r is not a constant

The relationship between bond futures and repo rates

ICMA Professional Repo Market & Collateral Management Course

Andy Hill, ICMA
November 2022

Contents

Exchange traded bond futures

Standardized contracts, based on notional bonds with pre-specified maturity, coupon.

Standardized notional (face) value for each contract ‘lot’.

Traded on regulated futures exchanges.

Standardized expiry dates (usually quarterly: Mar, Jun, Sep, Dec).

Usually physically settled on expiry with the delivery of a bond.

Delivery dates are either a fixed date or a specified date range.

Specified underlying basket of deliverable bonds (of similar maturity to the notional contract).

The price of the futures contract is linked to the prices of the underlying basket of deliverable bonds (using pre-determined conversion factors).

The counterparty to any transaction is the relevant clearing house.

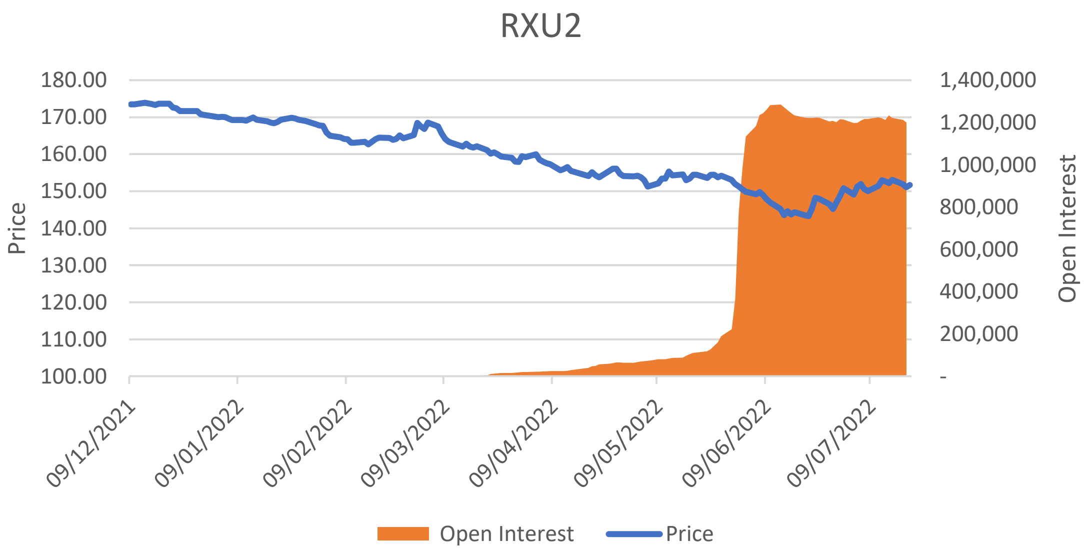
Positions are leveraged with margin (initial and variation) being paid to the exchange.

Example: Eurex Bund Contract

Exchange	EUREX
EUREX ID	FGBL
BBG ID	RX
Currency	Euro
Contract Value ('Lot size')	€100,000
Maturity	10 years
Coupon	6%
Deliervable bonds	German Government Bonds with between 8.5 and 10.5 years remaining to maturity
Price Quotation	Percentage value of par (to 2dp)
Tick value (0.0001%)	€10.00
Contract months	March (H), June (M), September (U), December (Z)
Delivery day	10th calendar day of contract month (or next business day)
Last trading day	Two business days prior to delivery date

Example: Eurex Bund Contract

RXU2	
First Trade Date	12/8/2021
Last Trade Date	9/8/2022
Delivery Date	9/12/2022
Deliverable bonds	
DBR 0 08/15/31	DE0001102564
DBR 1.7 08/15/32	DE0001102606
DBR 0 08/15/31 [Green]	DE0001030732
DBR 0 02/15/32	DE0001102580



Conversion factors

Conversion factors are intended to normalize the price of deliverable bonds with that of the futures contract.

They can essentially be viewed as a form of duration adjustment (or hedge ratio), however unlike duration / hedge ratios (which change constantly), conversion factors remain static for the life of the contract.

The exchange calculates and publishes CFs for bonds in the deliverable basket at the time the contract becomes listed for trading.

The CF is calculated by determining the bond price on the delivery date that would correspond to the yield that is equal to the coupon of the notional contract.

Example of calculating the conversion factor (Bund Future)

RXU2 (September 2022 Bund) has a notional coupon of 6%, with delivery date 09/12/22

DBR 0 8/31
Settle date: 09/12/22
Yield (Street Convention): 6.00%
Price: 59.4550

CF = 0.594550

DBR 1.7 8/32
Settle date: 09/12/22
Yield (Street Convention): 6.00%
Price: 68.5182

CF = 0.685182

Deliverable bonds		Conversion Factor
DBR 0 08/15/31	DE0001102564	0.59455
DBR 1.7 08/15/32	DE0001102606	0.685182
DBR 0 08/15/31 [Green]	DE0001030732	0.59455
DBR 0 02/15/32	DE0001102580	0.57734

The CF also determines the price at which a bond is delivered into the futures contract at expiry
This is **the final futures price at expiry * the CF**

So if the RXU2 contract expires at 151.50,traders short the contract would sell an equivalent notional value of DBR 0 8/31 (assuming that they wanted to or were able to deliver the CTD) at a price of 151.50*0.594550 = **90.07433**
Traders long the contract would receive bonds at the same price

Calculating the fair value of the futures contract

One bond in the deliverable basket will always be cheaper to deliver into the futures contract than the others. This is known as the 'cheapest to deliver' bond (or 'CTD'). The futures price will most closely follow that of the CTD (adjusted for the conversion factor).

The CTD can switch as bond yields/prices change, meaning that the futures price will track this new CTD (adjusted for its conversion factor). The probability of this happening is also built into the futures price (in the form of discount) and is called 'optionality'.

$$\mathbf{FV\ (F) = \frac{FP\ CTD}{CF} - O + D^{\S}}$$

where FV (F) = futures price fair value, FP CTD = the forward price of the CTD bond (at the expiry date, for value the delivery date), CF = conversion factor of the CTD, O = the optionality value of a CTD switch, and D = settlement risk associated with delivery[§]

FP CTD = Spot CTD * [1 +r (days to expiry/day count convention)]

where the forward price of the CTD (at the expiry date for value the delivery date) is the spot price of the CTD adjusted by the repo rate (r) from the spot date to the delivery date

[§] Delivery settlement risk is not usually included in conventional fair value calculations, but empirical evidence suggests that this is an important factor when determining the arbitrage value of the future

Example: Calculating the fair value of the Bund Contract

RXU2

FP CTD = Spot CTD * [1 + r (days to expiry/360)]

CTD is DBR 0 8/31 Spot date: 7/22/22 Price: 90.25 Repo rate spot-9/12/22: -1.50% (52 days)
Forward price: 90.054458
[CF: 0.594550]

$$\textbf{FV (F)} = \frac{\textbf{FP CTD}}{\textbf{CF}} - \textbf{O} + \textbf{D}$$

Assume zero optionality and no delivery risk

$$\text{FV (F)} = \frac{90.054458}{0.594550} = \textbf{151.47}$$

Gross Basis & Net Basis

The Gross Basis of a deliverable bond is the difference between the spot price of the bond and the futures price adjusted for the conversion factor of the bond

Gross Basis = Bond Price – (F * CF)

The Net Basis of a deliverable bond is the difference between the forward price of the bond (at the futures expiry date) and the futures price adjusted for the conversion factor of the bond.

Net Basis = Forward Bond Price – (F * CF)

The net basis can be considered as the cost of delivering the bond into the contract, adjusting for carry (ie. accrued interest – repo interest)

The bond with the 'cheapest' net basis is effectively the CTD (although usually it is better to think of the bond with the cheapest implied repo rate at the CTD)

Going long a bond and shorting the future is going long (or buying) the basis. Shorting a bond and going long the future is going short (or selling) the basis.

Traders may look to buy or sell the gross basis of deliverable bonds with a view to it richening or cheapening. This could be result of changes in the relative value of the bond and future due to moves in the yield curve (ie steepening or flattening), or the increased probability of a CTD switch.

Example: Bund Gross Basis & Net Basis

Calculating the CTD Gross Basis

RXU2: 150.98

DBR 0 8/31 Spot date: 7/25/22 Spot price: 90.019 CF: 0.594550

Gross Basis = 90.019 – (150.98 * 0.594550) = +0.254 or **+25.4c**

Calculating the CTD Net Basis

RXU2: 150.98 Spot date: 7/25/22 Spot price 90.019 CF: 0.594550

Repo rate s-9/12/22: -1.50% Forward price: 89.835211

Net Basis = 89.835211 – (150.98 * 0.594550) = 0.07 or +**7c**

Thus the cost of buying the CTD for spot, selling the future, repoing the bonds to the delivery date, and delivering the bond into the contract at expiry, is 7c. (0.07).

Taking the opposite position (shorting the CTD, buying the future, reverse repoing the bonds to the delivery date, and receiving the bonds through delivery will generate a profit of 7c (assuming that the same bonds are delivered and the CTD does not change).

Trading the basis and going to delivery

Trading the spread between a deliverable bond and the futures contract (ie going long of one and short of the other) is called 'trading the basis' (or 'basis trading').

When trading the CTD basis, it is usual to take the opposite position in the equivalent notional value of futures adjusted by the conversion factor. This is based on the assumption that the trade could result in delivery.

When trading the basis on deliverable bonds other than the CTD, it is usual to take the opposite position in the duration weighted notional value of futures. This is based on the assumption that the trade will not result in delivery, and will be unwound before expiry (hence duration weighting is more appropriate than CF weighting).

If going to delivery, a trader short a futures contract at expiry will deliver into the future the notional equivalent of bonds at a price that is determined by the **futures expiry price * the bond CF**.

Similarly, a trader long a futures contract at expiry will receive the notional equivalent of bonds (usually the CTD) with the same price determinant (futures expiry price * the bond CF).

The amount of bonds delivered in the contract (or received) will be the equivalent notional (face) value of the futures position.

Since the number of futures contracts is weighted by the CF (or by duration for non-CTDs) when trading the basis, should the trader go to delivery they will need to adjust the number of futures contracts at the last moment to ensure that the notional value of the bonds and futures are the same. This is called 'managing the tail' and the trader will want to execute their balancing futures trades as close as possible to the expiry value. This creates the risk of 'slippage', particularly as futures markets can become quite thin and volatile close to expiry. The more contracts that need to be bought or sold relative to the underlying bond position (ie the further the CF is from 1), the more risk of slippage.

Example: trading the basis and going to delivery

Selling the basis (non-CTD)

DBR 1.7 8/32 Spot Price: 104.0385 RXU2: 150.98 CF: 0.685182
Duration ratio: 0.708§

Basis = 104.0385 – (150.98 * 0.685182) = 0.59

Sell: €100mm of DBR 1.7 8/32 Buy: 0.708 * 1,000 = 708 RXU2

Buying the CTD basis and going to delivery

DBR 0 8/31 Spot Price: 90.019 RXU2: 150.98 CF: 0.59455
Basis = 90.019 – (150.98 * 0.59455) = 0.25

Buy: €100mm of DBR 0 8/31 Sell: 0.595 * 1,000 = 595 RXU2

At expiry, to deliver the full €100mm of DBR 0 8/31 requires being short 1,000 RXU2

Therefore, as close to expiry as possible (to minimize slippage risk), a further 405 contracts will need to be sold

Assume futures expiry is 150.00, and the additional contracts are sold at an avg price of 149.95: this would result in an additional delivery cost (or ‘slippage’) of €20,250 (0.05 * 100 * 405 * €10)

§ Note that unlike the CF, the duration ratio will change with time and price moves, requiring regular maintenance of the futures hedge

The Implied Repo Rate (IRR)

Buying a deliverable bond and selling the futures contract (with a view to making delivery) is the synthetic equivalent of going long a repo (ie a reverse repo).

The start price is the spot price for the bond, and the end price will be the futures price * the CF. Thus going long the gross basis has an implied repo rate (IRR).

Calculating the IRR:

$$\frac{IFDP - SDP}{SDP} * \frac{Dc}{Dd} * 100$$

where IFDP is the implied forward dirty price at delivery = (Futures price * CF) + accrued interest at delivery
SDP is the spot dirty price of the bond = Price + accrued interest
Dc is the day count convention (360 or 365)
Dd is the days to delivery from the spot date

Example: calculating the Bund CTD IRR

RXU2: 150.98

DBR 0 8/31 Spot date: 7/25/22 Spot price: 90.019 CF: 0.594550

Implied Forward Dirty Price:	150.98 * 0.594550	= 89.76516
	+ accrued interest (0%)	= 89.76516
Spot Dirty Price:	90.019 + accrued interest (0%)	= 90.019

Days to delivery (7/25/22 – 9/12/22) = 49 days

$$\text{IRR} = \frac{(89.76516 - 90.019)}{90.019} * \frac{360}{49} * 100 = \mathbf{-2.07\%}$$

So buying the DBR 0 8/31 (at 90.019) and selling the future (at 150.98) would be the synthetic equivalent of buying the DBR 0 8/31 repo for 7/25/22 - 9/12/22 at -2.07%

Trading the IRR vs the actual repo rate

The actual repo rate of the CTD bond, in theory, should be the same as the implied repo rate (assuming there is no meaningful optionality value or delivery settlement risk).

Differences between the actual repo rate (ARR) and the IRR provide trading opportunities.

The difference between the ARR and the IRR for a deliverable bond is the same as **the net basis**.

For example, if the ARR is lower (more expensive) than the IRR, this provides a ‘cash and carry’ opportunity, whereby the trader can buy the bonds, sell the future, lock in the ARR to delivery, and earn the difference between the IRR and ARR. This is essentially going long the (negative) net basis. In this instance, assuming that there is no delivery settlement risk, going long the net basis and going to delivery will guarantee this return.

Alternatively, if the ARR is higher than the IRR, this provides an opportunity to sell the (positive) net basis and lock in the difference between the ARR and IRR. This would entail selling the bond, buying the futures, and reverse-repoing the bond to delivery. On receiving delivery of the bond after expiry, the trader would be flat, having earned the net basis (or the ARR-IRR differential). Here the main risk is a switch in the CTD before expiry, meaning that the trader may not get delivered the bond they shorted and borrowed.

Example: Bund CTD reverse cash and carry

RXU2: 150.98

DBR 0 8/31 Spot date: 7/25/22 Spot price: 90.019 CF: 0.594550

From our previous examples, we know that buying the bond and selling the future has an IRR of -2.07%

Assume an ARR of -1.50%

Trade: Sell DBR 0 8/31 at 90.019
Buy RXU2 at 150.98
Reverse DBR 0 8/31 7/25/22-9/12/22 @ -1.50%
Run to expiry and take delivery

So long as the trader is delivered the DBR 0 8/31 following expiry, this will lock in a profit of -1.50-(-2.07) = **+0.57%** (for 49 days), or **7c** in cash price terms [(0.57 * (49/360) * 0.9019) = 0.07)]

Example: Bund CTD reverse cash and carry

Working through the P&L:

For spot (7/25/22):	Sell €100mm DBR 0 8/31 at 90.019	+€90,019,000
	Buy 595 RXU2 at 150.98 §	
	Reverse €100mm DBR 0 8/31 7/25/22-9/12/22 @ -1.50%	- €90,019,000

Assume a futures expiry price of 150.00

On expiry (9/10/12):	Buy 405 RXU2 at 150.00 [assume no slippage]	
Delivery (9/12/22):	Receive €100mm DBR 0 8/31 at 89.1825 (FP * CF)	- €89,182,500
	Bond P&L: (90.019 – 89.1825)	+ €836,500
	Futures P&L: ((150.00 – 150.98) * 100 * 595 * €10)	- €583,100
	Repo cost (-1.50% * (49/360) * €90,019,000)	- €183,789
	Net P&L:	**+ €69,611**
	or the equivalent of **~7c** (0.0007 * €100mm = €70,000)	

§ The number of contracts is adjusted for the conversion factor of the bond. In this case €100mm face equivalent is 1,000 contracts (future notional is €100,000) * 0.59455 = 595 contracts

Example: Bund Deliverable Basket

RXU2

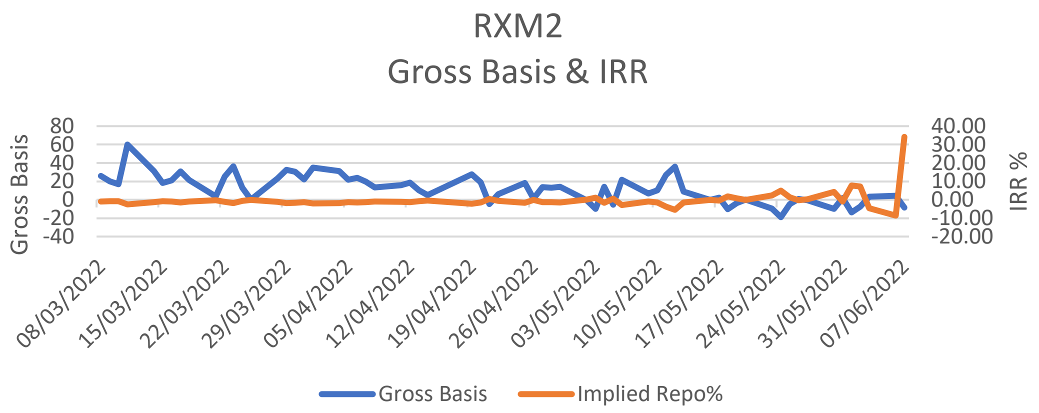
Price: 150.98

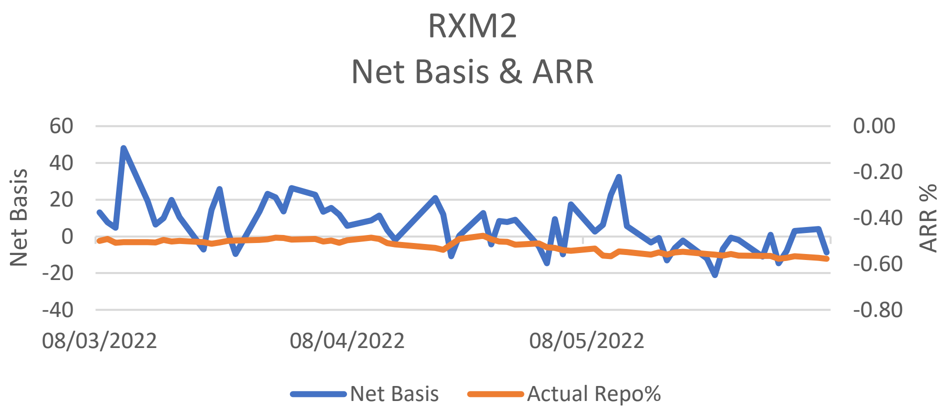
Value date: 07/25/22

Bond	Price	Conv Yield	Conver Factor	Gross Basis	Implied Repo%	Actual Repo%	Net Basis
DBR 0 08/15/31	90.019	1.168	0.59455	0.254	-2.072	-1.50	0.07
DBR 1.7 08/15/32	104.0385	1.27	0.685182	0.59	-2.551	-0.90	0.234
DBR 0 08/15/31 [Green]	90.1865	1.147	0.59455	0.421	-3.432	-0.80	0.323
DBR 0 02/15/32	89.0845	1.216	0.57734	1.918	-15.816	-0.70	1.833

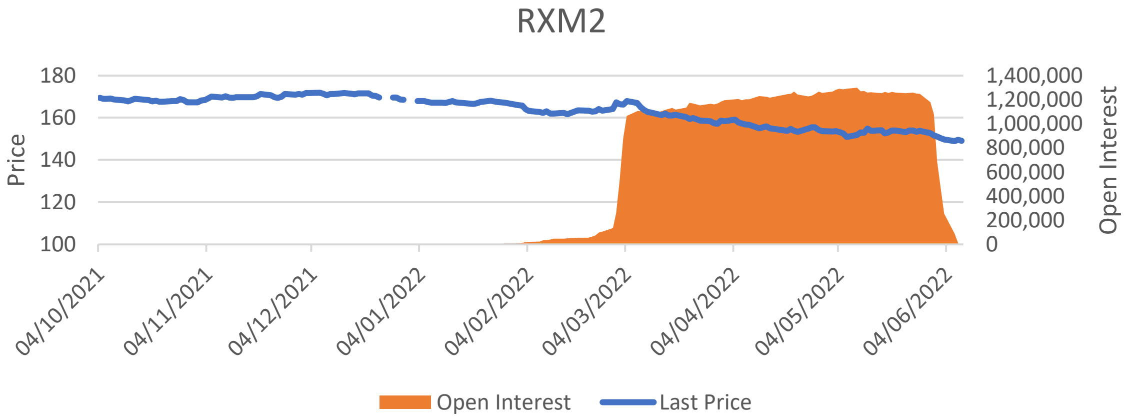
Example: Bund Gross Basis, IRR, and Net Basis

The below charts show the historical Gross and Net Bases and IRR for the June 2022 Bund contract





The Basis and IRR tends to become extremely volatile on the final day of trading as traders look to unwind their futures positions rather than go to delivery – which is reflected in the collapse of open interest



The futures calendar roll

The futures calendar roll is the spread between a price of the futures contract (usually the front month) and the next futures contract. The fair value of the calendar roll can be calculated using the same formula:

$$\text{FV CR} = \text{First Contract} \left[\frac{\text{FP CTD}}{\text{CF}} - \text{O} + \text{D}\right] - \text{Second Contract} \left[\frac{\text{FP CTD}}{\text{CF}} - \text{O} + \text{D}\right]$$

If both contracts have the same CTD (and assuming no optionality or delivery settlement risk), this can be simplified further:

$$\text{FV CR} = \left[\frac{\text{P CTD} * r^1 * (d^1/dc)}{\text{CF}^1}\right] - \left[\frac{\text{P CTD} * r^2 * (d^2/dc)}{\text{CF}^2}\right]$$

where P CTD = CTD spot price r^1 = repo rate to first contract delivery , d^1 = days to first contract delivery, CF^1 = CTD CF for first contract, r^2 = repo rate to second contract delivery , d^2 = days to second contract delivery, CF^2 = CTD CF for second contract, dc = day count convention (360 or 365)

Taking a position in the calendar roll with the same CTD is the equivalent of taking a repo position in the CTD from the delivery date of the first contract to the delivery date of the second contract (going long the roll is equivalent to going long the repo, and going short the roll, is equivalent to going short the repo). The IRR of the synthetic repo position can be interpolated from the CTD IRR for both contracts:

$$\text{IRR}^{CR} = \left[\frac{(1+ (\text{IRR}^2 * (d^2/dc))}{(1+ (\text{IRR}^1 * (d^1/dc))} - 1\right] * (dc/d^{2-1})$$

When trading the calendar roll, with a view to possible deliver, it is usual to weight the two legs based on the respective CTD CFs.

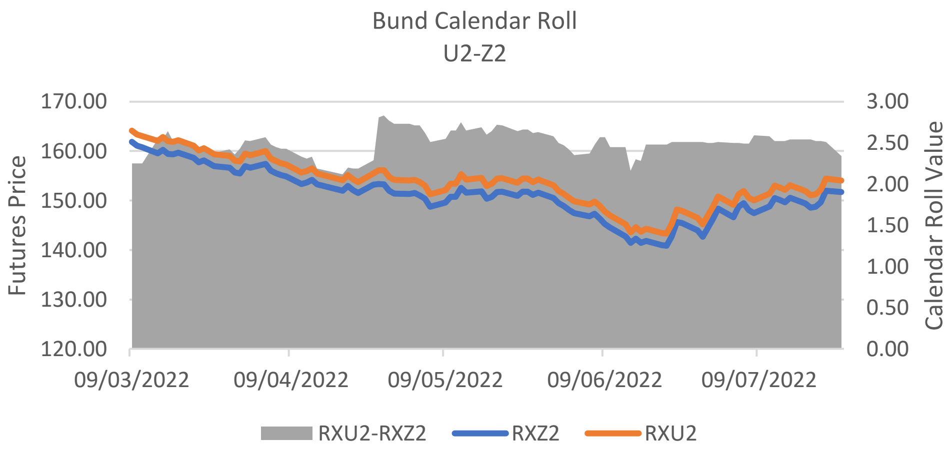
Example: the Bund futures calendar roll

The September and December 2022 Bund contracts have the same CTD (DBR 0 8/31)
We can calculate the fair value of the calendar roll (RXU2 – RXZ2) by taking the market repo rates for the DBR 0 8/31 to the respective delivery dates of both contracts (9/12/22 and 12/12/22 respectively, or 47 days & 138 days).

DBR 0 8/31
Spot date: 7/27/22 Spot Price: 91.63 Repo rate to 9/12/22: -1.08% Repo rate to 12/12/22: -0.32%
CF RXU2: 0.594550 CF RXZ2: 0.60325

FV CR = $$\left[\frac{91.63 * (-0.0108) * (47/360)}{0.594550} \right] - \left[\frac{91.63 * (-0.0032) * (138/360)}{0.60325} \right] = 153.90 - 151.71 = 2.19 \text{ (or 219c)}$$

Interpolating -0.32% 7/27/22-12/12/22 and -1.08% 7/27/22-9/12/22, the repo market value for 9/12/22-12/12/22 is **0.07%**



Example: the Bund futures calendar roll

We can also calculate the IRR of the calendar roll, by interpolating between the IRR of the CTD to each contract date using the actual futures roll values:

Future	Price	Cash Security	Price	Conv Yield	Conver Factor	Gross Basis	Implied Repo%	Actual Repo%	Net Basis
RXU2	153.87	DBR 0 08/15/31	91.63	0.97	0.59455	0.147	-1.225	-1.08	0.017
RXZ2	151.74	DBR 0 08/15/31	91.63	0.97	0.60325	0.093	-0.264	-0.32	-0.020

Interpolating -0.264% 7/27/22-12/12/22 and -1.225% 7/27/22-9/12/22, the IRR for 9/12/22-12/12/22 is **0.23%**

This implies that the IRR of the roll is 16bp cheap compared to the actual repo rate (0.07%)
Furthermore, the actual roll value (213c) is 6c cheap compared to the fair value of the roll (219c).
Economically, this is same thing:

16bp for 91 days on DBR 0 8/31: **16 * (91/360) * 0.9163 = +3.7c**
6c on the RXU2-Z2 roll, adjusted for the CF: **6 * 0.6 = +3.6c**
or
DBR 0 8/31 RXU2 net basis = +0.017; RXZ2 net basis = -0.020: difference = 0.037 or +**3.7c**

Assuming no optionality or settlement delivery risk, this difference could be realized by buying the calendar roll and selling the forward repo, then taking delivery against RXU2 and delivering into RXZ2. This is exactly the same as selling the U2 net basis and buying the Z2 net basis:

- €100mm DBR 0 8/31 + 595 RXU2 + €100mm repo DBR 0 8/31 $^{s\text{-}9/12/22}$
+ €100mm DBR 0 8/31 – 603 RXZ2 – €100mm repo DBR 0 8/31 $^{s\text{-}12/12/22}$
= + 595 RXU2 – 603 RZU2 - €100mm repo DBR 0 8/31 $^{\mathbf{9/12/22\text{-}12/12/22}}$

Delivery optionality

One of the components of the fair value price of a bond futures contract is ‘optionality’. This represents the possibility of a switch in the CTD. Note that a trader short the futures contract, if taken to expiry, will always want to deliver the CTD.

The optionality value is deducted from the CTD-based valuation of the future [see slide 8]. This is because traders who are short the futures contract are effectively long the option to deliver a different (cheaper) bond in the event of a CTD switch. Traders who are long the contract will receive whatever gets delivered into the contract (they are effectively short the option). Hence, where there is any optionality value associated with the contract, the futures will trade at a discount to the CTD-based fair value. This will be reflected as a positive factor in the CTD net basis.

The value of the optionality can be calculated using options valuation models, such as Black-Scholes. The same inputs for options pricing can be used: the yield at which a deliverable bond becomes the CTD is the strike price, with volatility, funding (repo rates), and time to expiry all impacting the optionality value.

Generally, the closer the net bases of bonds in the deliverable basket, the greater the optionality. The further the net bases of bonds in the deliverable basket are from each other, the lower the optionality.

The number of deliverable bonds in the basket can also have an impact, since this increases the probability of a CTD switch.

Example: Delivery optionality in the Bund contract

Value date: 7/25/22

RXU2 150.98

Bond	Price	Conv Yield	Conver Factor	Gross Basis	Implied Repo%	Actual Repo%	Net Basis
DBR 0 08/15/31	90.019	1.168	0.59455	0.254	-2.072	-1.50	0.07
DBR 1.7 08/15/32	104.0385	1.27	0.685182	0.59	-2.551	-0.90	0.234

Assume an upward parallel shift in the yield curve of 33bp:

RXU2 146.80

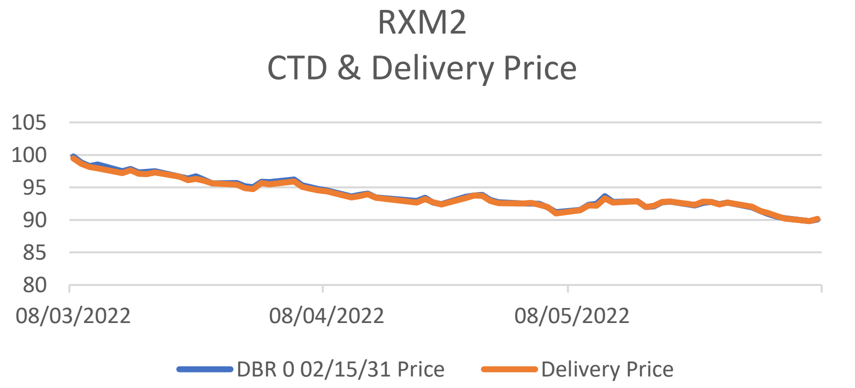
Bond	Price	Conv Yield	Conver Factor	Gross Basis	Implied Repo%	Actual Repo%	Net Basis
DBR 1.7 08/15/32	100.92	1.60	0.685182	0.335	-0.833	-0.90	-0.002
DBR 0 08/15/31	87.40	1.499	0.59455	0.120	-1.052	-1.50	-1.500

Thus if the market sells off by 33bp, the CTD will switch to the DBR 1.7 8/32

Example: Delivery optionality in the Bund and UST contract

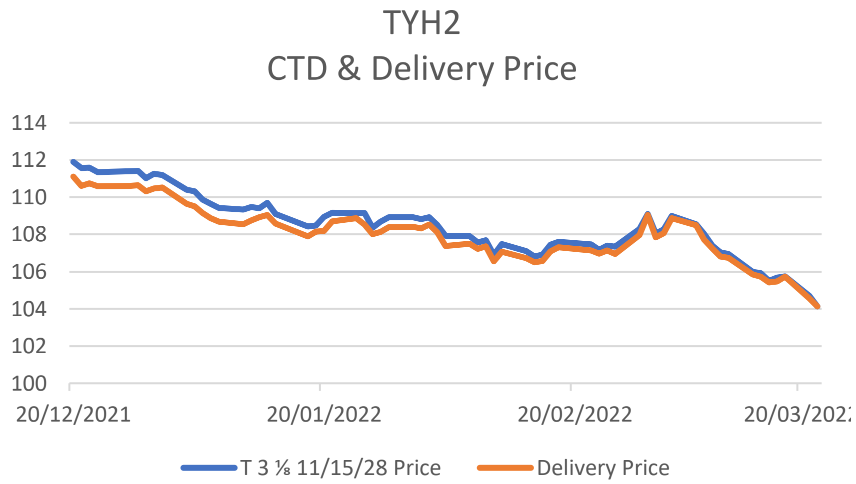
The June 2022 Bund contract had very little optionality of a CTD switch which is reflected in the CTD and delivery price being the same:

Cash Security	Price	Conv Yield	Conver Factor	Gross Basis	Implied Repo%	Actual Repo%	Net Basis
DBR 0 02/15/31	90.061	1.212	0.602865	-0.085	34.138	-0.578	-0.087
DBR 0 08/15/31	89.214	1.251	0.585695	1.635	-659.773	-0.578	1.634
DBR 0 08/15/31 [Green]	89.378	1.23	0.585695	1.799	-724.619	-0.578	1.798
DBR 0 02/15/32	88.323	1.29	0.568741	3.279	-1336.568	-0.578	3.278



The March 2022 US Treasury contract had much more optionality and saw a CTD switch:

Cash Security	Price	Conv Yield	Conver Factor	Gro/Bas (32nds)	Implied Repo%	Actual Repo%	Net/Bas (32nds)
T 5 05/15/37	132-19	2.417	0.902	0.893	2.767	0.35	-2.309
T 4 ⅜ 02/15/38	125-07+	2.449	0.8358	76.73	-82.4	0.35	73.95
T 4 ½ 05/15/38	127-00 3/4	2.461	0.8471	80.838	-84.907	0.35	77.976
T 4 ¼ 05/15/39	123-28 3/4	2.524	0.8151	131.334	-143.907	0.35	128.641
T 4 ½ 08/15/39	127-23 1/4	2.521	0.8401	136.26	-146.004	0.35	133.397
T 4 ⅝ 02/15/40	129-15 3/4	2.561	0.851	141.496	-149.578	0.35	138.549
T 4 ⅜ 11/15/39	125-21+	2.558	0.8254	139.643	-150.939	0.35	136.866
T 4 ¾ 02/15/41	131-09 3/4	2.636	0.8603	155.758	-162.632	0.35	152.727
T 4 ⅜ 05/15/40	125-22 1/4	2.591	0.8226	153.562	-166.294	0.35	150.785
T 4 ¼ 11/15/40	123-10	2.656	0.806	155.382	-171.678	0.35	152.688
T 4 ⅜ 05/15/41	125-12+	2.672	0.8172	169.206	-184.024	0.35	166.429
T 3 ½ 02/15/39	113-09 1/4	2.529	0.7381	153.966	-187.468	0.35	151.774
T 3 ⅞ 08/15/40	117-28 1/4	2.641	0.7662	168.811	-197.464	0.35	166.366
T 3 ¾ 08/15/41	115-28	2.694	0.7451	203.794	-243.321	0.35	201.431



Delivery windows vs delivery dates

Many futures contracts (such as the German Bund, Bobl, and Schatz, the Italian BTP, and French OAT) have a single delivery date following expiry.

Some bond contracts do not have a set delivery date, but rather they provide a period during which bonds can be delivered.

The 10yr US Treasury future, for example, provides for delivery on any calendar day during the delivery month (e.g. The September 2022 (U2) contract permits delivery from September 1 to September 30).

The 10yr Gilt future also provides for delivery on any calendar day during the delivery month.

This creates an additional degree of optionality for holders of short futures positions on if/when to deliver.

An important consideration is the cost of carry of holding a basis position. If the position provides positive carry (i.e. the IRR is cheaper than the ARR), the trader may wish to deliver at the last possible opportunity in order to maximize carry. If the carry is negative, they may be more inclined to deliver at the earliest opportunity.

Another important consideration is the futures optionality and the likelihood of a CTD switch during the delivery window. If there is a possibility for a CTD switch, then they may hold off on making delivery early (while weighing this up against any carry considerations).

Delivery settlement risk

As with any bond transaction settlement, there is a risk associated with the ability to deliver bonds into a futures contract.

Most holders of futures positions will not look to go to delivery, particularly if they are using the contracts as hedges, and will instead close out the position as the contract approaches expiry, usually rolling the position into the next contract month (this is known as the ‘calendar roll’). Accordingly, open interest tends to collapse in the final days before expiry (see slide 20).

Some traders, however, may wish to take advantage of arbitrage opportunities in differences between the futures and the basket, as well as repo rates, such as delivering the CTD into a long negative net basis position, or taking delivery against a short positive net basis position.

Where traders go to delivery, it is imperative that they settle the delivery of the requisite number of bonds to the futures exchange on the specified date. Exchanges will often take punitive action against members who fail to settle their deliveries, including fines and sometimes even suspension from trading on the exchange.

If traders who are short at expiry cannot deliver the bonds that they intend to deliver (usually the CTD), they will need to deliver another deliverable bond, which will invariably be more expensive (essentially they will be paying the Gross Basis at expiry).[§]

[§] The Gross and Net Basis is essentially the same at expiry (as the repo rate has less impact). This will usually be close to zero for the CTD, but depending on the nature of the deliverable basket, this could be meaningful for other deliverable bonds.

Delivery settlement risk (cont)

Operational risk is a key consideration when making delivery, and it is critical to ensure that back office processes are sufficiently robust and that the settlements team is fully focused on ensuring successful settlement (or flagging any potential issues).

The ability to make delivery can often be contingent on the settlement of other trades (cash or repo), which creates asymmetrical settlement risk. It is usually inadvisable to be in a position where the ability to settle a futures delivery is contingent on the successful settlement of another transaction.

Usually, traders who go to delivery will ensure that they have the bonds (either in cash or repo) in their 'box' at least a few days before the delivery date. In some cases they will use segregated accounts to ensure that the bonds are not inadvertently 're-used'.

Given the potential for failing the settlement on the end leg of a repo trade that runs to the futures delivery (ie part of a net basis trade), it is standard practice for futures related trades to 'go over' the contract date, making it explicit that the delivery option lies with the counterparty reversing the repo. With European futures contracts, for example, futures related repo trades usually end on the 20th of the contract month (roughly a week after the delivery date). Futures related repo trades to the actual delivery date seldom occur, given the risk of a settlement fail.

Delivery settlement risk: the March 2001 Bobl squeeze

In 2001, the March 5yr German government bond future (the ‘Bobl’) was successfully manipulated through a ‘squeeze’ on the deliverable basket, in particular the CTD.

The futures basket was unusual in that the CTD was an old 10 year bond (DBR 6.5 10/05) that had rolled down the curve and was eligible for delivery into the OEH1 contract. This was a relatively small (€ 10.25bn) issue, and relatively illiquid (much of it was thought to be held by buy-to-hold investors). Furthermore, it was a small basket of bonds, with the next CTD around 40c away in net basis terms, and the most expensive bond in the basket around 90c away. The total face value of the basket was a mere €43.1bn.

In February 2001, open interest for the contract began to rise significantly, reaching an equivalent value of around €57bn: larger than the value of the underlying basket and five times that of the CTD.

Unbeknownst to the market, the manipulator had built up a significant long position in the H1 contract (hedged by an equivalent short position in the M1 contract). They had also built up a significant long position in repo of the DBR 10/05 over delivery, as well as the next two cheapest to deliver bonds.

In the final days before expiry, open interest remained stubbornly high. At the same time, the repo liquidity in the DBR 10/05 dried up (as the manipulator withdrew supply), creating a surge of settlement fails. This meant that anybody short the future would struggle to deliver the CTD. A scramble to borrow the next two CTDs ensued, which also began to experience fails.

As the ability to make delivery with anything other than the most expensive bonds faded, so shorts rushed to buy back their futures, forcing the price ever higher. On the morning of expiry, the basis of the 10/05 traded at a low of -70c (ie the future traded 70c above ‘fair value’).

Eurex subsequently set long position limits for members to ensure that similar squeezes could not happen again.

Repo trading strategies and opportunities

For repo 'specials' traders,[§] the relationship between government bond futures and repo rates is one of the most important aspects of their role. They will carefully analyze futures deliverable baskets, and monitor closely the relative value (ie bases) between futures contracts and cash bonds. From this they will try to determine whether repo rates are cheap or expensive, to predict potential client (and trader) flows, and how best to be positioned (or 'axed').

Owning the CTD on repo over delivery in many respects is akin to being long the option to deliver into the future, should the future contract become relatively expensive (ie negative net basis). A common strategy is therefore to go long the CTD repo (ie reverse repo) over the delivery date. However, as with any option, it is important to understand what is its fair value (in this case the cost of the option is the spread between the GC rate and the CTD specific repo rate). Here, factors such as the size of the issue (and more importantly the 'float', ie how much is available in the repo market), the structure and relative expensiveness of the deliverable basket, as well as futures open interest. But in general, many would consider that owning the CTD over delivery, from an asymmetric risk perspective, is generally a good option. Accordingly, the CTD repo over delivery usually carries a fair degree of premium.

In the event that the futures price does spike relative to the CTD price (negative net basis), repo traders who are long the CTD repo now have to make a choice as to whether to sell the repo (which should have tightened in line with the IRR), or to sell the future (usually hedging by going long the next calendar contract) and make delivery (shorting the bond into the contract). The latter will usually be more profitable, particularly if the ARR lags the IRR, but entails delivery settlement risk, as well as having to unwind the resulting short basis position post delivery.

However, one of the risks of being long the CTD over delivery is lending it out in the short-dated market. If it suddenly richens in value, say as a result of the future becoming relatively expensive, you may not get it back (see Delivery Settlement Risk).

[§] 'Specials' traders make markets in repo rates (for varying terms) in specific bonds, rather than for generic collateral types (in many respects mirroring the role of market-makers in the underlying bonds). They are less concerned with outright repo rates, and instead focus more on the relative value of specific repo rates: ie the spread between general collateral (GC) and that of the specific bond; which is essentially what they trade.

Repo trading strategies and opportunities (cont.)

As with any option, it may make more sense to sell if the price is too high. Accordingly, it is not unusual for repo traders to go short the CTD in repo over the delivery date. Often, they may do this early in the roll (say, soon after the relevant contract becomes the front month) if they feel that the premium to GC is too expensive, and particularly if the repo is relatively ‘easy’ in the short-dated market.

Often a CTD bond will not become expensive in the short-dated market until close to expiry (when supply and demand becomes more skewed). Thus, a common strategy is to ‘sell’ (ie repo out) the CTD repo over delivery early in the roll (ie when the contract becomes the front month), ride the carry for the first two months or so, and ‘buy’ (ie reverse) the bonds back for the final weeks. While the spread at which it is reversed for the final weeks may be more expensive than the spread at which it was originally repo-ed, the carry from the first period of the trade can be more than enough to make the entire trade profitable. In fact, a twist to this strategy is to turn the position around and go long the CTD repo over delivery for the final weeks (if the trade goes to plan, this is akin to being paid to own the delivery option).

Example:

Trade date 6/16/22		Repo €100mm DBR 0 8/31 6/21/22-9/20/22 @ -0.70%	[91 days]
From 6/20 to 8/19		Reverse €100mm DBR 0 8/31 T/N @ avg -0.30%	[62 days]
Trade date 8/19		Reverse €100mm DBR 0 8/31 8/22/22-9/20/22 @ -0.90%	[29 days]
	(or	Reverse €200mm DBR 0 8/31 8/22/22-9/20/22 @ -0.90%)	

Repo trading strategies and opportunities (cont.)

Analyzing the optionality value of the futures contract can also provide trading opportunities, assessing the probability of a CTD switch and determining whether this is fully priced into the relevant deliverable repos. A relatively cheap repo for a ‘switchable bond’ could be worth owning, particularly in times of underlying bond market volatility or where there is the possibility of a big move in yields.

Taking long or short forward-forward repo positions in the CTD for the next contract, based on the IRR of the futures calendar roll, is another common strategy (sometimes in combination with taking the opposite position through the futures roll).

Another consideration can be whether a CTD bond drops out of the futures basket after a contract expiry. In this case it is quite likely that it will cheapen relative to the swaps curve once it ceases to be ‘in play’, which should imply a more expensive repo rate over delivery.

Otherwise, as part of their market-making mandate, specials traders may see opportunities to take long or short bases positions (gross or net), or even to take views on the futures calendar roll, based on their feel for, and observed flows in, the repo market.

Importantly, ‘r’ is not a constant in pricing bond futures: it is an actively traded variable that can have significant impacts on both bond and futures prices.

Key government bond futures contracts

Europe

Eurex:	Germany	30yr Buxl	10yr Bund	5yr Bobl	2yr Schatz
	France		10yr OAT	5yr OAT	
	Italy		10yr BTP		
	Switzerland		10yr Gvt Bond		
MEFF:	Spain		10yr BONO		
ICE:	UK	30yr GILT	10yr GILT	5yr GILT	2yr GILT

N America

CME:	USA	30yr Treasury	10yr Treasury	5yr Treasury	2yr Treasury
TMX:	Canada	30yr Gvt Bond	10yr Gvt Bond	5yr Gvt Bond	2yr Gvt Bond

APAC

OSE:	Japan		10yr JGB	5yr JGB	
ASX:	Australia	20yr Gvt Bond	10yr Gvt Bond	5yr Gvt Bond	3yr Gvt Bond
	New Zealand		10yr Gvt Bond		3yr Gvt Bond

r is not a constant

Author: Andy Hill, ICMA
andy.hill@icmagroup.org

This presentation utilizes bond and repo price data extracted from Bloomberg, as well as Eurex and CME futures prices. In some instances, this has been supplemented with proprietary data, mainly for illustration purposes. ICMA kindly acknowledges the data sources. The equations used in this presentation have been derived by the author.