps. An invoice spread trade replaces the Treasury cash leg with a Treasury futures contract. This has the advantage of avoiding cash markets and the financing logistics of repo. Because futures have a forward settlement date, the swaps leg is typically also forward settled to the same date.

For example, one can buy Sep FV contracts and pay a swap with a maturity date matching the FV CTD and settling on the 1st day of the FV delivery month. A useful Bloomberg screen for invoice spreads is IVSP. Invoice spreads are a popular way to trade swap spreads. Using options on futures vs options on swaps allows for variations. For example, buying a call on futures vs selling a receiver on the swap would provide a long invoice spread position (long bonds vs pay swaps) if rates rally and the options go into the money. If the options do not go into the money (higher rates) there is no spread position. This can be done with calls/receivers or puts/payers.

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Research Analysts

US

Mark Cabana, CFA
Rates Strategist
BofAS
+1 646 743 7013
mark.cabana@bofa.com

Ralph Axel
Rates Strategist
BofAS
+1 646 743 7011
ralph.axel@bofa.com

Bruno Braizinha, CFA
Rates Strategist
BofAS
+1 646 743 7012
bruno.braizinha@bofa.com

Katie Craig
Rates Strategist
BofAS
+1 646 743 7016
katie.craig@bofa.com

Meghan Swiber, CFA
Rates Strategist
BofAS
+1 646 743 7020
meghan.swiber@bofa.com