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# A practical intro to trading Bond Futures Basis: What is it and how does it work?



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Around half-way into 2022, something strange started happening in the UK government bond market — a product that usually exhibits stability and

boredom suddenly became exciting and volatile, rallying an amount that hadn't been seen for a long while, making savvy traders millions and losing others the same.

That product is **bond futures basis**.

It became apparent to me that there is a lack of understanding amongst both laypeople and professional traders around what bond futures basis is and how it works. In this post we will go through the following things that I've learned over the past year:

1. Why does it exist?
2. What is the *deliverable basket*?
3. What is a *CTD*?
4. What is the difference between *gross basis* and *net basis*?
5. What is a *CTD switch*?
6. What kind of market moves cause a CTD switch?
7. How does CTD switching impact bond futures basis?
8. Valuing the bond futures basis

## **Why does it exist?**

The first point of call is to recognise why there is a difference between the price of a bond future and that of its underlying bond.

*(A bond future is a contractual agreement to purchase a bond – the underlying – at some date in the future. It has a price that is different to the underlying bond*

*itself.)*

Say we choose to buy a bond future that delivers the underlying bond in 3 months time instead of buying the underlying bond itself today. This means three key things:

1. **Accrued interest:** We are *missing out on the accrued interest* from the coupon payments on the bonds that we would be getting if we owned it from today. This depends on the bond's coupon.
2. **Financing cost:** We are *not having to pay the financing rate* on the cash that we needed to borrow in order to buy the bond today. This depends on the bond's repo rate.
3. **Delivery optionality:** For a short position in the future, there is the *option to choose which bond you deliver as the underlying*. The value is usually close to zero, so we will get more into this in the next section, and in this one will focus on points (1) and (2).

Since there is usually a difference between the coupon on a bond and the repo rate, then all else being equal there will be some advantage between choosing the future over the bond, or vice versa. But by principles of no arbitrage, this needs to be accounted for by some price difference between the two.

For example, if the coupon on the bond is 5% and its repo rate is 0.5%, then there is a clear advantage in buying the underlying bond instead of the bond future: You earn accrued interest on a 5% coupon, and only have to pay 0.5% to borrow the funds to buy the bond, earning a net 4.5% annualised.

This means that the cash price on the underlying bond needs to be a lot higher than the price on the future to offset this advantage, in this example.

And that is precisely why there exists a difference: to offset the fact that in most cases there will be a clear advantage in choosing between buying the underlying bond at spot today or buying the future.

This price difference is the *bond futures basis* (pretty much).

## The deliverable basket

It's not strictly true to refer to a specific underlying bond when talking about a bond future, because whoever is short a bond future has a number of bonds that they are allowed to deliver, and it is up to them which one gets delivered. This essentially means there is a **selection of underlying bonds**. This selection of bonds is referred to as the **deliverable basket**, and the number of bonds in it can vary across different bond futures.

This choice of bond to deliver is referred to as **delivery optionality**, and it has some value. I.e. there is *value in having the choice*.

For example, consider the UK government bond future, expiring in September 2022. The deliverable basket consisted of 5 bonds:

- 1.000% UKT 2032
- 4.250% UKT 2032
- 0.875% UKT 2033
- 4.500% UKT 2034
- 0.625% UKT 2035

On the delivery/expiry date of the future, holders of the bond future can be delivered any one of those bonds, and they have no choice in which one gets delivered to them. This brings us back to the point (3) from the previous section - *delivery optionality*. Whoever has a short position in the future has the option to deliver any one of the bonds in the deliverable basket to the holder of the future.

In practice, most of the time there will only be one bond that it is clearly advantageous to deliver. This is the **cheapest-to-deliver (CTD)** bond, which we will discuss now, and it is why the delivery optionality is usually close to zero. (If it is obvious which bond is the CTD, then there is no real optionality there, because you have no incentive to deliver anything other than the CTD.)

## The cheapest-to-deliver bond

Consider the following trade that you intend to hold until the delivery date of the bond future:

1. Buy one of the bonds in the deliverable basket today, funded by borrowing in the repo market, and simultaneously...
2. ...sell the bond future, with the intention to deliver the bond that you bought in step (1) to people that bought the bond future from you.

This is a *long basis trade* (long an underlying bond vs short the bond future). In most cases there will be a single bond within the deliverable basket that is the most cost-effective for you to own on the above trade, thus making it literally the cheapest-to-deliver bond. This bond is the *CTD*.

But what characteristics drive whether or not a bond is the CTD? It will be the characteristics that drive profit or loss by holding the bond for the duration of the trade:

- **Financing/repo rate** (how much it costs to borrow cash to fund the bond purchase)
- **Coupon accrual** (how much interest you earn from the bond coupon)
- **Curve steepness.** Consider two bonds in the deliverable basket. If the spread between the two is very high/steep, then the longer bond is more likely to be the CTD because it has better *roll-down*.
- **Cash price.** A low cash price literally means less cash is needed to purchase the bond.

The bond in the deliverable basket with the most attractive combination of these will be the CTD.

## Gross basis vs net basis

Let's get into a bit of basic maths. We will show exactly how the basis is calculated, and what the valuation differences are between what we call **gross basis** and **net basis**, and how these relate to the characteristics bullet-pointed in the previous section.

First we need to understand what a **conversion factor** is. Each bond has a conversion factor, and it is a number that essentially equalises each bond. For a given bond, the gross basis is the difference between the bond price and the futures price, with the futures price multiplied by the bond's conversion factor. (Don't worry too much about how the conversion factor number is actually computed.)

Thus the **gross basis** is

$$B_{\text{gross}} = P - (f \times CF),$$

where  $P$  is the bond price,  $f$  is the futures price, and  $CF$  is the conversion factor for the bond. The **net basis** is the gross basis adjusted for the carry to delivery date from owning the bond. This means that we just use the bond forward price instead of the actual price:

$$B_{\text{net}} = F - (f \times CF),$$

where  $F$  is the forward price on the bond starting on the delivery date of the bond future. We can work with these formulas to represent the gross and net basis intuitively, which we will do now.

Start by rearranging the net basis formula:

$$(f \times CF) = F - B_{\text{net}}.$$

We can substitute this formula for  $(f \times CF)$  into the formula for gross basis:

$$B_{\text{gross}} = P - (F - B_{\text{net}}) = (P - F) + B_{\text{net}}.$$

Conceptually, the difference between the forward price of a bond and its spot price is exactly the carry on the bond up to the forward date. So if we let  $P - F = \text{carry}$ , then

$$B_{\text{gross}} = \text{carry} + B_{\text{net}}$$

Now think back to the first section in this post where we outlined why there is a difference between the underlying bond price and the futures price (i.e. why there is a gross basis). They were accrued interest (1) and financing cost (2) (the sum of which is *carry*), and delivery optionality (3).

Now we need to understand that since gross basis is a trade-able product, it won't always be priced perfectly (i.e. it can be too rich or too cheap). Let's call this *mispricing*. So gross basis consists of carry, delivery optionality, and mispricing:

$$B_{\text{gross}} = \text{carry} + \text{optionality} + \text{mispricing}$$

Looking at the last two formulas, it's clear that the net basis is just the *optionality* and *mispricing* components:

$$B_{\text{net}} = \text{optionality} + \text{mispricing}$$

Remember we described the net basis as "gross basis adjusted for carry to delivery". We can see this here! The conceptual formula is exactly the same

except with the *carry* component removed.

## Net basis and the CTD

There is a fundamental property of the net basis: the bond with the lowest net basis is the CTD. We can think about this intuitively, using our newfound understanding that the net basis is *optionality + mispricing*.

For now, let's assume the market is pricing gross basis perfectly, so that there is no *mispricing* and the net basis is just equal to the *optionality*.

Imagine that a single bond in the deliverable basket is far and away the CTD, which is usually the case anyway. Running a long basis position with this bond means there is very little (almost zero) optionality. This is because there is no reason why you would decide to deliver anything other than this bond to holders of the future, so the value of your optionality is basically zero.

Now imagine that you run a long basis position with the bond that is the most expensive to deliver. Your optionality on this trade is huge - it would be very cost-effective to use the optionality that you have to change from owning this bond to owning another one that is much cheaper to deliver. This then follows for all bonds between these two in the deliverable basket.

So the bond with the lowest net basis has the lowest optionality (simply from the formula), which means it must also be the CTD per the intuition above.

## Summary so far

There's a lot to unpack in the above, so let's take a breather and run through where we've got to:

1. There is a difference between the future price and its underlying bond price because of carry on the underlying bond and the optionality you have when being short a future.
2. This means that gross basis can be conceptually thought of as the sum of *carry*, *delivery optionality*, and *market mispricing*.
3. Within the deliverable basket of bonds, there is a single bond that is the cheapest-to-deliver (CTD), meaning that it is the most cost-effective bond to run a long basis position into the delivery date (long the bond and simultaneously short the future).
4. The net basis is exactly the gross basis with the carry to delivery accounted for, meaning that it consists of just *optionality* and *market mispricing*.
5. The bond with the lowest net basis is the CTD.

## **What is a CTD switch?**

As we now know there are a number of bonds in the deliverable basket that can be delivered to holders of the future, but in practice only one is the CTD, and it is this bond that will be delivered.

Within the deliverable basket it is possible for the CTD to change from one bond to another, which is called a **CTD switch** - this occurs when the market moves in such a way that a new bond becomes the one that is the cheapest to hold on a basis trade to delivery. This is a major and uncommon market event!

## **Which kinds of market moves cause a switch?**

Let's use an example to demonstrate this, with our newfound understanding of the drivers behind the *net basis* on a bond in the *deliverable basket*, and

what kind of market moves can change the value of these drivers.

Consider the deliverable basket for the Gilt future that we listed above. For a long while the CTD in this basket was the 4.25% 2032 bond. This is because it demonstrated, by a long way, the best carry if you were to hold it on a long basis trade into the delivery date of the future contract, which at the time was some time in September 2022. The next-in-line would be the 4.50% 2034 bond, if market moves permitted it...

Then very quickly, as global financial markets started to price more aggressive hiking of interest rates by Central Banks and higher long-term interest rates along with it, the following happened:

- Bonds sold off a lot (interest rates higher).
- Bonds with a higher PVBP (*Price Value per Basis Point* move in yields) drop more in cash price.

Since the 2034 Gilt (mentioned above) had a higher PVBP, it gained a cheaper cash price more quickly → It got very close to being CTD, but didn't quite get there!

Then another thing happened:

- The spread between the 2032 Gilt (CTD) and the 2034 Gilt (next-in-line CTD) started to steepen.
- A steeper spread between the two meant that the 2034 had a more attractive *roll-down*.

From the very start of this post, we saw that cash prices and carry/roll-down contribute to a bond being the CTD. And before long the two market events above saw the 2034 bond catch up as the cheapest-to-deliver, and was the official new CTD in the deliverable basket.

### **CTD switches and their impact on bond futures basis**

As we saw before, gross basis is comprised of the following:

$$B_{\text{gross}} = \text{carry} + \text{optionality} + \text{mispricing}$$

In the last section, we showed that a selloff in the global bond markets and a steepening in the spread between the 2032 bond and the 2034 bond saw us get close to a CTD switch from the 32s to the 34s.

As the market approaches this point, there becomes a big spike in the optionality component. Suddenly you have two bonds that could potentially be eligible for delivery — strong optionality for the person who is delivering bonds to holders of bond futures!

As this optionality grows, the value of gross basis needs to be considerably higher, and this is where the huge moves in a product that usually moves very little caught a lot of people off-guard, and made others millions!

### **Valuing gross basis**

Since gross basis is a trade-able market product with (usually!) high liquidity, it is potentially very profitable to compute the **fair value (FV)** of it.

You could then decide that it looks *rich* or *cheap*, and then either sell it or buy it, hopefully booking yourself a short-term profit as the market reprices, at which point you could then close your trade.

Let's look back at the important formula we saw before:

$$B_{\text{gross}} = \text{carry} + \text{optionality} + \text{mispricing}$$

The goal of computing the fair value (FV) of gross basis is to determine the value of the *mispricing* component and find a trade to enter. You do this in the following way:

1. Compute the *carry*.
2. Model the *optionality* value.
3. Observe where gross basis is trading in the market.
4. Rearrange the formula for *mispricing*, and then buy or sell depending on what it is!

This seems deceptively simple, but modelling the optionality is more subjective than it might seem, and different analysts/traders will have different ways of computing it — some good and some not so good. This means that the FV on the basis is not obvious!

When we get close to a CTD switch, those savvy traders that get ahead of the game, and notice an increasing *optionality* value before others, will be able to go long the basis as they attach a FV higher than the prevailing market prices.

*On the flip side*, as these unusual moves send the market into a frenzy when basis increases massively in value and people who are short the basis get squeezed out (i.e. they have to stop-out of short positions), the market can quite quickly *overprice* the basis value.

Again, those traders with a good FV model and an appreciation for market positioning can get short the basis or take profit on their long positions.

### **And that's it!**

This is a pretty brief and very practical introduction to the bond futures basis. Personally, it was a concept that I struggled the most in developing an understanding of, and I'm sure there are still some elements of misunderstanding on my part.

But I hope that this provides a welcome opening to the concept, and please feel free to counter anything I've mentioned in the comments below.

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**Written by Oliver Price**

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chris s

Feb 12, 2024

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2 replies



Aaron Bartlett

Dec 15, 2023

...

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1



1 reply



Browarren

Dec 6, 2023

...

Excellent job.



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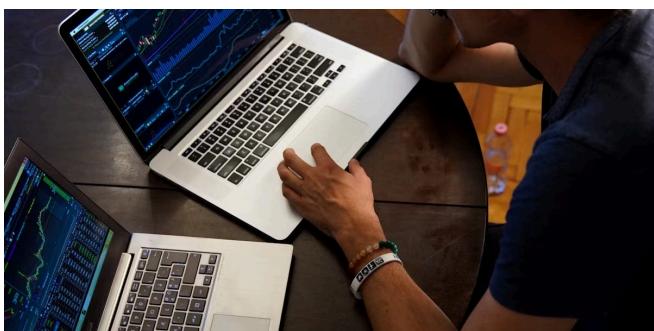
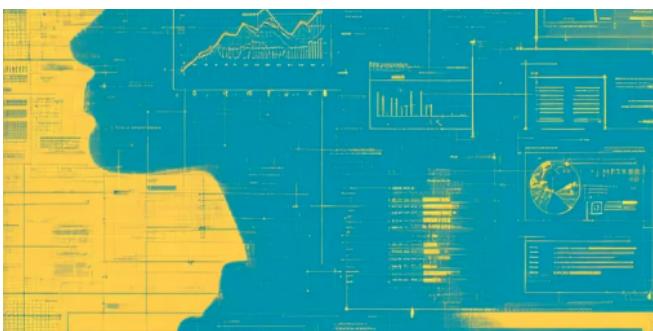


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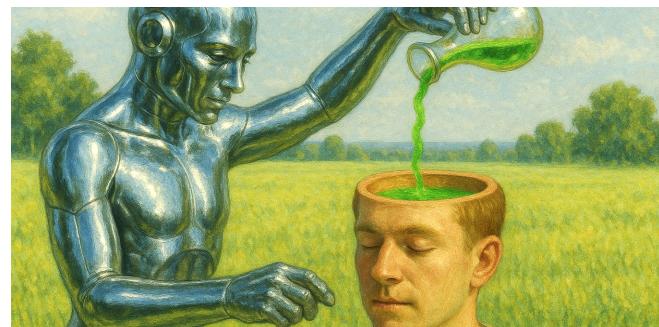


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